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Proceedings of the International Conference on Innovation, Technology, Enterprise and Entrepreneurship

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ICITEE 2019
Kingdom of Bahrain

Under the patronage of His Excellency, Dr. Majid bin Ali Al Nuaimi, Minister of Education and Chairman of the Higher Education Council in the Kingdom of Bahrain



This proceedings is dedicated to Prof Waheeb Al-Khaja, Chairman of the Board of Trustees of Applied Science University, for his vision and tireless efforts in transforming the University.

International Conference on Innovation, Technology, Enterprise and Entrepreneurship – ICITEE 2019 Kingdom of Bahrain

Edited by

Ghassan Aouad

Paul Ivy

Maryam Ali

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Preface

The complex challenges of the 21st century require complex solutions. This indicates a need to provide an inter-disciplinary forum where the most serious problems affecting current and future opportunities in the areas of technology, innovation and entrepreneurship can be discussed.

The International Conference on Innovation, Technology, Enterprise and Entrepreneurship (ICITEE) jointly organised by Applied Science University and London South Bank University (LSBU) is timely as it covers topics related to pressing issues affecting productivity and performance through innovation and the use of technological advances. The proceedings of the conference include 69 papers from researchers from 16 countries (Bahrain, UK, Turkey, Canada, Spain, Italy, Australia, UAE, KSA, Lebanon, Kuwait, Jordan, Indonesia, South Africa, Nigeria, Kazakhstan).

The ICITEE conference will provide a common forum for researchers and practitioners specialising in a range of subjects related to the conference themes to present their ideas, best practices, and research findings.

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Section 1
Innovation

Innovation Vision of the Turkish Construction Industry: A Comparative Qualitative Content Analysis of Strategic Roadmaps

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Abstract

Construction plays a crucial role in Turkey's economic development, accounting for nearly 8-9% of GDP. The growing global competitiveness of Turkish contractors also contributes significantly to the balance of payments of Turkey. It is widely acknowledged that competitiveness of firms depends on national "innovation systems," that is shaped by government policy, and an innovation vision is needed at the industry-level as well as supporting mechanisms such as funding schemes for research and development in the priority areas, and platforms to enable knowledge transfer between various stakeholders. In this paper, we will discuss the innovation vision within the Turkish construction industry, by referring to various construction industry-specific reports. Specifically, we will investigate the vision and conceptualization of innovation in the "Construction Industry Roadmap" as a part of the 10th Development Plan that was prepared by the Turkish Ministry of Development. A comparative study has been carried out between this report and a white paper entitled as "Shaping the Future of Construction: Insights to redesign the industry" that was prepared by the World Economic Forum (WEF) by conducting a content analysis using NVivo. Although the content of two documents in terms of the "drivers" and "enablers" of innovation coincides to a large extent, the innovation was approached in a broader sense considering concepts such as "systemic innovation", "lessons learned", "disruptive innovation", "eco-innovation", "incremental innovation" and "open source innovation" in the WEF's report. Potential benefits of looking at the innovation system from a wider lens will be discussed as well as recommendations for further studies.

Keywords: innovation, strategic roadmaps, qualitative, construction.

1. Introduction

Construction industry is one of the driving industries in the world economy. It has special importance for a country's economy with its input-output relations with other industries and contribution to employment. Construction plays a crucial role in Turkey's economic development, accounting for nearly 8-9% of GDP. Turkish construction sector has undertaken an increasing volume of international commitments in recent years. According to the Engineering News Record (ENR) list in 2003, there were just 8 construction companies from Turkey. In 2018, 46 Turkish firms were in the ENR list. As of 2016, the total revenue of the Top 250 International Contractors was 468.12 Billion US Dollars, 5.5 % of which was carried out by the Turkish contractors (Engineering News Record, 2017). According to the 2023 vision of Turkish Contractors Association (TCA) (2011), there are four targets which are;

- To have at least 40 firms in the ENR's Top 225 International Contractors list and increase the share in the global construction market.
- To increase the number of innovative and technology-intense projects and increase their share up to 30% of all awarded contracts.
- To establish at least 5 EPC contractors operating in international markets.
- To invest at least 1% of profit in R&D activities and thereby increase innovation.

It seems that the first target has already been achieved as of 2016. However, there are also ambitious targets which are mainly related with increasing the innovation capability which necessitate deliberate strategies and policies. Innovation is considered to be an important source of competitiveness in international markets. As it has long been recognized as one of the key factors contributing to national economic growth, competitiveness, and higher living standards, industry strategic plans/roadmaps are prepared, and public policy instruments are designed to increase the innovation potential of contractors. Types of innovation vary from the gradual incremental change of current products to revolution, disruption, and reinvention of new industries (Sammot-Bonnici and Paroutis, 2013). Sundbo (2002) states that innovation can be forced by changes in markets and industries and generated independently by the

company's internal initiatives. The process of innovation is influenced by the decision maker's choice of strategic actions, and as of the last principle; innovation requires internal and external social networks to utilize new ideas and resources. Seadan and Manseau (2001) have reported country-specific observations drawn from case studies of 15 countries to discuss the effectiveness of public policy instruments to foster innovation in the construction industry.

In this paper, we will concentrate on a recent document prepared by the Turkish government to enhance the innovation potential of the Turkish construction industry. In the next section, we will summarize previous efforts carried out by Turkish Contractors' Association to develop strategic roadmaps. Then, the strategic documents that were used in the comparative analysis are briefly explained. Findings from the comparative analysis are reported as well as some conclusions.

2. Strategic Roadmaps in the Turkish Construction Industry

One of the pioneering strategic documents prepared for the Turkish construction industry was published by the Turkish Contractors Association (TCA) in 2004. In this document, the excessive emphasis was put on the importance of increasing the competitive capacity of Turkish contractors in the international markets. According to TCA's strategic plan (2004), improving productivity was the key to maintaining and increasing the competitiveness of Turkish contractors. To achieve competitive advantage in the international market, three strategic objectives were determined: enhancing the quality and improving the human capital and physical capital (TMB, 2004). In the physical capital improvement plan, the requirement of innovation for construction companies to maintain their positions in the highly competitive market is highlighted. Moreover, it was mentioned that an effective R&D network within the industry is needed to support innovation creation (TMB, 2004). It is also worth mentioning that the formation of collaborations and strategic alliances were recommended as a possible solution to the problems in the industry. In the document, although "innovation" was not pronounced directly, the objectives and proposed solutions to existing problems in the industry implied innovative approaches and practices.

In 2011, a workshop was organized by TCA with the participation of different stakeholders, such as contractors, professional managers, senior government participants, financial sector representatives, and academics. In the workshop, it was agreed that the strategic targets which were mentioned in the 2004 strategic plan are still valid. In addition to those, the primary objectives of the Turkish contractors and priority areas were categorized under six main groups as follows:

1. Institutionalization in the sector, collaboration, and improvement of sectoral reputation.
2. Overseas breakthroughs, branding, incentives, and accreditation
3. To solve urbanization problems in the country, improvement of legislation and regulation of the build-sell sector
4. Improvement of the consultancy sector and increasing the use of domestic construction materials in international markets
5. Developing alternative financing methods for infrastructure
6. Enhancing the human capital and R & D

It is interesting to note that in this document, the word "innovation" was used in combination with "use of advanced construction technologies" and "increasing the R&D activities and allocating a larger budget for R&D" was identified as the "strategy" to enhance innovation. There are no specific strategies or actions about how to enhance innovation except increasing R&D expenditure. It can be concluded that "innovation" become a strategic issue starting from 2010s in the Turkish construction industry. However, no specific strategic and/or action plans were prepared by the government or civil organizations. In the next section, we will investigate the most recent strategic document prepared regarding the Turkish construction industry and compare it with a global strategic report.

3. A Comparative Study of Strategic Documents considering innovation

In this study, two strategic documents, which are 10th Development Plan that was prepared by Turkish Ministry of Development (2014) and a white paper "Shaping the Future of Construction: Insights to redesign the industry" that was prepared by World Economic Forum (WEF) (2017), were used to compare innovation vision in the Turkish construction industry and vision in a global roadmap.

3.1 Strategic Plan of the Turkish Construction Industry (SPTC) as a part of the 10th Development Plan

Strategic Plan of the Turkish Construction Industry (SPTC) as a part of the 10th Development Plan is a strategic document that was prepared by the Specialized Commissions and Working Groups that carried out their studies under the Republic of Turkey Ministry of Development. The main objective of the SPTC is to formulate strategies and identify action items for related stakeholders to reach the Vision 2023 targets of the Turkish construction industry. Within the context of the SPTC, the vision of the construction industry was determined by considering the results of a SWOT analysis. In order to realize this vision, seven strategies, and nine strategic programs were determined. These strategic programs are "training", "technical consultancy services", "competition", "differentiation of services and collaboration", "expanding abroad", "user-oriented and sustainable built environment", "occupational health and safety", "innovation", and "coordination". Among these strategic programs, innovation is identified as one of the highest priority programs. The key themes that appear in SPTC presented in Table 1 reflect the innovation vision of the Turkish construction industry.

Table 1: Eight Key Themes from SPTC

Key Themes	
1.	Innovation system
2.	Research and development
3.	Technological foresight
4.	Collaboration
5.	Strategic alliances
6.	University-industry-public cooperation
7.	Innovation culture
8.	Technical consultancy

3.2 "Shaping the Future of Construction: Insights to redesign the industry" that was prepared by the World Economic Forum (WEF Report)

"Shaping the Future of Construction: Insights to redesign the industry" (WEF Report) was prepared by a working group consisting of academics, industry leaders and experts in the World Economic Forum (WEF) as a white paper in 2017. In the WEF Report, the aim is to present the outputs of the studies that are carried out by the working groups for creating and analyzing innovative ideas and discussing the possible effects of these ideas and the barriers that may hinder to implement these ideas. In the report, different challenges in six major areas that the construction industry has faced (Table 2) and the innovative solutions to these challenges are presented as separate cases.

Table 2: Challenge Areas Covered in the WEF Report

Challenge Areas	
1.	Project delivery
2.	Life-cycle performance
3.	Sustainability
4.	Affordability
5.	Disaster resilience
6.	Flexibility, livability, and well-being

3.3 Qualitative Content Analysis

The commercially available qualitative data analysis software NVivo was used for qualitative content analysis. The steps are summarized in Figure 1. First, both of SPTC and WEF Report are imported to NVivo software. Based on SPTC's context of the innovation program, eight themes are analyzed, and the results are added as initial key themes. Additionally, frequently occurred concepts are searched to evaluate

accentuated concepts in documents. With the help of Auto Code Wizard in NVivo, details of the WEF Report is gathered about particular themes into a node for further exploration. Auto-coding feature is designed to speed up the coding process for large volumes of textual content. Only the nodes related to innovation are taken from auto-coding outputs, and manual coding process is conducted for further exploration. The aim of manual coding is finding detailed innovation related themes. In this sense, the manual coding process is continued until the main themes and relationships between innovation and themes are reached. After reaching the main themes and their relationships, comparison diagram of strategic documents is drawn using NVivo Project maps option for graphic representation of the different items used to explore and present the connections in the data. As the final process of the flowchart, outputs come from the comparison diagram are interpreted. The process mentioned in the flowchart is examined in detail in the following paragraphs.

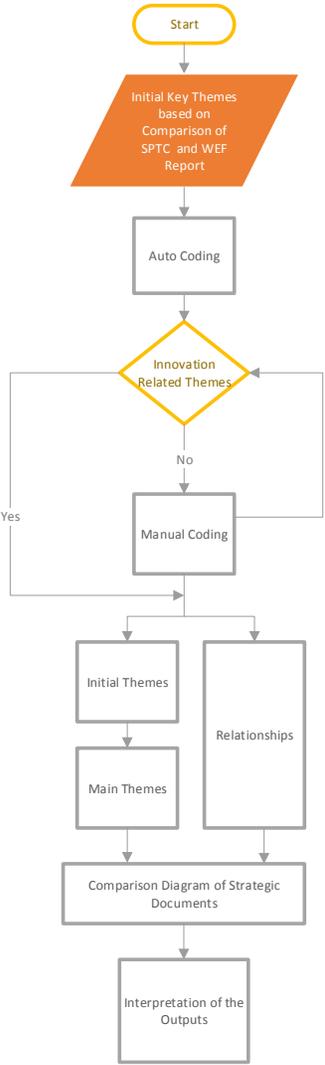


Figure 1: Flowchart of Qualitative Research

In SPTC, eight main steps are mentioned within the context of the innovation program. In the initial step of the content analysis, each of these eight steps was evaluated and determined as key concepts (see Table 1) that will be searched in the WEF Report. By using the “Text Search” option in the software, the occurrence frequency of these concepts was queried. As a result of the text search, it was seen that all the eight key concepts obtained from SPTC are mentioned in the WEF Report. Therefore, these concepts were assigned to both documents as common nodes. Furthermore, both documents were analyzed individually by using

of the font indicates the number of times the word or phrase was found. Furthermore, the software enables to see the wider context of the phrases found in the word tree. In this sense, "innovation" as the root, concepts mentioned related to innovation are shown in the tree. It allows to see the bigger picture related to innovation mentioned in the WEF Report.

As a result of this analysis, it can be seen that the WEF Report gives wide coverage to "Barriers to innovation" and "Innovation and solutions." Innovation types such as systemic and incremental innovation mentioned in the WEF Report were noticed through this word tree easily. Furthermore, the tree helps to observe why WEF Report gives importance to innovation and what can be done "to foster" or "to encourage" the innovation can be observed by the help of this tree.

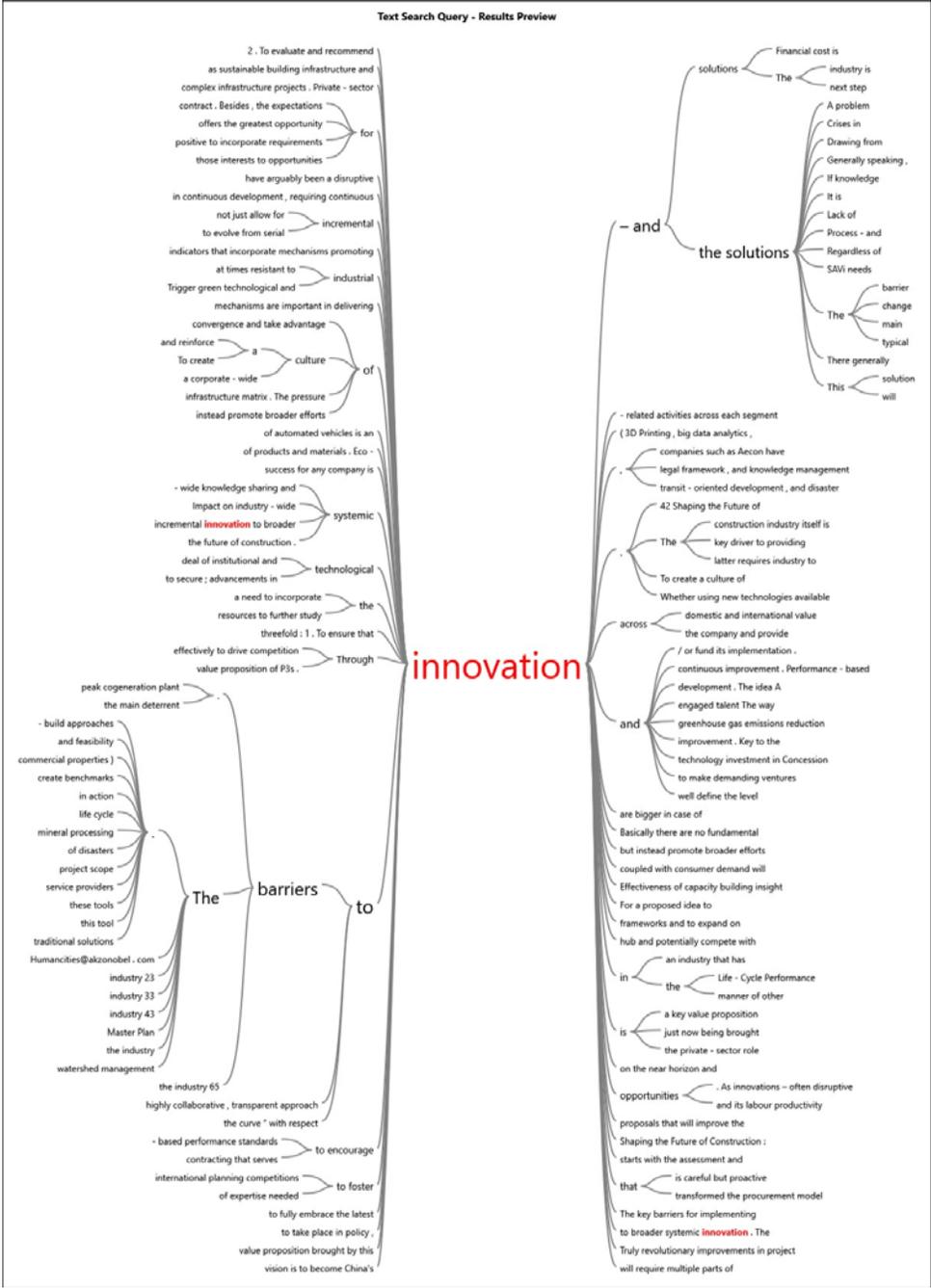


Figure 3: Word Tree for the Word "Innovation"

To consolidate key themes and their relationships reached from the initial themes, nodes can be visualized using cluster analysis. As an exploratory technique, cluster analysis diagrams provide a graphical representation of nodes to demonstrate similarities and differences. Nodes in the cluster analysis diagram that appear close together are more similar than those that are far apart. Grouping of nodes is based on the ratio of sharing similar words and coded similarly. For this study, a horizontal dendrogram type is used for cluster analysis, which is a horizontal branching diagram. Also, items clustered using Pearson correlation coefficient that is one of the offered similarity metrics by NVivo. When the horizontal dendrogram (Figure 4) is examined, similar themes are clustered together on the same branch and shown with similar colors, such as “Lessons learned” and “Value engineering”.

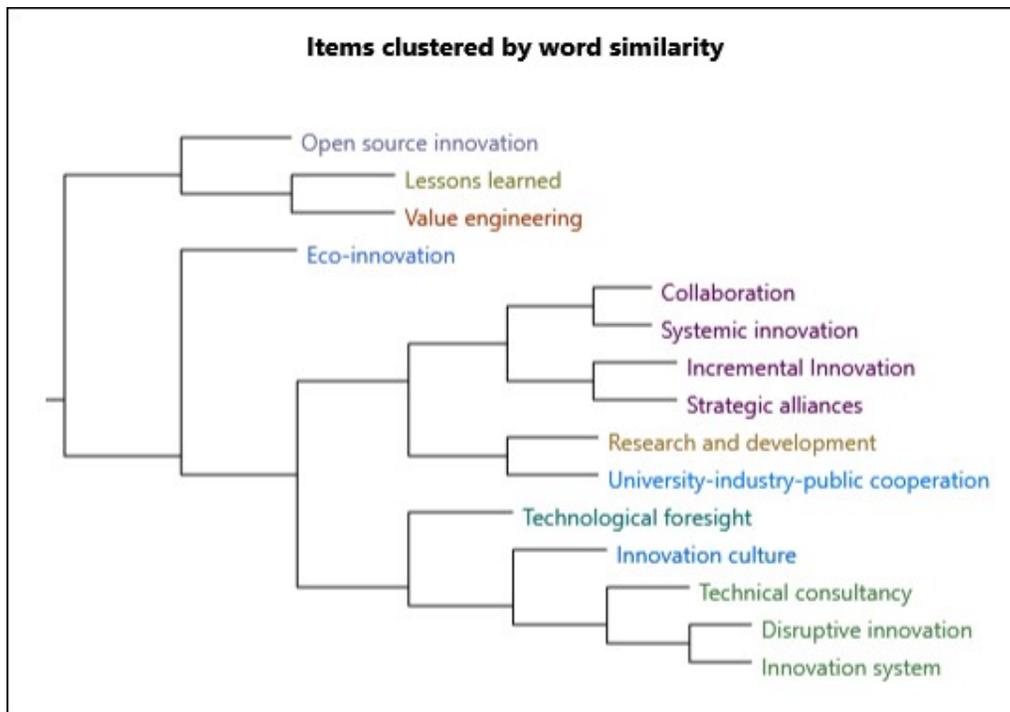


Figure 2: Items Clustered by Word Similarity

When the main themes and their relationships are created, a comparison diagram is created using NVivo comparison diagrams feature. The diagram is used to compare two of the same type of project items to see their similarities and differences. In this case, the WEF Report and SPTC are the selected cases, and their documents are shown as a pdf file symbol (See Figure 5). Since the themes are assigned as a node, the blue circles represent the assigned nodes. As it is seen in the figure, while similarities are gathered around eight nodes, there are additional seven nodes which is not even mentioned in SPTC.

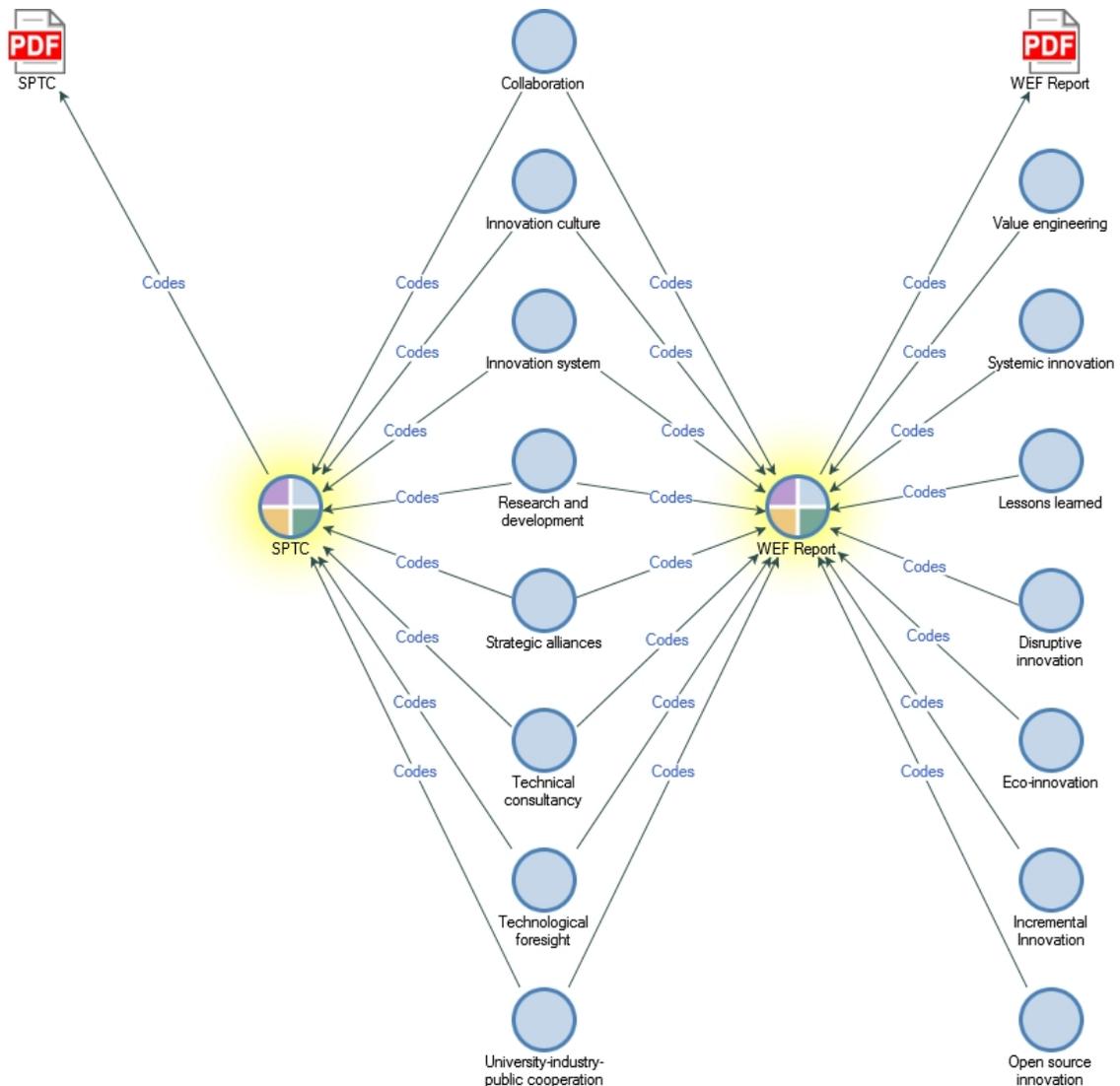


Figure 5: Comparison Diagram

4. Discussion of Findings

The main advantage of conducting data analysis using NVivo software is possibility to eliminate human error that would be expected to occur if the comparison were carried out manually. In addition to the human error, biases are eliminated to a certain extent, and this type of data interrogation enhances the overall impression of the data and credibility of the findings.

In this study, the core contents of the WEF Report and SPTC are analyzed and identified. Seventeen themes from WEF Report and eight themes from SPTC are determined. When the comparison diagram is observed given in Figure 3, both SPTC and WEF Report points out the necessity of developing an innovation system for a technology-oriented construction sector. Mutual connections exist between the reports. In this context, both documents recommend to take the following steps:

1. Creating an innovation system
2. Creating/preserving a culture of innovation in the sector
3. Determination of strategic priority research and development activities for the sector (BIM-building information modeling, lean construction, sustainability, waste management, etc.)
4. Conducting determination of technological foresight and R & D agenda as a regular work
5. Establishment of special support programs for the construction sector, and arrangements (incentives, etc.)

6. Developing public cooperation in order to support the R & D activities of NGOs
7. Establishment of platforms to improve university-industry-public cooperation in R & D activities
8. Effective use of existing mechanisms (technology transfer offices, etc.)
9. Creating good practice examples and benchmarking opportunities for the sector
10. Encouraging innovation through the selection of technical consultants based on qualification

As can be seen in the comparison diagram in Figure 3, while different types and novelty degrees of innovations are mentioned in the WEF Report, these subjects are either not referred or mentioned very superficially in SPTC. Key themes mentioned in the WEF Report are value engineering, systemic innovation, lessons learned, disruptive innovation, eco-innovation, incremental innovation, and open source innovation. Value engineering as an organized effort that analyzes the function of a process or a product is expressed in the WEF Report as an innovative solution throughout the life cycle stages of the construction projects in order to achieve affordability. Systemic innovation corresponds to the type of innovation that only generates value if accompanied by complementary innovations. In the WEF Report, it is mentioned as a need to evolve from incremental serial innovation to broader systemic innovation. Systemic innovation is given as a requirement to improve the future of construction. It also requires multiple parts of the industry to transform in tandem. Moreover, an outcome of the comprehensive industry collaboration proposes developing an outline to systemic innovation frameworks. In the WEF Report, consequent developments are needed to take place in policy, innovation, legal framework, and knowledge management and education systems in order to reach the full potential of the industry-wide-transformation. The ability to leverage valuable knowledge and lessons learned to early adopters across the company is mentioned as a factor to reduce redundancy and create process efficiencies. In this sense, the repetition of mistakes is avoided. If the knowledge transfer is to be successful, there must be an openness and richness in the communication of information and knowledge. Crucial knowledge gained from a project is not always documented and added value of lessons learned is not widely recognized as a contributing factor to project success. The WEF Report mentions that methods for evaluating and measuring the effectiveness of the life cycle lessons-learned program are needed to be established since it helps management to monitor, improve and illustrate the value that lessons learned provide to the life cycle. Furthermore, the WEF Report expresses that all relevant stakeholders need to communicate with external stakeholders to reach a common understanding about value, and all should be able to access lessons learned. Disruptive innovation helps to create a new market and value network and eventually goes on to disrupt an existing one. This innovation type is also referred in WEF document in which as a disruptive innovation, PPP is introduced as a key concept. In this sense, it is argued as a way of transformation of existing method for delivering large complex infrastructure projects. Eco-innovation, as the development of products or processes that contribute to sustainable development and elicit direct or indirect ecological improvements is another expressed theme in the WEF Report. In the report, the importance of eco-innovation is shown with the assessment and selection of goods and materials that respect people's health and environment, and focusing on sustainability has led to the necessity of eco-innovations. In addition to that, incremental innovation is mentioned as one of the keys to the industry's success. The incremental changes are not an option instead; it should be seen as a key to reach radical goals, out-of-the-box solutions, and executions. Moreover, it is stated that demanding improvements must not just allow for incremental innovation. Further, they should also promote broader efforts of innovation and continuous improvement. Truly revolutionary improvements in project execution need a transformation of the industry. In this sense, not only incremental innovation but also broader systemic innovation is necessary to evolve. As a more radical innovation concept identified as open source, is presented in the WEF Report. Since close innovation is limited to proprietary internal resources, including internal Research and Development, as a general definition, open innovation includes external resources to acquire ideas and skills (Curmi and Sammut-Bonnici, 2015). In this sense, open source innovation is characterized by opening the innovation process and its process that is essential for how stakeholders collaborate on ideas to make them become a reality in a complex project. The significance of open source innovation is to create a huge ecosystem of innovators who are sharing knowledge with others to create new resources instead of competing for scarce resources, which is highlighted in the WEF report. It can be concluded that WEF report considers different aspects of innovation and proposes more comprehensive strategies to enhance it when compared to SPTC. A richer picture of the innovation system is definitely more beneficial to develop effective strategies.

5. Conclusions

Innovation is a source of competitive advantage. It is a strategic theme mentioned in various roadmaps prepared to foster competitiveness of Turkish contractors in international markets. However, in majority of cases, innovation is considered as a “target” that can be achieved by increasing R&D expenditure. Moreover, it is highly associated with technological advances and innovation system is not conceptualized and expectations from this system are not well-defined. The aim of this study is to compare innovation as a concept that appears in the strategic plans in Turkey with a global report. Results of a comparative qualitative content analysis of two strategic documents, namely SPTC and WEF reports, are depicted. In SPTC, based on the analysis of the current situation of the Turkish construction industry, several strategies are proposed to enhance competitiveness and to increase the share of the Turkish construction industry in the international markets where “innovation” is identified as a high priority strategic program. In the WEF report, the challenges in the global construction industry are addressed, and the possible solutions to these challenges are proposed considering innovation in a wider perspective. Strategic themes that are not mentioned in SPTC include value management, lessons learned, and systemic, disruptive, incremental, open source and eco-innovation. A wider perspective is needed to formulate strategies to enhance innovation system in the construction industry.

Finally, it is argued that comparative qualitative research can help policy makers to understand the strengths and weaknesses of their strategic plans by comparing it with others. Policymakers can benchmark from other documents and incorporate alternative options and/or themes that would be helpful for their strategic plans. This study presents findings of a specific application, however it has a number of limitations. The two strategic documents that are used to demonstrate how qualitative content analysis may help strategic planning may not be directly comparable as their aims are not exactly the same as well as the dates. Analysis could be carried out considering various similar strategic documents rather than just one global report. The benefit of using content analysis, which is mainly, potential increase in the quality of plans, could not be monitored and validated in this study. Further studies are required to demonstrate potential benefits of utilization of comparative content analysis for preparation of strategic roadmaps.

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Innovation Management: Exploring The Energy between Management Innovation and Technological Innovation in the Context of Global Value Chains

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Abstract

The paper aims at building a conceptual framework that captures the intricate relationships between management innovation, technological innovation, and a firm's sustainable competitive advantages defined as the ability to upgrade within global value chains (GVCs). The conceptual framework address the drawbacks highlighted in the recent research studies about management innovation-performance relationship. While this research would offer an essential theoretical base to further develop an empirical study, it would also provide important practical insights. First, traditionally, startups build their business cases around proposing new technologies. While technological innovations offer a temporary competitive advantage, most startups often faile to develop fertilized management capabilities (management innovation) that sustain their initial success. Second, federal and provincial policies primarily promote high tech. Initiatives. While such initiatives gain political approval, there is no evidence to support the link between these high tech initiatives and SMEs' long-term success. On the contrary, as these startups grow, they lack managerial capabilities required to survive in the long run.

Keywords: Innovation management, technological innovation, management innovation, global value chains, Innovation system

1. Introduction

There is a substantial body of knowledge about innovation, its sources, drivers, processes, antecedents, and outcomes. As with many complex organizational concepts, the literature provides multiple definitions and typologies of the concept of innovation (Damanpour, Walker, & Avellaneda, 2009).

The typology that is most relevant to this research is the distinction between technological innovation and non-technological innovation, called in in this study management innovation (MI). Whereas technological innovations refer to technology-based innovations (Damanpour, & Aravind 2012), which can be codified and commonly associated with a process or product (Yam, Lo, Tang & Lau, 2011), management innovations pertain to new management practices, processes, structures or techniques (Birkinshaw, J., Hamel & Mol, 2008). Research about technological innovations has dominated the innovation literature and informed our understanding of the nature of innovation (Birkinshaw, J., Hamel & Mol, 2008). However, over the last decade, there was a surge of research studies about other types of innovation including non-technological / management innovation (Khosravi, Newton, and Rezvani, 2019; Damanpour, & Aravind 2012).

What literature tells us is that innovation, when it is properly implemented, would most likely result in improved organizational performance. There are a plethora of research studies that link innovation to performance improvement whether it is a financial improvement and/or capabilities enhancement (Azar and Ciabuschi, 2017; Damanpour, Walker, & Avellaneda, 2009). These studies are largely based on the conventional understanding of innovation as a technological-based innovation (Damanpour, & Aravind 2012). Despite the vast amount of research studies about the innovation-performance relationship, there are few areas that surprisingly have received little attention. First, there are relatively little research studies that investigate the relationship between different types of innovation and the impact of such a relationship on performance (Volberda, Van Den Bosch & Heij, 2013; Damanpour, & Aravind 2012); more specifically, the relationship between technological innovation and management innovation has not been not fully appreciated (Khosravi, Newton, and Rezvani, 2019). The second area is the role of context in investigating the relationship between management innovation and organizational performance (Khosravi, Newton, and Rezvani, 2019 and Azar and Ciabuschi, 2017). This can be attributed to the fact that management

innovations tend to be more complex and less visible than technological innovations (Azar and Ciabuschi, 2017). Also, the consequences of management innovation go beyond financial measures to include organizational and innovative capabilities which is difficult to measure (Khosravi, Newton, and Rezvani, 2019; Walker et al., 2015).

This study contributes to the existing body of knowledge on management innovation by addressing the following questions: how does the relationship between management innovation and technological innovation influence organization performance? Is there synergy that can be assumed from advancing one type of innovation over another? We address the shortcomings highlighted in recent research studies about the management innovation – performance relationship’s studies by incorporating the concept of the global value chain, which to the best of our knowledge, has not been used as a conceptual framework to analyze the complex relationship between management innovation and performance.

The next second provides a theoretical overview of management innovation and its relationship with technological innovation outlining the consequences of this relationship on organization performance. Then, we introduce the concept of global value chains. Finally, we propose the conceptual framework that connects management innovation with technological innovation in the context of GVCs.

2. Management Innovation

Innovation, as a concept, has been extensively researched, and its definitions, typologies, processes, sources, antecedents, and outcomes are often vigorously debated. Overall, the literature about innovation has distinguished between two different research paradigms (Volberda, Van Den Bosch, and Heij, 2013). The old industrial innovation paradigm which is informed by Schumpeter’s early work, who had coined the terms product and process innovations (Walker, Chen, and Aravind, Deepa, 2017; Schumpeter, 1943; Fagerberg, 2005). While the premise of product and process innovation is commonly associated with technological imperatives, it does not entirely disregard other forms of non-technological innovations; nevertheless, it emphasizes the logic of the rational perspective of developing and adopting innovations in an organization. The rational perspective argues that innovation is an invention that adds economic value and makes senses from internal, i.e. organizational, or external, i.e. environmental, perspectives. The new paradigm of innovation research has rapidly evolved around the concept of non-technological innovations that are associated with the way of work in an organization rather than a specific product or service. Researchers used different terms to refer to non-technological innovations (Zhang, Khan, Lee, S., and Salik, 2019), including organizational innovation, administrative innovation, and management innovation (Damanpour & Aravind, 2012). Volberda, Van Den Bosch, and Heij, (2013) argued that although these terms overlap “ administrative innovation, organizational innovation, and management innovation are not identical”. They posited that “the concept of management innovation is more encompassing.” Further, the concept of business model innovations also seems to overlap with the concept of management innovation. In this study, we adopt Hamel (2006)’s definition of management innovation that is “*a marked departure from traditional management principles, processes and practices or a departure from customary organizational forms that significantly alters the way the work of management is performed*”.

Birkinshaw et al. (2008) discussed two levels of management innovation: the operational level and the philosophical level. They argued that operational level is more researchable as it deals with specific tools and techniques that can be tracked and analyzed. Birkinshaw et al. (2008) were the first to introduce a framework that discusses how management innovation is developed in organizations. Over the past few years, there have been several published literature reviews about the concept management innovation including the works of Damanpour and Aravind (2012), Khosravi et al., (2019) and Volberda et al. (2013). Despite the recent surge of research studies, all the recent literature reviews highlighted the need for more research on the topic of management innovations.

To make the prima facie case for the necessity of the theoretical discussions presented in this paper, we propose the following constructs. First, the relationship between MI and technological innovation is still relatively under-researched. This relationship was normally conceptualized around the notion of socio-technical system theory, whereby technological innovations are associated with the technical core or technical system of an organization and management innovations are associated with social core or social system of the organization (Walker et al., 2015). The social-technical system theory argues that both systems need to coexist for an organization to perform. Hollen, Van Den Bosch, & Volberda (2013) proposed three possible trajectories of that relationship: 1) management innovation precedes technological innovation, 2) technological innovation precedes management innovation, and 3) simultaneous interactions between technological innovation and management innovation. The mainstream research supports the proposition that management innovation is a necessary precondition for technological

innovations (for example, Azar and Ciabuschi, 2017; Camisón, and Villar-López, 2012). Other researchers (for example, Hollen et al., 2013) argue that both types of innovations need to be combined over time in an intertwined way in order to achieve sustainable competitive advantages. On the other end of the spectrum, startups which build their initial success on adopting technological innovations are a case in point that suggests that technological innovation precedes management innovations in those startups.

Second, the relationship between management innovation and performance has not been fully explored (Walker, Chen, and Aravind, 2017; Azar and Ciabuschi, 2017). Khosravi et al. (2019) identified three types of outcome including financial performance, organizational capabilities and innovative capabilities. They argued that while management innovation drives organizational long-term success “ empirical studies regarding management innovation – outcomes relationship remains scarce”. Most of the studies focused on financial performance while missing aspects of competitive positioning, including effectiveness and efficiency. Unlike technological innovations, the consequences of management innovations on performance go beyond the financial performance to organizational capabilities which can be difficult to quantify (Damanpour, & Aravind, 2012). Thus, the extant literature does not seem to offer a framework to holistically assess the impact of management innovation on organizational overall competitive advantages and positioning (Azar and Ciabuschi, 2017).

Third, while many research studies highlighted various environmental factors, the full effects of context have not been fully captured. The role of context is important when investigating the complex and multidimensional innovation-performance relationship.

3. *Global Value Chain*

The Global Value Chain (GVC) approach provides an analytical framework that captures the movements of goods, services, capitals, ideas, and knowledge (know-how) within global networks. The GVC approach has gained importance as a means to engage in the discussion of international trade, global-local dynamics, understanding value creation processes, the formation of geographical specialization, and reflecting on regional and national policies (OCED, 2013; OECD, WTO-OMC, & World Bank, 2014). The GVC approach identifies linear value-adding steps between the key actors in a sector (Gereffi & Fernandez-Stark, 2011). It examines the specific characteristics and dynamics relevant to each step in a global value chain, including outsourcing and on/offshoring practices, which facilitate the analysis of governance structures present in these chains. The GVC approach focuses on several dimensions; among others, two key analytical dimensions have received the most attention: 1) the governance structure that explains the power asymmetry within GVCs (Gereffi et al., 2005; Gereffi & Frederick, 2009; Gereffi & Fernandez-Stark, 2011) and 2) the upgrading process through which a firm would climb up the value chain (Gereffi & Fernandez-Stark, 2011). For example, moving from being a raw material supplier to an assembly manufacturer to an original equipment manufacturer (OEM) to an original brand name manufacturer (OBM) to an original design manufacturer (ODM).

Because of the formation of GVCs, SMEs no longer need to possess huge infrastructure to engage in global value chains. Existing literature provides few insights into integration at the organizational level. The available research focuses on the extent to which a region or an economy is integrated into GVCs.

The GVC literature defined five different types of governance structure: 1) markets, 2) modular, 3) relational, 4) captive, and 5) hierarchy (Gereffi et al., 2005; Gereffi and Fredreick, 2009; Gereffi & Fernandez-Stark, 2011). As for the upgrading process, the VGC literature defined a number of possible upgrading trajectories including product, process, functional and inter-sectoral upgrading trajectory (Pietrobelli and Rabellotti, 2011; Gereffi & Fernandez-Stark, 2011; Elola et al., 2012).

4. *The Conceptual Framework*

Within the context of GVCs, success is measured by the ability of a firm to integrate into GVCs. Integration into GVCs consists of participation in GVCs and upgrading in GVCs. Participation refers to company capacity to systemically utilize its resources to produce goods or services that are valued by GVCs' players. Participation is normally evident by directly exporting goods or services; outsourcing; indirectly exporting goods and services, i.e., through other firms; and purchasing inputs directly from suppliers abroad. Upgrading refers to a firm's ability, once successfully plugged into GVCs, to learn, acquire, and develop the knowledge and expertise needed to climb to a higher value-adding position. Upgrading in GVCs is normally evidenced by the introduction of a new or substantially improved product or service, which has helped the company move to a higher value-adding position. For example, moving from being a raw material supplier to an assembly manufacturer to an original equipment manufacturer (OEM) to an original

brand name manufacturer (OBM) to an original design manufacturer (ODM). Upgrading capabilities have long been considered synonymous with firm-level innovative capabilities (Pietrobelli and Rabellotti, 2011; Morrison, Pietrobelli, & Rabellotti, 2008),

Analyzing the relationship between technological innovation and management innovation, and the consequence of this relationship on performance in the context of GVCs would arguably address some of the shortcomings that were highlighted in recent research studies about the management innovation-performance relationship's studies. First, the context of GVCs can be well-captured through the different governance structures within a GVC. That provides, more or less, a controlled context in which the study can be conducted. Second, the accumulative influences of performance improvement of an organization on the context can also be investigated through observing the changing roles of organization with GVCs and their impacts on forming the corporate governance of the GVC in which they operate. Third, performance improvement that goes beyond the so-called financial measures can be measured by a firm's ability to participate and upgrade in GVCs. Performance improvement in GVCs is assessed through the ability of an organization to participate and upgrade in GVCs.

The conceptual relationship between technological innovation, management innovation, and performance in the context of GVCs could be thought of as a matrix as shown below:

Innovation Type	Participation	Participation
Technological Innovation	√	X
Management Innovation	√	X
Technological and Management Innovation	√	√

Figure 1: Conceptual relationship between technological innovation, management innovation and performance in the context of GVCs.

Three scenarios can be drawn from the above diagram constituting future research hypothesizes. First, when organizations develop or acquire technological innovations without rethinking their management practices. In this case, these organizations would enjoy temporary competitive advantages that result from their technological innovations, which would enable them to break into GVCs. Nevertheless, due to their inability to maintain and manage their technological edge, their competitive advantage would fade, and eventually, they would lose their competitive position in the GVCs. Captive and hierarchical types of governance would evolve, reflecting a high level of power asymmetry in GVCs and the tendency of lead firms to adopt a vertical integration strategy. Accordingly, clusters are less likely to emerge in such situations. This is the case of startup companies which fail to develop fertilized management capabilities (management innovation) which would enable them to build on their initial success.

The second scenario is when organizations develop management innovations without investing in a new product or service technology. As per Azar and Giabuschi (2017) and Khosravi et al. (2019), management innovations would result in enhanced organizational capabilities which, probably, would be reflected in improved effectiveness and efficiency. Thus organizations would most likely be able to maintain competitive parity with their peers, and, therefore, maintain their position in GVCs. However, breakthrough performance improvement is less likely in the short-term. Captive and hierarchical governances (Gereffe et al., 2005) are most likely to emerge where lead firms would have considerable power over other firms. That reflects the existing situations where US multinational firms have dominated the existing Canadian supply chains. However, in the longer term, these management capabilities developed in these firms would help reduce the cost of technology adoption knowledge transfer and learning. Hence these firms would gradually build move up in the GVC and influence the overall context in the GVC to move away from hierarchical and captive structure toward more modular and relationship structures (Pietrobelli and Rabellotti, 2011). It is important to note also that the role of lead firms in that context which can play an important role in helping local firms improve their capabilities and adopting technologies that align with the technologies adopted in these lead firms (Ernst & Kim, 2002; Bessant et al., 2012).

In the third scenario, organizations not only have successfully introduced technological and management innovations but also built synergy between them. It is postulated that these organizations would be able to fully integrate into GVCs; i.e participate and update in both directions, upstream and downstream, investing in knowledge-based capital (KBC). Relational type of governance (Gereffe et al., 2005) would most likely evolve, promoting learning, networks, and clusters (Tsekouras & Papaioannou, 2002; Bessant et al., 2012). Research has shown that knowledge transfer is commonly associated with innovations. Pietrobelli and Rabellotti (2011) discussed two important examples that reflect such dynamics. The first is the Taiwanese computer industry, where a number of local players were able to

develop sufficient upgrading capabilities to become OBM (Kishimoto,2004). The second is the emerging of the metalworking cluster in Espirito Santo in Brazil (Villaschi et al., 2007). Further, the synergy between both types of innovation would enhance organizational resilience to adapt to rapidly changing technologies. Walker et al. (2017) argued that management innovations follow the logic of creative accumulation, whereas technological innovations follow the process of creative destruction.

5. Conclusion and further research

This paper presents a conceptual framework to analyze the relationship between management innovation and technological innovation and the consequences of this relationship on performance. The paper is based on well-identified gaps in the literature: 1) the relationship between management innovation and technological innovation has not been fully explored, and 2) management innovation – performance relationship is not fully appreciated. The study incorporates the concept of global value chains to address the shortcomings highlighted in the existing research studies that investigated management innovation-performance relationship. To the best of our knowledge, the concept GVC has not been used as a framework to analyze innovation-performance relationship.

The presented framework suggests three possible scenarios which capture the three trajectories of the relationship between management innovation and technological innovation in the context of GVC. We argue that the proposed framework offers an essential theoretical base to further develop an empirical study as each of the above scenarios reflect a theoretical hypothesis.

For the empirical study, we propose an inquiry process that embodies the Sequential Exploratory Strategy of mixed methods approach (Creswell, 2009) incorporating case study analysis and quantitative analysis. For the case study analysis, we propose to employ the replication logic of the multiple case study research strategy (Yin, 2003), whereby three Canadian SMEs will be selected, each of which represents one of the above three proposed scenarios. The purpose of the case study analysis is to refine the theoretical proposition and the key research variables that will be used in the quantitative stage. In quantitative stage, the research will analyze the data generated from the Survey of Innovation and Business Strategy conducted in 2009 and 2011 (Statistics Canada, 2014).

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Modern Paints and Modern Art: Synthetic Paint Media and their Impact on Art of the 20th Century

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Abstract

The introduction of Nitrocellulose as constituent for manufacturing industrial coatings and house paints to the market as early as 1920s was followed by a myriad of other synthetic colouring materials, such as Alkyd paints, PVA paints and Acrylic paints. Shortly after, artists were inclined to experiment with those new materials. That inclination was clearly expressed and explained by Jackson Pollock (1912-1956) who contended that "new needs need new techniques." Thus artists who witnessed the peak of the industrial age wanted to express it, but found out that traditional materials and techniques would not let them fulfil that need. Synthetic paints were employed in art as they were perceived as the good fit for the nature of that new age. Those new paint materials also prompted the need for new techniques of application. Techniques long used by artists since the Renaissance shifted drastically towards more rapid and utterly experimental trends.

This paper provides a historical review on the role of synthetic colouring materials as an important factor that had a genuine impact on the modern history of art. It keeps track from the earliest attempts by artists to employ synthetic paints in their artworks until the dominance of acrylics over other types of synthetic paints. In other words, this paper presents a chronology of the employment of each major type of synthetic paints by important artists.

Keywords: Synthetic media, acrylic paints, modern art

1. Introduction

Humans have employed paints for thousands of years in a vast variety of purposes. The application of paints mainly depended on them being comprised of two constituents; pigment and medium. The pigment is the colouring component of the paint while the medium is the substance which bind the pigment particles together. The two constituents have been constantly gotten or obtained from common natural sources, either inorganic or organic. Accordingly, several techniques depended on the type of paint used, such as oil paints, aquarelles, gouache, tempera, fresco, casein, etc.

Oil paints are known centuries ago. Oil paints are known to painters in Northern Europe at least from the 13th Century (Mills and White, 2012, p. 36). Oil paints are generally made by utilizing 'drying' vegetable oils, for example, linseed oil. It is now well-known that the word 'drying', implies a chemical change to the oil-based paint film occurs in the presence of Oxygen which unleash a process known as polymerization.

The final decades of the nineteenth Century accompanied a new art world that has just been altered against customary structures and thoughts. The introduction of photography, in the form of Daguerreotype, by the mid-Nineteenth Century touched off solid responses among painters. Some of them feared that their art has been going to lose its stature. It is said that when the French artist Paul Delaroche (1797-1856) saw Daguerre's innovation he announced: "from today, painting is dead" (Bann, 1997, p. 226). The French Impressionists, on the other hand, have made the entryways wide open to an ensuing escalation of art movements overflowing with new points of view, and subsequently encouraged artists to effectively search for new methods and materials to address their own thoughts and structures they needed to make. Synthetic polymers were rather among the most important artist materials in this context.

By the beginning of the Twentieth Century, a range of synthetic polymers have been already invented. Accordingly, new types of pigments and binders have made its way into paints and coatings. The new paints were essentially introduced to the market as household and industrial paints. Numerous artists were ready to experiment with those new materials. For instance, Picasso utilized the alkyd-based 'Ripolin', Siqueiros and Pollock employed the nitrocellulose-based 'Duco' and Kenneth Noland used the polyvinyl-

acetate 'PVAc emulsion' paints. Eventually, acrylic-based paints began to spread among artists since the second half of the Twentieth Century.

This paper is an overview of those revolutionary media that have indeed influenced the art world. It starts with a historical review of modern paints and give an insight into the introduction of acrylic paints for being particularly important in the course of modern art. Finally the paper discusses the application of synthetic paint media in the context of fine art.

2. *Synthetic Paint Media: A Historical Overview*

Modern paints can be classified into groups identified by their main component, and put in an ascending order according to their introduction to the market as shown in *Table 1*.

Table 1 Timeline of introduction of prominent binders of modern paints (Learner, 2007, p. 4)

Paint Type	Timeline of Introduction
Nitrocellulose paint	1920s
Alkyd paint	1930s
PVA emulsion paint	1940s
Acrylic solution paint	1940s
Acrylic emulsion paint	1950s

The introduction of a synthetic medium to the market is relatively easily trackable. However, it isn't as clear to follow when exactly that synthetic medium was first employed in a work of art (Russell, 2010, p. 122). Prior to the introduction of dedicated artists' synthetic paint, artists actively employed commercially available household and industrial paints. Materials that are produced specifically for artists usually come years after being produced for other commercial purposes. Gettings (1971, p. 8) clearly, yet sarcastically, explains this: "The artist is, and always has been, too unimportant an economic unit in society to have a massive industry working at his behest, so the exciting new range of polymers and copolymers which are now available to him have been developed mainly for other purposes than the production of pretty pictures intended to grace the walls of homes and galleries." In this way, until makers perceived the requirements of the artists of the Twentieth Century and understood that the readily accessible synthetic media could be remanufactured towards making dedicated paints for artists, artists utilized whatever accessible from the new media.

Supposedly, Picasso was one of the earliest artists who have employed household paints of his time for part of his oeuvre (Standeven, 2011, p. 4). "He likely preferred it... because it has a glossy finish and takes days rather than months to dry" (Orwig, 2013). Picasso used these paints all through his whole aesthetic life since the time of Cubism until his death in 1973 (Learner, 2005, p. 249). A Ripolin factory was established in France, and was commercially available in France at least from 1907, so it was normally the earliest commercially available synthetic paint employed by Picasso in 1912, and no long after that similar paint was employed by other known avant-garde artists such as Joan Miró (1929-1983) and Francis Picabia (1878-1953). Another example is Sidney Nolan (1917-1992) who experimented with commercial synthetic paints from the mid-1940s (Standeven, 2011, p. 4). The English artist Francis Bacon (1909-1992) was another outstanding painter whose studio, according to Russell (2012, p. 200), was found to have contained numerous tins of synthetic paint particularly of the commercial brands Dulux and Carsons.

In general, the manufacturing of commercial paints all through the Twentieth Century relied upon three principal chemical groups of binding media; alkyds, PVAc emulsions ($C_4H_6O_2$) and Nitrocellulose $[C_6H_7(NO_2)_3O_5]_n$ (Learner, 2005, pp. 249-251). As per (Learner, 1998, p. 8) Alkyd paints consist three constituents: "a polyhydric alcohol (usually glycerol or pentaerythritol), a polybasic acid (normally phthalic anhydride) and an unsaturated mono acid (normally added in the form of a drying oil)." PVAc is a rubbery thermoplastic polymer that is widely used in the manufacturing of cements and household paints. PVAc paints was introduced around a similar time as acrylic paints to the market during the 1940s. Probably acrylic paints superseded PVAc among artists which explains why PVAc was employed only temporarily for this purpose. Nitrocellulose was the earliest constituent of modern industrial coatings. Nitrocellulose was shortly, however largely discontinued, and superseded with thermosetting acrylic coatings in the car

business" (Association, 1993, p. 245). Early nitrocellulose paints, for example, Duco was extensively experimented by Siqueiros, particularly in his murals.



Figure 1: (*RIPOLIN*, no date) credit to Museum of Fine Arts, Boston.

3. Acrylic Paints: A New Era For Art

It was the time of the Great Depression, as economy unprecedentedly collapsed in the US, when Leonard Bocour (1910-1993) began his business as a colourman in 1932 in New York. Bocour recalls in a later interview (Leonard Bocour, 1978) that he had no other job, so he "went selling the paint from studio to studio." Bocour's business began in a leased room and afterward consistently developed until the late 1940's as his then newly introduced paint 'Magna' was flourishing. Bocour Magna was undoubtedly a milestone in the historical development of artists' materials. Thanks to the surge of science and technology, Magna was a significant prologue to a new era of fine art from the Mid-Twentieth Century onwards.

Acrylics, however, has already had a relatively long history prior to its introduction as an artists' material. Synthetic polymers were being developed in chemistry labs since the Mid-Nineteenth Century. In the early 1840s an Austrian chemist, Josef Redtenbacher (1810-1870), oxidised acrolein with air and produced a new acid which he called acrylic acid (Neher, 1936, p. 267). This is a synthetic colourless acidic liquid that is corrosive in nature. Acrylic acid later became the source of an increasing variety of by-products employed in innumerable applications. According to (Kricheldorf, Nuyken and Swift, 2004, p. 241), Georg W.A. Kahlbaum, a Swiss chemist, published an early report on polymerisation reaction of methyl acrylates and methacrylates. With the advent of the Twentieth Century the greater part of the acrylic derivatives were already known at that point (Standeven, 2011, p. 106). Acrylic polymers started to be methodically considered for specialized use in the early Twentieth Century. This is evident in the thesis submitted in 1901 by the German chemist Otto Röhm, entitled "Products of the polymerisation of acrylic acid" for which he consequently registered a patent in 1912 (Aftalion, 1991, p. 149). Later, Röhm and Hass Company for chemical industry was established in Germany in 1907, and then in the US in 1909. In 1913, Röhm and Hass subsidiary company started producing acrylates and their polymers where paint making was found to be one of the possible applications of the products (Aftalion, 1991, p. 151). Trade names of acrylic resin produced for paints based on water by Röhm and Hass are shown in

Table 2. By the Mid-Twentieth Century, Leonard Bocour began to bring acrylic resin supplies from Röhm and Haas subsidiary by which he was making his revolutionary acrylic paint; Magna.

Table 2: Acrylic resin raw material products' trade names Röhm & Hass for paints manufacturing (Flick, 1994, p. 458)

Raw Material	Chemical Description	Source
AC-1024	Acrylic emulsion	Röhm & Haas
Acryloid WR-97	Acrylic resin	Röhm & Haas
Acrysol ASE-60	Water-soluble acrylic resin	Röhm & Haas
Acrysol I-62	Water-soluble acrylic resin	Röhm & Haas

Acrysol I-98	Water-soluble acrylic resin	Röhm & Haas
Acrysol QR708	Water-soluble acrylic resin	Röhm & Haas
Acrysol RM-5	Water-soluble acrylic resin	Röhm & Haas
Acrysol RM-825	Water-soluble acrylic resin	Röhm & Haas
Acrysol RM-1020	Water-soluble acrylic resin	Röhm & Haas
Acrysol SCT-275	Water-soluble acrylic resin	Röhm & Haas
Acrysol TT-615	Water-soluble acrylic resin	Röhm & Haas
Acrysol TT-935	Water-soluble acrylic resin	Röhm & Haas
Acrysol WS-68	Water-soluble acrylic resin	Röhm & Haas

Back to Bocour's interview which was conducted with him at the age of 68 in 1978 when he recounted the beginning and the development of Magna paint to his interviewer. "It started about November 1941, some guy walked into the shop... with something like white syrup. I said, "What's that?" He said, "It's an acrylic... Frankly, I'd never heard the term" he recalls. Bocour went on to test that new substance and examine its potential as a binder. He initially mixed acrylic resin and white pigment. His goal was to investigate the ability of acrylic of keeping the pigment as white as possible. "What really got me was how white it was," said Bocour (Leonard Bocour, 1978) (

Figure 2).

Soon after, there became a decent assortment of colour hues prepared by Bocour (

Figure 3). Magna paints depended acrylics that are solvent soluble. Those paints were, like oil paints, could be thinned by certain organic solvents such as mineral spirits. Francesca Casadio, a conservation scientist, describes the important impact of Boucour's Magna: "Magna paints acquired rock star status with many artists..." and specifically with the acclaimed Pop artist Roy Lichtenstein Casadio elaborates "Magna produced the smooth, matte, commercial, pop-art look [Lichtenstein] liked. With it he could emulate mass-produced, popular art like advertisements or comic books, abandoning the thick, expressive brushstrokes and nuances of Abstract Expressionist painting that held premier position at that time." (Casadio, 2012)



Figure 2: "Leonard Bocour, the inventor of Magna, holding a tube of the revolutionary paint" (Casadio, 2012)

Not long after, however, the currently widespread acrylic emulsion paints, that can be thinned in only water, were produced just a couple of years after the introduction of Magna paints. Waterborne acrylic paints made even more success and superseded solvent based Magna acrylic paints. Several trade names started to be marketed since the 1950s, such as 'Liquitex' by Henry Levison in 1954, 'Cryla' by Rowney and co., Britain in 1963 and 'Hyplar' by M. Grumbacher, Inc., USA in 1966 (Jablonski *et al.*, no date, p. 2).



Figure 3: Colour chart of Magna paints from the 1950s by Bocour (morrislouis.org)

As indicated by Pomerantz, Goist and Feller (1977, p. 35), "the term 'acrylic' has been connected to any paint which depends on an acrylic binder that can be dissolved either in an organic solvent or in water. However, as indicated by Learner and Ormsby (2012, p. 566), acrylic emulsion paints are of "highly complex formulations." Furthermore, Learner (1998, p. 9) gives a useful account of the chemical nature of acrylic paints media:

"Acrylics are high molecular weight (HMW) polymers of the esters of acrylic and methacrylic acids. They are available either as dispersions or in solution, but the dispersion (or emulsion) form is by far the most important... The early acrylic emulsions were mostly based on a copolymer of ethyl acrylate (EA) and methyl methacrylate (MMA). More recently, these emulsions have largely been replaced by copolymers of n-butyl acrylate / methyl methacrylate (nBA/MMA). Sometimes styrene is used instead of MMA in the copolymer (i.e. a styrenated acrylic) which will reduce the cost of a formulation, but will render the film more prone to yellowing. The solution form of acrylic paints have all been based on poly n-butyl methacrylate (pnBMA)."

From an artists' point of view, acrylic emulsion paints demonstrated to have been especially flexible for the different applications for which they can be utilized. The versatility of acrylic paints is significant advantage. They can provide either very thin layers or impastos, particularly given the speedy drying time acrylic paints are famous with. Acrylic emulsion paints can likewise be blended with an assortment of different materials so as to accomplish certain impacts. For example, these materials can be utilized to increment or abatement gloss, they can be utilized to change consistency and they can even be utilized to actuate craquelure effects.

4. *Synthetic Paints In The Artistic Context*

Remarking on a question with respect to his controversial painting techniques, Jackson Pollock (1912-1956) commented that "new needs need new techniques," and he at that point expounded: "modern artists have found new ways and new means of making their statements. It seems to me that the modern painter cannot express this age, the airplane, the atom bomb, the radio, in the old forms of the Renaissance or of any other past culture. Each age finds its own technique" (Karmel, 1999, p. 20).

Likewise, Mayer (1991, p. 257) additionally believes that “no movements or schools of art began as a result of the discovery of new materials or inventions of new techniques.” (2004, p. 119) Elkins also concluded that “acrylics could only be successful in the twentieth century, when painters are more likely to be impatient... in past centuries, acrylic would have seemed to dry far too quickly.”

Many Twentieth Century’s renowned artists actively looked for new artistic trends. Clever colourmen role was to fulfil the needs of those artists. Leonard Bocour portrayed that when he was reviewing the occasions when his new paint item turned into a hit, as he basically stated: “We truly were filling a need” (Leonard Bocour, 1978).

Among the early celebrated artists who have employed Magna Paints, Leonard Bocour especially makes reference to Morris Louis (1912-1962), Jules Olitsky (1922-2007), Kenneth Noland (1924-2010) and Helen Frankentahler (1928-2011) (Leonard Bocour, 1978). Those all were American Abstract Expressionists who spearheaded the art scene in the US during the 1940s. Morris Louis was evidently specifically enthusiastic about Bocour’s new material. On that Bocour reviews: “Morris Louis was one of my steady customers... When I go around talking about acrylics, the only one that they really ask me about is Morris Louis” (Leonard Bocour, 1978).

David Alfaro Siqueiros (1896-1974) the revolutionist Mexican artist who, driven by his strong political ideology, acquired new techniques and materials to fulfil his expression in, particularly his famous wall paintings (

Figure 4). Siqueiros used spray guns fed with the Duco paint (Winegrad, 2001, p. 38), which is nitrocellulose-based low-consistency enamel paint marketed since 1923 by the American company Du Pont (Standeven, 2007, p. 76), that was mainly manufactured for industrial coatings.



Figure 4: Siqueiros giving a presentation of his technique on one of his mural paintings (Randee Silv, 2013)

Siqueiros' energy and eagerness drove him to sort out multiple workshops under the entitled *A Laboratory of Modern Techniques in Art* where innovative methods and media could be used to make art (Baetjer, 1997, p. 66). Those workshops were led at Siqueiros' New York studio in 1936, with some of his fellow artists, including; Jackson Pollock, Axel Horr, Clara Mahl, Conrado Vasquez and Roberto Berdecio (Hurlburt, 1976, p. 238).

Through Siqueiros' workshops, Jackson Pollock seems to have admired Pyroxylin, which was a trademark of synthetic paint based on nitrocellulose by Du Pont marketed since in 1904. The properties of Pyroxylin while dripping accidentally on the floor probably shaped Pollock famous technique he later embraced. (Stein, 1994, p. 98).

Dan Christensen (1942-2007) was another abstract painter who experimented with synthetic media (

Figure 5). Starting during the 1960s, Christensen admired the properties of acrylic paints over oil paints. He was able to thin acrylic paint layers to the textures he wanted without losing the colours tense.

Moreover, he enjoyed working with added substances made to broaden the characteristics of the acrylics (Christensen and Peters, 2011, p. 3).

The English artist Peter Sedgely (1930-) has likewise reached his own style as an Op-artist using synthetic paints and spraying techniques (

Figure 6) (Chilvers and Glaves-Smith, 2009).

Another English artist is Barrie Cook (1929-) who also employed a spray gun and acrylic paints in his paintings. His painting shown in (

Figure 7) is one of "a series came about through several months of drawing, invariably using a spray gun and involving a number of formats and ideas," (*Barrie Cook, 'Painting' 1970*, no date)

Synthetic media, particularly acrylic found considerably inviting hands of the Pop artists in the post-WWII England and in the US during the 1950s and onwards. The American Pop artist James Rosenquist (1933-) employed commercial spray cans onto his canvases (Figure 8). The English painter Peter Phillips (1939-) who was one of the prominent Pop artists back then in the 1960s used spraying methods in combination with acrylic paint (Honnef, 2004, p. 19) (

Figure 9).

Photorealism artists were influenced by by Pop Art. Many Photorealists employed acrylic paints in their techniques in order to achieve 'photographic' effects. Such Photorealists included, for instance, the prominent Photorealist Chuck Close (1940-) (Finch, 2012). And Audrey Flack (1931-) whose paintings were frequently finished with acrylic paints on top of oil paint layers. In (Figure 10) Flack is shown while finishing a portrait, of the former Egyptian president Anwar El-Sadat, that was commissioned to her by the American government in the 1970s, in which she combined acrylic paints with spraying techniques

Figure 11.

Another important Photorealist is Don Eddy (1944-) who learned his careful and painstaking method, of combining acrylic paints with spraying techniques, from his early work in a garage owned by his father



Figure 5: Dan Christensen, *Conjugate* (1967), acrylic on canvas 48x48" (danchristensen.com)

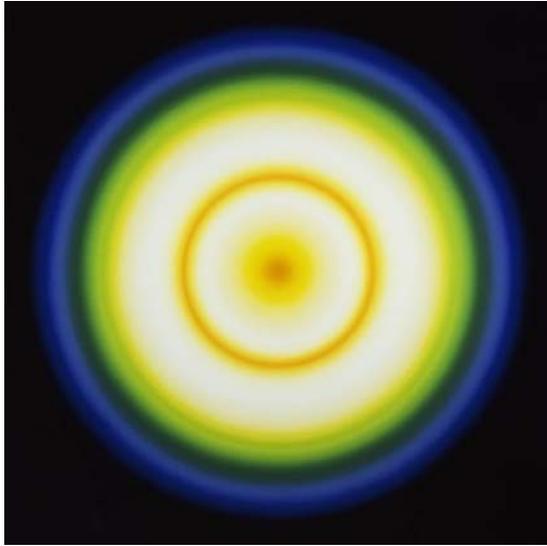


Figure 6: Peter Sedgley, *Colour Cycle III* (1970), acrylic paint on canvas, 1841 x 1829 mm (Tate collection)



Figure 7: Barrie Cook, *Painting* (1970), acrylic paint on canvas, 2440 x 3047 mm (Tate collection)



Figure 8: James Rosenquist, *Marilyn Monroe, I* (1962), Oil and spray enamel on canvas, 236.2 x 183.3 cm



Figure 9: Peter Phillips, *Mosaikbild/Displacements* (1976), acrylic on canvas, 220 x 230 cm, private collection (peterphillips.com)



الرئيس يتسلم الصورة التي اهداه له وفد رجال الاعمال الامريكيين تقديرا لجهوده من اجل السلام

Figure 10: Left: courtesy of Archives of American Art, Smithsonian Institution. Right: courtesy of El-Sadat Museum, Egypt.



Figure 11: Don Eddy, *Bumper Section XIX* (1970) (*doneddy - 1967-72*, no date)

5. Conclusion

Synthetic media reshaped the world of art since at least the beginning of the Twentieth Century. Avantgarde artists of that time embraced a plethora of these new materials and accordingly they achieved new ideas and techniques. By the 1960s Waterborne Acrylic paints became widely available and gained increasing publicity among artists for their several advantageous properties. Until today, and probably for many years to come, acrylic medium is considered the second important invention for the artworld after oil paints. The tracking of the history of synthetic media and their impact on fine art bring about other interesting perspective of the way artists executed their artworks in the Twentieth Century.

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Creativity, Design, Management, Innovation, Enterprise and Entrepreneurship: A Conversation Starter

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Abstract

The Creative Industries – and the value generated by creativity and innovation - are a powerful way for countries and companies to elevate their profile, performance and appeal. As an invaluable part of the creative industries, design has been receiving increased attention in many regions of the world due to its ability to be used for cultural expression, competitive differentiation, creative speculation and process innovation. Design is also known as a tool that can catalyse innovation, and growing in awareness is its value as a tool that can catalyse entrepreneurship. The common ground between design and entrepreneurship is that they both take a creatively enterprising, purpose-oriented and risk-assuming approach to problem-solving, opportunity-finding, customer creation and market identification. However, just as entrepreneurship needs to be managed (through ventures, innovations, strategies and outcomes to take an idea into market and so make the business venture a success), so design needs to be managed (through strategies and processes for creativity, design and innovation that will ensure delightful products, services and experiences, satisfied customers and business success).

Taking a managed approach to design has already been proven to benefit both enterprise revenues (profitability) and national economies (growth), while simultaneously having a positive impact on social, environmental and cultural 'quality of life' concerns. Within the complex conditions of the world in which we live, the intricate challenges and *wicked* (seemingly impossible) problems we face, individually and collectively, might be better regarded as creative problems, design challenges and entrepreneurial opportunities – otherwise we are at risk of overwhelm. This paper presents design in the context of creativity and enterprise and serves as a conversation starter on design management as an integrative organisational framework for fostering innovation and entrepreneurship in business and beyond. It is intended to contribute to the field by (1) providing a brief introduction to the creative economy for readers who are unfamiliar with the economic importance of the creative industries, and (2) serving to inspire non-designers and entrepreneurial thinkers to be curious about, and participate in, in the area of design management.

Keywords: creative economy, design management, innovation, entrepreneurship

1. Introduction: The Creative Economy

For many countries, the presence of creativity and innovation as desirable assets is because they are some of the best ways to increase competitive advantage (1) in *countries*, through cultural expression and growing economies, enterprises, skills and talents, and (2) in *commercial companies*, through the provision of innovative products and services that shift the status quo from price competition to wider ecosystem co-creation and local/regional transformation. Inspired by economic success stories such as Silicon Valley, the drive to stimulate a culture of enterprise in countries and companies is evident through the number of regional innovation strategies and creative start up platforms being launched.

This growth in the *creative economy* reflects the current economic paradigm anchored in the growing power of ideas, and how people make money from ideas. Media entrepreneur and analyst John Howkins (2001) believes that the creative economy is driven by the view that twenty-first-century industries depend increasingly on the generation of knowledge through creativity and innovation. The activities concerned with the generation or exploitation of creative ideas are supported by global economies through national design policies and creative industry strategies, for example, in 2013, Oman hosted a creative economy symposium which promoted *The Role of Policies and Strategies in the Development of Crafts, Arts and Creative industries in the Sultanate of Oman*. The added-value of creativity can also impact global companies through investment in corporate innovation and entrepreneurship strategies, for example, Philips *Innovation Awards* to stimulate entrepreneurship and innovation. Creativity is increasingly

important to well-being—economic (employment, growth), social (happiness, welfare) and environmental (sustainability, circularity). Dubai, a city embodying the very idea of innovation, sees creativity as playing a key role in enhancing social wellbeing, national reputation and added value economic creation, and views the creative industries themselves to be a significant contributor to GDP globally (Al Maktoum, 2015).

2. *The Value of the Creative Industries to National Economies*

For countries that want to grow their *Creative Industries*, stimulating a culture of creative enterprise is key. Creative Industries activities and operations typically include the areas of design, arts and crafts, advertising, architecture, fashion, film, music, TV, radio, performing arts, publishing and interactive software. Government support for the creative industries, creative enterprise and creative entrepreneurship aims to catalyse ecosystem innovation and to drive the launch of new ideas for the products, services and experiences that keep clients, users and customers coming back for more. Creative and innovative ideas are particularly important to economic wellbeing – individually, locally, regionally and globally. In the United Kingdom (UK), for example, the creative sector is one of the UK’s most important industries, driving economic growth and supporting jobs across the country. UK Creative industries generated GBP £71.4 billion Gross Value Add (GVA) in 2012. The value of the sector increased by 15.6 percent between 2008 and 2012, compared with an increase of 5.4 percent for the overall UK economy. It is estimated that in 2012 the sector generated over GBP £8 million an hour and employed nearly 1.7 million people (UK Creative Industries Council, 2014), and it is second only to the economic contribution made by financial service industries. The value of the creative industries to the UK in 2018 is up from GBP £94.8 billion in 2016 to GBP £101.5 billion (DCMS, 2018).

In Austria, the creative industries are a key economic factor and driving force for Austria as a place of innovation, and a place where the role of the creative industries in contributing to the development, dissemination and marketing of new products, services, business and added-value models have substantial influence on the innovation, growth and dynamics of Austria as a business location (Federal Ministry of Science, Research and Economy, 2016). Their creative industries strategy (2017) sets out four objectives:

1. Strengthening Austria’s innovation system
2. Strengthening the competitiveness of the creative industries
3. Strengthening the creative industries’ transformative effect on other economic sectors
4. Strengthening Austria’s international image as a creative country of culture and innovation

3. *Design: The Link between Creativity and Innovation*

Design is one of the activities within the creative economy that is making an impact on economic success and wellbeing of many nations. A report on the UK *design economy* by the UK Design Council asserts that “Design and design skills are at the heart of the fourth industrial revolution. They give us the tools to respond to these unprecedented challenges, and instigate the growth, innovation and jobs that will drive the UK’s global future” (Design Council, 2018). In the UK, one of the triggers for the rising popularity of design both inside and outside of the creative industries was a 2005 government report – the Cox Review (HM Treasury, 2005) - which, while investigating the value of creativity and innovation to the UK, secured the place of design in future debates about creativity and innovation:

- Creativity is the generation of new ideas—either a new way of looking at existing problems or the discovery of new opportunities.
- Innovation is the exploitation of new ideas.
- Design is what links creativity and innovation—it shapes the ideas so they become practical and attractive propositions for users and customers.

A design (noun) has form and function; it is the outcome of the process of designing. To design (verb) is to plan, to create, or to devise. Design can be thought of as a process (designing), a practice (the designer), an outcome (the design), a way of thinking (design thinking) and a way of being (designerly). Currently, design is considered to be an important tool for stimulating innovation and gaining competitive advantage (Kramolis et al, 2015). Innovation is incredibly important to all organizations today—not only as a source of revenue and growth, but also as a source of reinvention and as a value-generating way to survive and thrive amid challenging economic times. These challenging times are disrupting business models and institutions built on old-world industrial economic models, and their internal structures are adapting, evolving, or not surviving. Business as usual is giving way to the need for new forms of enterprise. In this context, design is being engaged as a way to identify latent opportunities for innovators and entrepreneurs, hence the rise in design thinking as a process for creative problem-solving and opportunity-

finding, and the instigation of design policies within governments, institutions and corporations as a way to raise awareness of design as a generator of new business models, new types of products and services and new types of customer, user and citizen experiences.

4. *Good Design is Good Business*

In 1950, Thomas Watson, CEO of IBM, recognized that "good design is good business." Good design generates social and economic value, makes the world a better, more interesting place, and enhances the quality of our lives. For the UK Design Council, "good design puts people first. It uses creativity to solve problems, challenge thinking and make lives better. Designers operate across the whole economy. They shape the built environment, the digital world and the products and services we use, creating better places, better products, better processes and better performance" (Design Council, 2018).

Design is well established in how it can support businesses to establish corporate identities, develop brands, and differentiate products from competition. Design professionals operate within business in a range of different ways, for example, as in-house design teams, out of house consultancies and agencies, freelance experts, design entrepreneurs, or as interdisciplinary teams blending a range of roles and responsibilities, both client side and consultancy side. Many businesses see design as "the key to greater productivity, resulting in higher-value products and services, better processes, more effective marketing, simpler structures, and a better use of people's skills" (Wrigley, 2016). The role of design is rapidly expanding in scope to encompass more areas, using its people-centred approach to cross traditional, functional and hierarchical boundaries within both client and consultancy organisations, for example, bridging between specialist departments and skillsets such as marketing, product development, finance and engineering.

The first challenge for many organisations, however, is to see beyond design as aesthetics, look and feel. Non-design led firms are often not aware of the potential design can offer, seeing design as 'wasteful' styling or as an excessive cost, and not as a long-term investment for improving business performance. A second challenge for many organisations is to see the potential for design as a customer-centred process that can bridge managerial divisions or silos of expertise thereby avoiding a *clash of cultures* or a difference of perspective on what is important in terms of individual or departmental beliefs, values, assumptions, behaviours and agendas. Increased awareness and debate around the role of design in business and beyond is successfully moving the position of design beyond questions of *style and aesthetics* to the design of a *process*, the design of *an experience*, design as *a catalyst for innovation*, and design as *an enabler of cultural or transformational change*. "Demand for change within industry is evident, with many companies universally are looking to design to help them transform, innovate, differentiate and compete in a global marketplace. The benefits of design include increased quality of goods and services, improved production flexibility, and reduced material costs" (Wrigley, 2016). The Design Management Institute (USA) advises organisations to go one step further and become more 'design-minded', going beyond engaging designers as professionals to actually integrate design into their overall business strategy. The value of design carries weight in business as it can "produce a different way of thinking, doing, and tackling problems from external perspectives" and design has thus "become one of the most persuasive and effective processes for solving problems, ensuring long-term business sustainability, and gaining competitive advantage" (Wrigley, 2016) Integrating design into business strategy, through different ways of thinking (for example, design thinking) and doing (for example, prototyping to fail fast) ensures that design becomes "a vital and important strategic business asset, contributing to the success of innovation" (Wrigley, 2016).

5. *Enabling New Perspectives through Human-Centred Design*

As a strategic business asset, design is particularly interesting as an enabler of new ideas and insights, especially in how we can convert the ideas and insights into new products and services that enrich our 'quality of life' experiences. There are several reasons for this.

- Design is *familiar*. We experience design every day in our interactions with products, services, spaces and systems.
- Design *puts people first*. Design is a people-centred, problem-solving process, and with rising demand to take a more socially just, economically efficient and environmentally responsible approach to world challenges, design is well positioned to help put quality of life and wellbeing first.

- Design *gives form to ideas*, both through the process of design (for example, design thinking) and the outcome of design (for example, form and function).

As a people-centred, problem-solving process, design can and does address challenges facing both public and private organizations. By putting people at the core of how products, services, and systems are designed, design as a methodology brings fresh thinking to current local and global debates about whether to restore, redefine, or redesign existing systems—hospitals, schools, governments and services that ultimately define people’s daily interactions and influence the quality of their life experience. As a result, many regions of the world are re-evaluating the role of design in relation to creativity, enterprise, technology and innovation, and either repositioning how they historically perceived and engaged design skills and capabilities, or reassessing and introducing new policies and programmes to raise levels of design awareness and design capability. This is particularly the case when considering design for *cultural expression* (brand identity, regional differentiation of products, services and experiences), *competitive differentiation* (choosing one brand over another), *creative speculation* (alternative ways to think about and visualize better futures) and *process innovation* (aligned with, for example, sustainability, cradle to cradle and circular thinking).

In the United Arab Emirates, for example, Dubai is committed to engaging and realising the potential of design as a catalyst for innovative new ideas and creative enterprise across ecosystems and platforms in the region – and beyond. The establishment of Dubai Design Week, the largest creative festival in the Middle East, reflects Dubai’s position as the regional capital of design. By providing an accessible meeting point for the global design community and a platform for regional design, and by serving as a catalyst for the growth of the creative community in Dubai and the UAE, a wide variety of design disciplines (architecture, product, furniture, interior and graphic design) are given the opportunity to connect with both industry and the public. This positioning reaffirms the city as a global gateway city for the 75,000 visitors that attended Dubai Design Week events in 2018 (Dubai Design Week, 2018).

6. *Designing better Businesses and Enterprises*

Beyond national economies and their agendas for competitive growth, many local and global shifts are impacting how business and enterprise operates, how we live and what tools we use to think more entrepreneurially (and responsibly) about the future we want to create. Currently, there is growing demand for taking a more holistic approach to the societal, environmental, political and cultural impact of how commercial businesses and other organisations operate. As a result, new types of enterprises are emerging (for example, social enterprises, creative enterprises, green enterprises) many of which are using commercial business tools to achieve wider goals that benefit society and the environment, or that take a long-term view of the ecological effects of their actions (for example, using triple bottom line accounting). New business models and value propositions - ones that place societal measures of well-being (Gross Domestic Happiness) on a par with economic measures of well-being (Gross Domestic Product) and consider sustainable development and growth metrics (people, planet, profit) to be as important as return on investment - are becoming the new normal. Just as new enterprises are asking themselves, ‘what kind of business do we want to be?’, so many potential customers are asking themselves, ‘what kind of businesses do I want to support with my consumer purchasing power?’

Design is one of the tools being engaged as an effective process for solving problems, identifying challenges and unlocking opportunities - it produces, in the words of Wrigley (2016), *a different way of thinking, doing and tackling problems from external perspectives*. When considering design as a tool to solve complex or *wicked* problems and catalyse alternative and better business models, the demand for new forms of enterprise is also driven by numerous global challenges we face as humanity (poverty, famine, war, flooding) and the not always positive local impact of multinational corporations (pollution, corruption, exploitation, domination and centralization). In many affected regions, *business as usual* is over, and as a result, forward-thinking organisations are wisely looking for new business opportunities and new ways to generate ideas, add value, achieve efficiency and create equity. Design has, in effect, entered the language of enterprise, with phrases such as designing your business, designing your life, designing the future, and innovation by design now being accepted as part of business strategy, start-up enterprises and popular culture. Consider Unilever’s *Safe and Sustainable by Design* initiative, which ensures products are safe for consumers and workers and better for the environment, or EdX’s *Applied Entrepreneurship 1: Design Thinking for Business Acceleration*, which addresses business growth through the generation of innovative ideas using design thinking.

We are literally surrounded by design in the culture of everyday life and in the communities, objects, spaces, and systems we connect with every day. Design is, in fact, “a very old human capability that has been forgotten by the mainstream educational systems and the traditionalists alike... Both these streams need to reestablish contact with the discipline if we are to face the vagaries of change that is upon us from all directions” (Lomas, 2015). Amid the current times of change, and because of the day-to-day familiarity we have with design, the human-centred approach of design, and ability of design to generate and catalyse new ideas, design as a language, skillset and approach can and does help to identify different, alternative, and better ways of doing things and thinking about things. Design can help us reconnect everyday life back to what people really value and, ultimately, back to our own core human values.

7. *Design as Catalyst for Innovation and Entrepreneurship*

Design as a catalyst for innovation is well established, for example, in the concept of *design-driven innovation* in which the quality of the user experience arises “not as a result of analysis of user needs but rather through a design process which seeks to give meaning to the shape and form of products – features and characteristics which they didn’t know they wanted” (Tidd and Bessant, 2014). Beyond the recognition of design as an innovation methodology, design as an entrepreneurial methodology has been recognised within, for example, India’s National Design Policy, launched in 2007. “Design is a driver of innovation and is recognized as a key differentiator for providing a competitive edge to products and services. Consequently, innovation in manufacturing processes as well as entrepreneurial methodology is an extremely important strategy” (India Design Council, 2011). Some of these innovative processes and entrepreneurial methodologies that are intended to bridge design, innovation, entrepreneurship and enterprise in India include the setting up of specialized *Design Centres* or *Innovation Hubs* for sectors such as automobile and transportation, jewellery, leather, soft goods, electronics/IT hardware products, toys and games. By providing common facilities and enabling rapid product development, high performance visualization, enterprise incubation and financial support through venture funding, loans and market development assistance, the idea is to support start-up design-led ventures and young designers’ design studios (India Design Council, 2011). Within India’s National Design Policy is the recognition, in spirit, of *change by design* and that “entrepreneurs too are creative people who see opportunities quickly and have the ability to harness the resources necessary to bring them to fruition. In the process, they bring about change” (Kirby, 2007).

From an ideas generation point of view, both design and entrepreneurship take a creatively enterprising, purpose-oriented and risk-assuming approach to problem solving, opportunity finding and challenge seeking, whether through customer creation, market identification, technology leadership or product innovation. Entrepreneurship is “a way of thinking, reasoning and acting that is opportunity based, holistic in approach and leadership-balanced” (Timmons & Spinelli, 2004). Entrepreneurship, like creativity, design and innovation, is anchored in the growing power (and financial value) of ideas, and we are currently witnessing the birth of new forms of entrepreneurial enterprises and collaborative ventures, springing up inside and outside organisations and across local and regional ecosystems. In 2018, for example, BMW Group launched the *UK Innovation Lab* for automotive entrepreneurs and intrapreneurs, the idea being to develop external startups and staff creativity through incubation, collaboration, creativity, innovation, technology, customer experience design, entrepreneurship and intrapreneurship (BMW Group Press Club UK, 2017). An open-minded, creative and purposeful approach to *entrepreneurship by design* and concepts like *design as entrepreneurship* is presenting an interesting and human-centred frame of reference to address the growing call to solve contemporary world challenges, by designing better business models and make things *better by design*.

8. *Educating, Catalysing, Managing and Collaborating for Entrepreneurial Thinking*

One of the factors that make enterprise and entrepreneurship so fascinating academically and commercially is that great ideas rely on a balance of creativity and business acumen, which includes being open to the source of, the methods behind, and the value of, all kinds of original, unexpected, risky and status-quo-challenging concepts whose impact we may not even fully understand at the time of their inception (for example, disruptive innovations like Uber and Airbnb). Great ideas attract investment, venture capital and the title of being a successful entrepreneur. Truly creative and innovative entrepreneurial ideas – the holy grail for founders and investors – are of particular fascination. However, for James O’Grady (2012), there is a difference in how we perceive, organise and educate for *generating new ideas* (for example, entrepreneurial thinking, design thinking) and *delivering on ideas* (for example,

managerial entrepreneurship, design management). “Most of today’s courses on entrepreneurship simply teach students how to apply core business methods to a new venture. They focus on managerial entrepreneurship, that is, what happens after the idea has already been developed. While these courses are important, it is vital to supplement them with classes that focus on innovation itself. Innovative entrepreneurship course material needs to instruct students in the process of generating new ideas” (O’Grady, 2012). The opportunity also exists to engage *design as entrepreneurship* course material to instruct students in the process of generating new ideas using *design as a catalyst for innovation*. Further, just as managerial entrepreneurship teaches students how to apply core business methods to a new venture, so the opportunity exists to engage *design management* to teach students how to better manage design-led ideas, assets and innovations – and to deliver market success, navigate corporate politics, seek venture capital, define financial value or recognize ecosystem complexities as a path to delivering external success. This determining, communicating and capitalizing on *the business case for design* is the realm of design management and as an organizational framework it presents an interesting way to bring together design, innovation, entrepreneurship and management – perhaps as an *organizational methodology* to bridge the culture clash between idea generation and idea management, innovative entrepreneurship and managerial entrepreneurship, and design as entrepreneurship and design management.

One of the recommendations from the Cox Review (2005) was to enhance interdisciplinary education between arts and science, business and design, engineering and entrepreneurship and other disciplines ripe for co-creating value. Equally, one of the reasons for the growing demand for interdisciplinary education (including design management) is the recognition that any *clash of cultures* is also an innovation opportunity, where inviting diverse disciplines to collaborate on a project, organisational or ecosystem level and beyond can lead to the launching of radically new enterprises, products, services and experiences. Managing how to adeptly bridge this culture clash, have a positive impact and operate holistically in relation to various contexts, disciplines and roles is one of the main challenges faced by anyone learning about and working within any organisational setting today. One of the Cox Review concerns was that business can limit creativity’s power to one of aesthetics, rather than a new way of thinking, as path to new products and services, and to greater productivity (Best, Bouette & Kirby, 2007). To be influential and launch new ideas - whether creative and entrepreneurial business models or radical design innovations - a better understanding of the challenges and opportunities inherent in bringing together the associated disciplines, their cultures and the overall organisational culture itself is a powerful advantage - especially for those wanting to affect change in the world, those “attempting to find a way through the bear pit of ill-structured, ambiguous or wicked (seemingly impossible) problems” (Buchanan,1992) or those seeking shelter from traditional management controls and incentives, which may well be set up as an efficient and effective management framework, yet which so often undermine early stage creative ideas and where advantages may be lost if not protected (O’Grady, 2012).

One of the most valuable aspects of design management as an approach is that it provides a framework for new creative problem-solving approaches and tools and new entrepreneurial methods and processes to be implicitly integrated into existing managerial approaches and methodologies. In this sense, design management as an integrative organisational framework may be able to help to transform barriers to entrepreneurial cooperation, by recognising and accommodating both the problem-solving approach of design and entrepreneurship, and the administrative and controlling focus of enterprise and management. Looking at culture clashes as innovation opportunities, the potential exists to align with and extend the innovation agenda – and to change mindsets (O’Grady, 2012).

9. *Design Management: The Management of Design*

Design management is about the effective management of design. The wide variety of perspectives that exist on design management reflect the rich array of individuals, professionals and academics, and their associated contexts, involved. Peter Gorb (1990) describes design management as ‘the effective deployment of the design resource available to the organisation in the pursuance of its corporate objectives.’ Bill Hollins (2004) defines it as ‘the organisation of the processes for developing new products and services’, and for Rachel Cooper and Mike Press (1995), being a design manager is about ‘the response of individuals to the needs of their business and the contribution they can make to enable design to be used effectively’. Design management is a unique discipline that requires distinctive methods and skills (Green et al., 2014) and has the role of connecting the purpose of the organization with the function of design (Baars & Ruedi, 2016).

Taking a managed approach to design is proven to be good business. Research conducted into a portfolio of 16 publicly traded stocks from companies considered to be “design-centric” contingent on a

set of criteria that reflects best practices in design management, shows a 211% return over the S&P 500 (DMI, 2015). The Design Value Index (DVI), includes a number of well-known companies such as Apple, Microsoft, Ford and Walt Disney. Further, taking a managed approach to design aligns well with organisations that take a managed approach to innovation. According to the Design Management Europe Survey, in companies where innovation is highly valued, innovation management and design management seem to work well together. Furthermore, in companies where innovation is highly valued, the effective management of design also seems to be present (Best, Koostra & Murphy, 2010).

From a customer point of view, *touchpoints* are an important part of how a business makes itself seen and heard, touched and felt – through brands, products, services or experiences – using the power of design to shape ideas so they become practical and attractive external propositions for users and customers. All of these design touchpoints need to be managed. But delivering touchpoint success means that the intangible aspects of how design is present within an organisation also needs to be managed. These internal working processes and interdisciplinary relationships that are also a part of the integrative nature of design management:

- How we manage the relationships between people – clients, design consultancies, stakeholders, end-users or customers.
- How we organise the teams, the processes and the procedures of any design project.
- Deciding how products and services come to market – the linking of the systems, the places, and the final delivery of a designed and managed customer experience.

10. Design Management in the Corporate Context

In large corporate or institutional contexts, Design management is about the effective management of design in relation to strategy and vision, process and tactics, and operations and implementation. Managing design around a framework of Strategy, Process and Implementation (Best 2015) helps assert how design can play an invaluable means of achieving strategic goals and organisational objectives. It also allows for design tools, methods and processes, and design management thinking, planning and implementation skills, to be integrated into existing corporate or institutional structures. Design management, by the very nature of how it brings different disciplines, professions and stakeholders together, tends to take a holistic view of how to facilitate and deliver the best possible solution for all parties involved. The process of managing design within corporations and institutions allows for the engagement of both in-house (the corporate design resource) and out of house (design consultancies and agencies) design expertise within different organisational stages:

- Managing the Design Strategy: Inspiring design thinking and projects, and conceiving design projects and initiatives. For example, identifying and creating the conditions in which design projects can be proposed, commissioned and promoted; engaging design thinking in an organisation's strategy; identifying opportunities for design; interpreting the needs of customers; looking at how design contributes to the whole business.
- Managing the Design Process: Developing and leading design projects, agendas and possibilities. For example, demonstrating how strategy can be made visible and tangible through design; how to craft the presence and experience of an organisation; how to influence how the organisation is perceived; how to influence how the brand is perceived.
- Managing the Design Implementation: Managing and delivering design projects and outcomes. For example, the process and practice of managing projects; the decision-making processes involved in specifying materials, working relationships and responsibilities; developing design guidelines and manuals; maintenance; translating the design globally.

To relate design management to the organisational environment, design can be seen as potentially existing or engaging at three levels:

- Design at the corporate level (including vision, strategy, policy and mission).
- Design at the business unit level (including tactics, systems and processes).
- Design at the operational level (including project management, delivery, tangibles and touch points).

11. Design Management in the Context of Small to Medium Enterprises

Small to medium enterprises (SMEs) form a significant part of all economies – whether developed, developing or emerging. Because of the scale of operations, SMEs can take advantage of their inherent flexibility and ability to make decisions at speed. This can be a source of competitive advantage when, for

example, clients are looking for creative ways to discover cost savings in their processes in which SMEs could be involved (for example, outsourcing).

With the growing shift to product-service systems, networks of enterprises (as opposed to the corporate organisation per se), the expanding culture of start-ups and the *gig economy*, and local and regional ecosystem innovation, the concepts and principles of design management are also finding their way into SMEs, both inside and outside the creative industries. In this context, design management is about the successful management of the people, projects, processes and procedures behind the design of our everyday products, services, environments and experiences. Equally, design management is about the management of the relationships between different disciplines (such as design, management, marketing and finance) and different roles (such as clients, designers, project teams and stakeholders) (Best, 2010).

Bringing any product, service or experience to market often requires extensive input and support from a wide range of different people, with different areas of expertise, capabilities and skills. But the way in which the people, processes and projects are managed can have an enormous impact on the success, or failure, of the final outcome. Equally, the different planning processes require different approaches (for example, 'first-to-market' versus 'just-in-time' processes). It is the role of design management to locate all these professionals, projects and processes within an interdisciplinary and collaborative framework, and to be aware of the wider business, societal, political and environmental contexts, so as to support a coherent, financially viable and delightfully crafted experience.

12. Conclusion

This paper presents design in the context of the creativity economy, the creative industries and creative enterprise and serves as a conversation starter on design management as an integrative organisational framework for fostering innovation and entrepreneurship in business and beyond. Theodore Zeldin described conversations as a meeting of minds with different memories and habits. "When minds meet, they don't just exchange facts, they transform them, reshape them, draw different implications from them, and engage in new trains of thought. Conversations don't just reshuffle the cards; they create new cards" (Zeldin, 2007). By presenting the paper as a conversation starter, it is hoped to inspire readers to be curious about the relationship between design, entrepreneurship, management and enterprise, to raise awareness of design management as an integrative organisational framework and to reinforce the economic importance of creative economies both globally and locally. As academics and professionals, we have the potential to engage in conversation with each other, shift our mindsets and together, *create new cards*. We can begin by seeing the complex conditions of the world in which we live and the intricate questions we face, individually and collectively, as creative problems, design challenges and entrepreneurial opportunities. Here's to working with our clashing cultures and catalysing innovation and opportunity by design.

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The Height of Future Architecture: Significance of High versus Low Rise Architecture in Science Fiction Films

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Abstract

This paper examines the development of the notion of high rise buildings versus low rise buildings in Science Fiction (Sci-Fi) films through the twentieth century and the start of the twenty first century. It traces selected films that are considered important shifts in the depiction of the future city in fictional films. Through the medium of cinema, Sci-Fi films provide a visualization of what cities could turn into in the future. This paper analyses the recurring patterns in the implementation of buildings' heights within the storyboard. It highlights how architecture is used by filmmakers to signify different aspects of the future city through building height. Height is used as strong signifier to portray notions of class divisions and the status of city inhabitants. The paper explores the overlap between contemporary architecture and cinema through an investigation of the role the cities played in the films plotlines. In this premise, the paper aims to describe the role that architecture and its height played in supporting the storyboard. This paper is an attempt to raise theoretical attention towards an understanding of the relationship between architectural characteristics and cinematic space. It can be argued that buildings and their respective heights have been used in Sci-Fi films to convey different messages based on the characters and the psychological and social - as well as the physical - context in which they dwell.

Keywords: architecture, science fiction, skyscraper, vertical, horizontal

1. Introduction

The silver screen has a long association with architecture and the utilization of architectural signifiers by the directors to convey their personal visions and statements. Architecture in cinema is used as a communication tool through which directors and film makers send certain messages. This is particularly evident through the genre of science fiction films where architectural signifiers depict different aspects of the society, (economical, political, sociological, ecological and technological). Film architecture is an architecture of meaning. There is nothing in the frame that is not important or does not have something to say (Schall, 2000).

2. The Vertical versus the Horizontal

In the 1920s European cities consisted predominately of high density; low-rise masonry housing [Fig. 1] and the high-rise buildings which dotted the skyline of the United States were as yet totally unknown within the continent. As such, it is of interest then as to how Fritz Lang's German future assumed such a strong vertical presence in his 1927 film, *Metropolis* [Fig. 2].



Figure 1: Typical view of Germany in 1920s. **Figure 2:** "City of the Sons", concept sketch for the *Metropolis* (1927) skyline. **Source:** Neumann, D., 1999. *Film Architecture: Set Designs from "Metropolis" to "Blade Runner"*. 1st ed. New York, Prestel

German architectural and urbanistic debates of the 1920s and 1930s are remembered primarily for their focus on the Bauhaus and "the new sobriety of modern architecture", with some much more complex arguments being discussed at the time including: "city vs. country living, industrialization vs. agrarianism, Americanism vs. medievalism." Contemporary German films such as *Metropolis* reflected these debates (Neumann, 1999).

3. *The Emergence of the Skyscraper*

The question of the skyscraper was taking centre stage in urban debates and widespread doubts about the building form were being perceived. Conservative anti- American architects, planners and journalists viewed this fascinating icon of modernity as nothing more than a "vulgar symbol of rampant capitalism" (Clemens, 2003).

They were referred to as towering monsters, owing their existence to the proliferation of beastly capitalism, assembled in the most chaotic and senseless fashion, clad in luxurious fake architecture, which was far from appropriate for its profane purpose (Neumann, 1999).

Consensus abound, however, that the skyscraper was a logical and essential development of urban city planning and that Germany should build skyscrapers, but only as long as they were different from the American ones. What the German planners called for was a new form of nationalist architecture that would be less historicist and more symbolically and politically powerful than any American skyscraper. A rather large number of such projects were attempted [Fig. 3 & Fig. 4].



Figure 3: Project for federal office building for Berlin, 1920, by Otto Kohtz.



Figure 4: Project for trade fair tower in Leipzig, by E. Haimovici & R. Tschammer, 1920.

Source: Neumann, D., 1999. *Film Architecture: Set Designs from "Metropolis" to "Blade Runner"*. 1st ed. New York, Prestel.

Metropolis, therefore offered a rationalized German critique to the chaotic mess of America's dark city streets. While the old Gothic cathedral at the end of the film clearly identifies the city as German [Fig. 5], it is the central view onto the skyscrapers and the new spirituality of the dominant central tower that makes this a pessimistic re-interpretation of the modern city. By personifying skyscrapers with the status of film stars, *Metropolis* succeeded in elevating the debate about monumentality and the high-rise to a

new international level. The film had an almost immediate impact on urbanistic visions portrayed in other films and in popular culture, where the debate openly continued (Neumann, 1999).

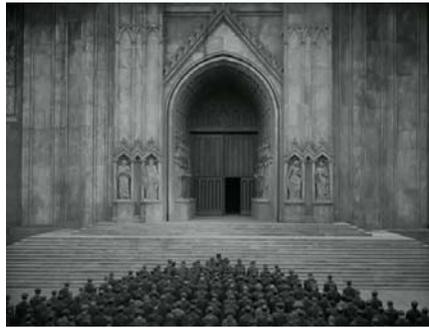


Figure 5: The final seen of the Cathedral in Metropolis (1927).

4. *The Science Fiction City*

Tracing the development of the 'science fiction city' throughout cinematic history in terms of the vertical and the horizontal, it is discernible that prior to the 1950s, it was "the vertical, lofty and aerial quality of the city" of such films as *Just Imagine* (1930) and *Things To Come* (1936), rather than the city's pedestrian and base horizontality, that was being highlighted. Indeed, the prevalent Modernist society of the period equated "height" with the active reach of human aspiration, and "the loftiness" of the city as its most aesthetically significant social value.

Cultural geographer Yi-Fu Tuan explains: *"The vertical versus the horizontal dimension? [A] common response is to see them symbolically as the antithesis between transcendence and immanence, between the ideal of the disembodied consciousness (a skyward spirituality) and the ideal of earth-bound identification. Vertical elements evoke a sense of striving, a defiance of gravity; while the horizontal elements call to mind acceptance and rest."*

The science fiction city of the late 60s to the 70s poeticized neither highness nor fullness as positive values. On the contrary, both types of signifiers reflected a perceived sense of negativity in which cities have "turned in on themselves to become lowering oppressiveness and overcrowded" (Sobchack, 1999).

Indeed, if the utopian science-fiction city is perceived as aspiring, then the science fiction city during this period is dystopian and perceived as asphyxiating.

In the science fiction films of the 70s, visual horizontal elements juxtapose the less positive modes of existence: resignation, stasis, asphyxiation and death; with more positive active modes: expansion, dispersion and play. The *Soylent Green* (1973), visualizes a New York City that no longer aspires but suffocates and expires. Emphasis is not on the height of buildings but on their baseness. Verticality is no longer significant- and the city's horizontal dimension stresses its limitations, not its openness (Sobchack, 1999). [Fig. 6]



Figure 6: The horizontality in Soylent Green (1973), emphasis on the limitation.

By the 80s, the idealized and lofty science fiction city is imagined as completely decentred and marginalized. The postmodernist city has no centre, it is all centre or else all decentred, dispersing its

activities in all directions. This is evidenced by the fact that despite having record breaking skyscrapers, the Los Angeles of *Blade Runner* (1982) has little to do with verticality and lofty aspiration. The “trajectory of our attention tends to stay grounded” (Horsley, 1994). This LA is literally exhausted, generating “the strange blend of hysteria and euphoria” that comes with utter fatigue.

In the 90s urban science fiction assumes another dimension: the city here is not only “grungy” like Ridley Scott’s Los Angeles but also bottomless and, in various ways, unfathomable. In *Dark City* (1998) the entire plot specifically emphasizes and visually “concretizes the rootless, vertiginous and insecure sense that the city is groundless in both time and place” (Sobchack, 1999).

In *The Fifth Element* (1997) buildings’ tops and bottoms recede into invisibility [Fig. 7]. This dizzying and densely layered labyrinth of architecture and motion; it is neither skyscraper (there is no visible sky as such) nor ground.



Figure 7: The unfathomable depth of the city in *The Fifth Element* (1997). There is no sky, and there is no ground.

In the future cities of the late 90s, such as those experienced in *Dark City* (1998) and *The Matrix* (1999) invisible forces render the metropolis liquid, literally dissolving and coagulating it in front of the viewer’s eyes. This is attributed to a general loss of existential co-ordinates experienced in the contemporary metropolis.

In *Equilibrium* (2002), the role of verticality comes with a political significance. Visual effects supervisor Tim McGovern worked alongside Kurt Wimmer and Wolf Kroeger to formulate the look of the walled Librian metropolis. McGovern, who won an Oscar for *Total Recall* (1990) started with a theme of grandiosity. He explains: “*The whole idea of fascist architecture is to make the individual feel small and insignificant so the government seems more powerful and I continued that design ethic in the visual effects* [Fig. 8]. *For example, Libria is surrounded by a seventy-five feet high wall, the walls just keep going on and on and use vertical and horizontal lines in a Mondrian-type way*” (Momentum Pictures, 2002).



Figure 8: The insignificance of the people in the fascist city of Libria is emphasized by the grandiosity of the buildings surrounding them (*Equilibrium* 2002).

5. *Class Division & the Architecture of Status*

Despite the promise of greater efficiency and more goods for less work, the machine age has proven that relatively few people benefit from the apparent advantages of mass production. The fruits of a capitalist society are not shared equally; it is the factory owners and investors who reap most of the economic gain. As production becomes more efficient and automated, fewer workers are needed, and therefore, lower wages are implemented. The process results in a state of industrial poverty and the stratification of

society which in turn leads to social animosity. Thus, the metaphorical machine for living seems to be designed to maximize the profits of the capitalist rather than to provide a better standard of living for the workers (Smethurst, 2003).

The conflict of class and its architectural manifestations are most strongly pronounced in Fritz Lang's *Metropolis* (1927). In the film there is a clear separation between the workers' city found deep underground [Fig. 9], and the Edenic pleasure garden environment enjoyed by the elite in their skyscrapers [Fig. 10]. Each citizen's place in the social hierarchy is expressed in physical terms by the level of the city in which they live: workers at the very bottom, the rulers at the top, and the machine in between. The elimination of contact between the different layers of the city removes the possibility of communication, and further aggravates the social divide (Jin, 2003).

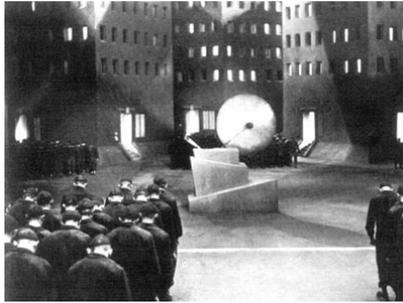


Figure 9: The Workers' Underground City (*Metropolis*, 1927).



Figure 10: The City of the Sons, from above (*Metropolis*, 1927).

Status is understood through the types of architecture the characters inhabit. The offices and apartments of the "Thinkers" are inspired by the then brand new Art Deco style, and also infused with an air of De Stijl. Underground, in the workers' city, there is an obvious difference in the architectural setting. Masses of workers and children dwell in the depths of the earth, forever bound to a life under sewer systems and water supply pipes. Here in the narrow sunless streets, life is crowded and undesirable. Buildings are twisted and monumentally scaled, windows too small, ceilings oppressively low, interiors devoid of any comfort and a feeling of claustrophobia prevails. Everything is dark, dreary, and deprived of emotion. A kind of prison at the scale of the city (Boake, 2003). This mindless world of discipline and duty is almost like a "gigantic forced labour camp cunningly disguised as a society" (Hermansson, 2003). [Fig. 11 and Fig. 12]



Figure 11: "In the Elevator" concept drawing for *Metropolis*, (1927).



Figure 12: Freder works the machine (*Metropolis*, 1927).

The cityscape in *Metropolis* is divided between high and low: the city dwellers who live above the ground are contrasted to, and in conflict with, those who dwell beneath the streets. This dialectic above/below corresponds to a difference in class. The workers labour below; the upper classes who benefit from their labour frolic above. Scenes of upper-class life revolve around pleasure, while scenes of the workers reveal mechanized, depressed figures who seem barely human. Lang envisioned the high vs. low, upper class vs. working class dichotomy as inevitable, but not necessarily inevitably in conflict (Desser, 1999).

The biblical associations abound, with the workers toiling away in Purgatory on gigantic machinery, surviving despite back-breaking labour and regimented assembly-line work; and the masters enjoying the benefits in the above ground Paradise city that the machine supports (Smethurst, 2003). The biblical association is carried further throughout the film, with direct references being made to the Tower of

Babel story [Fig. 13]. The story of Babylon is the universal symbol of man equating himself with God through built form (Boake, 2003).

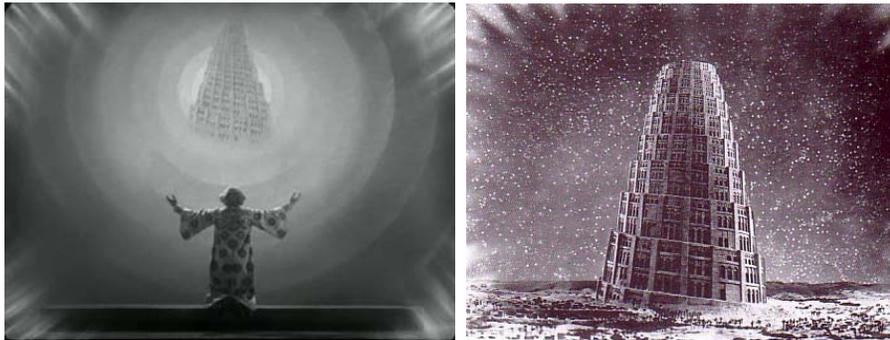


Figure 13: The Tower of Babel (*Metropolis* 1927).

The film thus foreshadows what would happen if industrialization was allowed to go too far. The tower of the scriptures was essentially built by the many for the piety of the few. The implication is that the city is also a modern Babel, built by the workers for the benefit of the few.

The world of *Metropolis* shares something with that portrayed by H.G. Wells' great science fiction adventure novel, *The Time Machine* (1895). While on the surface the world of the year 802,701 (just like the City of the Sons, in *Metropolis*) appears to be a beautiful utopian-like society that wants for nothing. However, the Time Traveler soon realizes that things are not as they seem. An excessive capitalistic state which separated the haves and the have-nots, through the slow process of evolution, has resulted in the creation of two new species, thus perpetuating the class war. The descendants of rich capitalists, The Eloi, live above ground leading a leisurely existence in a kind of paradise while the descendants of the factory workers, the Morlocks, exist below the surface, running the machinery necessary for the Eloi to survive. Lang's film seems to be showing the early stages of this dichotomy. However, while Wells' approach is essentially Marxist, Lang's is the direct opposite, preaching not Marxist inspired class warfare but a non-violent religiously inspired reconciliation between the classes (Kuhn, 1999).

To help understand why the city in *Metropolis* (1927) is depicted in this fashion, there are a number of aspects to keep in mind about the environment in which the film was produced. Germany at the midpoint between World War I and World War II, was a country where manufacturing was still the king of the economy, even though the economy itself was "in shambles, inflation was out of control and the National Socialist, or Nazi, party was starting to come to prominence". However, the majority of the wealthy Germans lived high above the poverty of the common citizen. *Metropolis* thus tried to portray the city that might have risen from Germany's despair, and it has very often been considered to be just an elaborate piece of Nazi propaganda. In fact, the film was much loved by Hitler and Fritz Lang was even offered a job creating films for the Third Reich. Lang, being half Jewish, however, refused the offer and escaped to the United States where he continued his successful career (Swett, 2001).

If *Metropolis* (1927) attempted to create a German response to the skyscraper, *Just Imagine* takes the skyscraper to its most American incarnation. The set-back skyscraper of the 1920s was a direct result of the New York Zoning Laws of 1916. While Hugh Ferriss (1929) attributes the evolution of this form of high-rise to the solution of the oppressive shadowing of whole neighbourhoods by adjoining skyscrapers; the architectural historian Francisco Mujica argues that the similarities of such buildings to Mesoamerican pyramids makes them distinctly and historically American (Neumann, 1999).

Ridley Scott's *Blade Runner* (1982) like *Metropolis* (1927) reveals class structure through its vertical architecture. The film accepts street-level squalor as a given, and attempts to expose the vertical corruption inherent of utopian societies gone awry. The wealthy and affluent rule in their Paolo Soleri inspired Archologies, while "the poor swarm in seemingly subterranean warrens". Unseen, but alluded to, is a third area in the film: the 'off-world' colonies. Only those who qualify are relocated to the colonies, leaving behind, in the cities, those who are beyond redemption (Bullock, 1991).

The figuration of racism in *Blade Runner* translates into the high/low spatial metaphor present in *Metropolis* and other films. The replicants and the people of colour inhabit the teeming, rain-soaked streets, as police craft hover above giant television screens beaming down their audio-visual messages to a population which cannot take advantage of the advertisements' promises of a better life off world. Deckard, the blade runner assigned to kill a group of replicants, similarly lives high above the crowded

streets, protected by ultra-modern security devices and other high-tech equipment. Highest of all, though resides Eldon Tyrell, technocrat extraordinaire and Master of LA's Metropolis, in a pyramid some seven hundred storeys high (Desser, 1999).

Far above the decadence of the streets are the peaks of skyscrapers. In these high places, detached from the world below, live the elite privileged by the illumination of a still discernible sun. The grandiose solemn interior of Tyrell's Office [Fig. 14] is intended to have a Neo-Fascist and almost Gothic look to physically strike fear in the visitor. With ten meter high columns and huge windows that overlook the cramped streetscape of the lower class, Tyrell's spacious office symbolizes the power of the capitalist over the workforce below (Lam, 2003).

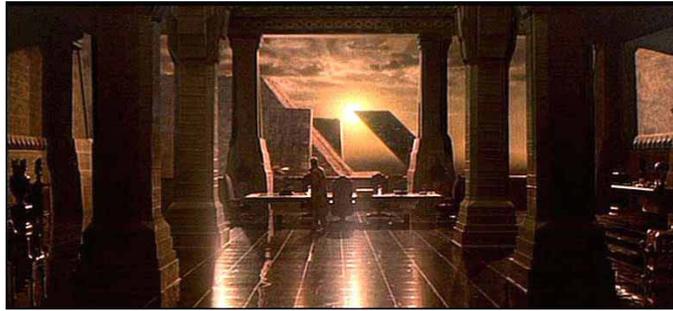


Figure 14: Tyrell's office: frightening scale and power. The only place in the city that can still see the sun (Blade Runner, 1982).

Architecture and its association with capitalist status is also represented in *The Fifth Element* (1997). The tower Zorg inhabits [Fig. 15] represents a literal translation of being at the top of the hierarchy. Unlike the Tyrell Corporation's Ziggurat or The New Tower of Babel; Zorg's tower, however, does not take up a central and dominating position. The building is one of the tallest in the city but not the most prominent. In fact, the New York of 2259 seems to lack such a central vertical element.



Figure 15: Zorg's tower reaches into the New York sky (The Fifth Element, 1997).

The *Batman* films (1989 - 2005) point to a continuing thread of corruption in 'high places'; referring both to the habitual action of villains to establish their bases of operation in penthouse lofts. Gotham Cathedral's central location within the cityscape symbolizes the importance religion must have once possessed in the city. The dark silhouette of the Cathedral looms in the lit up skyline as a reminder of the forgotten values of a now predominately capitalist and corrupt society [Fig. 16].



Figure 16: The Cathedral in Gotham City as the center of the cityscape symbolizes the importance religion must have once possessed in the city (Batman 1989).

The paradigm of architectural spatial patterning representing the above/below is transformed in the 1971 film *THX-1138* into the inside versus the outside. The totalitarian computers which seem to run this colorless future culture have decreed that its citizens must live inside a protective shell, outside which there is nothing but desolate waste. This concept of a shell, literalized on the spatial level with its stark white, empty interiors and, a total absence of exterior space, is symbolized on the social level [Fig. 17].

The citizens are completely cut off from genuine emotions and personal connections, isolated by drugs and constant computer monitoring. Names have been replaced by letters and numbers; conformity is ensured by physical resemblance - all the inhabitants have shaved heads and wear stark white uniforms. All differences - of class, race and gender have thus been eliminated. To assert difference is to take the first step towards rebellion (Desser, 1999).



Figure 17: The stark white empty interiors in *THX-1138* (1970), emphasis the social status of its inhabitants.

The monochromatic approach to architectural colour in *THX-1138* was taken to its extreme in *Equilibrium* (2002) with the addition of a political agenda. Libria is a stark, black-and-white (colour, after all, evokes feelings) metropolis [Fig. 18], which is run by a mysterious dictator named the Father who wields power through a group of Ninja-like "clerics" who enforce his vision of peace through the chemical control of all emotion.



Figure 18: The stark, black-and-white buildings of Libria revealing a community deprived of all its feelings (*Equilibrium* 2002).

Equilibrium presents a vision of a world at peace, with a tremendous human cost. This is a world where war is a distant memory, yet where there is no music, no art, no poetry, where anyone who partakes in such banned activities is guilty of a "Sense Offence," a crime that carries a death sentence. It is a world where the age-old question "How do you feel?" can never be answered because all feelings have been shut out. The bland-hued architecture of the city of Libria reveals a society deprived of its emotions [Fig. 19]. On the other hand, the Father inhabits a fully decorated, coloured, and ornamented house contrary to the houses of his people who are not allowed to use colours or any artefacts, as it signifies the existence of feelings among them [Fig. 20]. The whole architecture of the film resembles a fascist political state (Momentum Pictures, 2002).



Figure 19: The minimalistic monochrome interiors of people of the city of Libria (Equilibrium 2002).



Figure 20: The colorful and decorated place where the dictator of the city stays is the opposite of that of his people (Equilibrium 2002).

6. *Architecture, Control & Manipulation*

The modern city is perceived in science fiction films as a labyrinth with a mastermind-like power lying unseen at its centre. The Master's power to control events is inversely proportional with the citizens' capacity to perceive what is happening. The grip of such a society on its citizens is embodied in the controlling and moulding effect of the city's architecture, achieved through a twisted reversal of the ideals of Architectural Determinism (Lyssiotis and Mcquire, 2000).

The large and ominous buildings in *Brazil* (1985), for example, seem to engulf and stifle their human counterparts. In some respects, the external world tries to force control on the internal world of the mind (Hamel, 1998). The ducts are interpreted as an umbilical link between the civilians and their centralized government; they are a clear symbol of the internal complexity and lack of organization of the modernist machine.

In *Blade Runner* (1982) the physical exposure and vulnerability of street level space makes it a realm where people are unable to see and know, or to escape being seen. In *Things to Come* (1936) control is achieved through stylistic uniformity. Meant to convey a sense of order, efficiency and peacefulness; the unity of form and finish, the blankness of the buildings, the uniformity of dress, and the lack of vitality on the streets; are all evidences of a social system that favours the collective over the individual. The overwhelming artificiality of Everytown creates an environment where everything is closely controlled and monitored.

In *Equilibrium* (2002), the city of Libria [Fig. 21] presents a controlled state taken to its extremes. The emotion suppressing state's agenda is clearly expressed through the city's architecture. Buildings, like the people that inhabit them are faceless and devoid of any feeling. The fascist's states media manipulative machine is inbuilt into the infrastructure of the city: giant billboards overtake whole build facades, and loud speakers that air a constant stream of propaganda are located at every corner (Spicciati, 2002).



Figure 20: Libria: a fascist state where all citizens are rendered emotionless by the state (*Equilibrium*, 2002).

7. Conclusion

This paper provides a considerable insight into of the significance and motives behind the architectural elements implemented in science fiction films. It is evident that the altitude of buildings acts as an architectural signifier and as a metaphor for both the social status of the members of the society, and as a metaphor for the struggle between the rich and poor, the haves and have-nots, and the thinkers and the workers. A noticeable recurring trend is that the elite of the society inhabit the upper part of the city buildings and live in compositions of large geometric forms, while the lower classes inhabit the lower parts of the city.

Regardless of the status of the protagonists in science fiction films, the places where they live and work portray a lot about their personalities starting from social status to their ideologies and mental state. However, the architectural style remains the main signifier used by filmmakers to convey the real personalities of the protagonists. Throughout the history of science fiction films it is the modern style that always accompanies the dominant personalities and is used as a signifier for the state of imprisonment and entrapment the protagonists suffer, while the vernacular and classical styles accompany those of a lower status.

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The Role of Managerial Innovation in Improving Human Resource Performance at Bahrain Sport Federations

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Abstract

This research investigates the impact of managerial innovation in improving human resource performance at Bahrain Sport Federations. Literature shows that managerial innovation has proved its positive impact, but when it comes to Human Resource Performance, little research has been carried out in this regard. The Kingdom of Bahrain pays great attention for sports because it is considered one of the vital elements that contributes to achieve the Kingdom's vision 2030. This justifies why innovation, in the last two decades, has been the focus in business literature, reports and government policy. Little attention, however, has been given to the possible impact of managerial innovation on human resource performance. In order to clarify matters, this paper evaluates the impact of managerial innovation on the human resource performance at Bahrain Sport Federations. The data are gathered through questionnaire distributed to the employees who work at Bahrain Sport Federations and are analyzed through the SPSS v.23 software.

Keywords: Managerial Innovation, Human Resource, Performance, Bahrain Sport Federation.

1. Introduction

Organizations of all types, sizes and tasks face a common challenge: they need to raise the level of their human resources so that they can adapt to the requirements of rapid change. Modern organizations are stepping up efforts to improve the performance of their human resources and devote a large part of their budget to finding ways to improve performance. (Walker, Chen, Aravind 2015).

In the last period, the Civil Service Bureau issued directives on the performance management system. These directives seek to improve the performance and improve performance in the public sector, which is based on the vision and aspirations of the Kingdom of Bahrain, which aspires to optimize the utilization of human resources with a high degree of effectiveness that can contribute in improving the performance of human resources and creating an effective environment (Miniaoui & Schilirò , 2016).

Innovation is the leading characteristic of successful organizations in today's business, in addition, innovation as a managerial concept has become vital asset and competitive edge for many organizations operating in rapidly changing, complex and competitive environments (Awan & Javed 2015). Therefore, managerial innovation has an integrated and effective role and is a fundamental process in improving the performance of human resources, which is a key requirement in order to keep pace with and improve the performance of organizations and human resources.

Creativity is considered the appropriate organizational environment for human resources in all sectors as it has a great role in the sports sector and from it we see its active role in sports federations and it is a manifestation of human behavior which reflects positively on the human resource by giving their children creative abilities and abilities and exploiting them to optimize their performance and research For creative and creative solutions to the problems they may face. (Walker, Chen, Aravind 2015).

The honing of the skills and abilities of subordinates and the development of their skills and work within the team and raise their morale may contribute to achieving the desired goals to achieve local and international championships and reach the global and raise the name of the Kingdom of Bahrain.

The majority of the organizations are working to define the concept of human resources performance in order to know the factors, gaps and deviations that may adversely affect the performance of their human resources and work on the performance of their human resources in order to meet the challenges that may face the organization. Correct and evaluate these factors, deviations and fill the gaps (Awan & Javed 2015).

1.1 Problem Statement

One of the biggest challenges in the public sector is to improve the human resource performance and to try to bridge the gap between the actual human resource performance and the expected performance of them. The sports sector is one of these sectors and given the current sport status in Bahrain and the attention of the leaders, and found that there is an urgent need to improve the performance of human cadres in order to fit the progress and development and achieve competition among the countries of the world, it is necessary to pay attention to improve the level of human resource performance to keep pace with this development and growth, Bahraini all sports federations concerned with the performance of its human resources and achieved the preparation of management through managerial innovation (Miniaoui & Schilirò , 2016).

The main challenge of many federations is to contribute to local and international championships and to win and win championships which in turn can raise the name of the Kingdom of Bahrain in the field of sports by improving the performance of human resources starting with the administrators in all sports federations of the Bahrain Olympic Committee through Change and improvement through the development of the capabilities and skills of creative individuals and achieve the desired objectives of the different federations (Ahmed and Hamdan 2015).

Although the sports federations in the Kingdom of Bahrain have been successful in different areas, they have a number of obstacles to improving the performance of their human resources: late completion of work, inability to adapt to working conditions and responsibility (Zhang, Khan, Lee, & Salik 2019). Hence, solutions must be found that may contribute to overcome the obstacles by focusing on the abilities and skills of creative individuals represented in the creative elements of individuals, which contributes to improving the performance of their human resources and work to raise the name of the Kingdom of Bahrain internationally (Ahmed and Hamdan 2015).

The managerial innovation is a challenge to the organization and its human cadres because of its importance and a great impact on the survival of organizations and prosperity and achieve the competitive advantage that aspires to achieve, so it is necessary to reduce dependence on the traditional approach to address the problems and challenges, whether internal or external that may oppose the organization and try to intensify efforts to employ the curriculum Which has a significant role in improving the performance of human resources in organizations (Osman, Shariff & Lajin 2016).

In addition, managerial innovation is one of the basic requirements in contemporary management (Choi, Jang & Hyun, 2009), which includes several elements of the most important originality, fluency and flexibility. Authenticity can be a contributing factor in improving the performance of human resources by means of the ability to produce new ideas in the field of work and the ability to think quickly in different circumstances and not be bored with the completion of work. While fluency may contribute by giving quick solutions and applying new methods to tackle problems at work, finally, flexibility can contribute to the improvement of performance by being able to accept criticism, put ideas and suggestions and see things from different angles at work.

It is clear that there is little data and published research on improving the performance of human resources in the sports federations in the Kingdom of Bahrain. It was necessary to address and research in this field through studying the influence of the elements of administrative creativity (originality) And flexibility) in improving the performance of human resources in sport and raising the name of the Kingdom of Bahrain to achieve outstanding performance and the achievement of local and international tournaments.

2. *Literature Review*

2.1 Human Resource Performance

The concept of performance has raised the interest of researchers and thinkers in the field of management because the human factor is the main focus in organizations and human factor can be considered as one of the indicators of the level of efficiency of employees and achieve the highest level of achievement desired according to the available possibilities, the human element in his performance is one of the most important elements of the survival and growth of the Organization So that the majority of organizations are working to define the concept of human resources performance in order to know the factors that affect negatively and to work to correct and modify the shortcomings and imbalances in these (Kim, 2000).

Researchers have been interested in human resource performance and have been involved in a lot of research to find solutions to human resource performance problems in organizations. Performance is the only way to achieve the desired objectives of the Organization. Organizations are still looking for new leaders by involving individuals in decision-making and creating a system of incentives to stimulate the efforts of the organization's staff and other methods of the organization in order to improve the human resources performance (Imran and others 2012).

Performance is a sign that addresses how well a business achieves, moreover, to meet its goals and objectives with the help of a talented administration, good governance, and a constant redefining to meet the business objectives (Shouyu, 2017). Organizational performance is one of the most important concepts in management research (Ho, 2008). Researchers consider that the performance of the organization is inadequate, most researchers have used the term performance to specify the measurement of input and output efficiency and transactional efficiency (Anitha 2014).

2.2 Managerial Innovation

The concept of managerial innovation is based on the general concepts of creativity itself. Innovation in management is related to new ideas in the field of management (Prajogo 2006). Excessively improve policies, strategies and working methods and review them from time to time to ensure quality of work (Ho, 2008).

Managerial innovation can also be defined as the creation or creation of a new mechanism of action by optimizing the resources available to achieve the desired objectives at a lower cost and as quickly as possible (Choi, Jang & Hyun 2009).

The managerial innovation is defined as the initiative initiated by the manager and his ability to get out of the ordinary and traditional sequence in the idea and the way of thinking and this change is a qualitative change, through the employee's sensitivity to problems and shortcomings and knowledge of the missing elements when the creative thinking goes to the requirements of life management process in the business. Choi, Jang & Hyun (2009) believes that managerial innovation is the exploitation of creative skills in solving problems in order to achieve the general benefit of the organization and achieve its desired objectives.

Elements of managerial innovation:

1. **Originality skill:** The ability of the creative person to achieve something rare and unique and the ability to generate new ideas and innovative marketing methods or to reach a solution to the problem may be exposed to the organization (Prajogo 2006).
2. **Fluency skill:** the ability of the individual to pump a set of ideas without any hindrance in a kind of fluency:
 - Fluency recall: the ability to retrieve and recall ideas stored in mind and words quickly without confusion and add to the enjoyment of the individual intelligence and acumen.
 - Verbal fluency: the ability of the individual to launch a stream of words and words that are similar in weight and rhyme with ease.
 - Correlative Fluency: The ability of the individual to produce rapid expressions and words that are coherent and homogeneous in meaning.
 - Formal Fluency: means the ability of the individual to respond quickly and provide proofs, clarifications and examples.
 - Expressive fluency: the ability of the individual to think quickly and the formation of words and words coordinated so that the formulation of language is correct and expressive sentences.
3. **Flexibility:** Focus on type rather than quantity. It is the ability of the individual to present diverse ideas, and does not depend on thinking about fixed frameworks and boundaries, adherence to one solution but the ability to move from one situation to another and look at the problem in different ways to reach multiple solutions (Prajogo 2006).

2.3 The role of Managerial Innovation in Improving Human Resource Performance

Improving performance can be defined as the utilization of all available resources to improve output and thus process productivity and achieve technological integration that capitalizes on optimal utilization (Rajapathiran & Hui 2017).

The modern organizations adopt a philosophy of performance improvement, where they are convinced of the need to constantly improve and improve all the organizational factors that follow in the organization and affect the performance of the employees from the top leaders to the organizational levels in all areas

of the organization's activity, the organizations rely on improving performance according to the plans they adopt in this regard. It also achieves important goals related to quality and performance Shouyu 2017).

2.4 The role of originality in improving the human resource performance

The performance of human resource and its link with innovation is a complex and multidimensional concept. The emergence of the creative individual with new and new ideas for the ideas of peers can therefore judge the idea in the original, when these ideas are not subject to the ideas of the conventional and out of the ordinary and distinct, and the greater the degree of production of new ideas and said the prevalence and departure from traditional growth has increased its authenticity, The level of human resources performance and thus contribute to improving the performance of the Organization in general, we can summarize the above, that when the individual generates a set of new creative ideas helps improve performance and achieve the best returns for organizations and work and achieve the Meet growth and that contribute to achieving better financial returns and the best service (Karabulut, 2015). In line with the views about The past studies such as Shouyu (2017) aimed to identify the relationship between creativity and the types and performance of employees in an insurance company in Sri Lanka, and one of the most important findings of the study is that effective management can help to provide more creative and effective results to improve the performance of employees for the better and thus reach the company desired objectives.

There is positive statistically significant influence at ($\alpha \leq 0.05$) of originality on human resource performance at Bahrain Sport Federations.

2.5 The role of fluency in improving the human resource performance

Fluency, which includes the quantitative aspect and is meant to be able to call the largest number of ideas suitable for a particular position within a relatively short period of time, which helps to improve performance and achieve the best returns for organizations and work to achieve the competitive advantage of sustainable and survival and growth and achieve the best results and services, which helps to improve the performance of the organization And reach their desired goals (Karabulut, 2015).

There is positive statistically significant influence at ($\alpha \leq 0.05$) of fluency on human resource performance at Bahrain Sport Federations.

2.6 The role of flexibility in improving the of human resource performance

It includes the qualitative aspect of creativity and we can know flexibly is the diversification of ideas that come from the individual, and flexibility is meant to look at things from several aspects and the ability to move from one situation to another and look at the problem in different ways to reach multiple solutions. All this contributes in one way or another to improve performance and raise its standards for the better and achieve the organization's goals (Karabulut, 2015).

The flexibility of human resources allows the organization to adapt to the various requirements, both internal and external, thus helping the organization to achieve competitive advantage through the outstanding performance of its employees.

There is positive statistically significant influence at ($\alpha \leq 0.05$) of flexibility on human resource performance at Bahrain Sport Federations.

2.7 The Framework of Research

According to literature review (Karabulut 2015; Nusair 2013; Prajogo 2006), the research proposed model of research contains the managerial innovation as independent variable and human resource performance as dependent variable. Figure (1) shows the model of research.

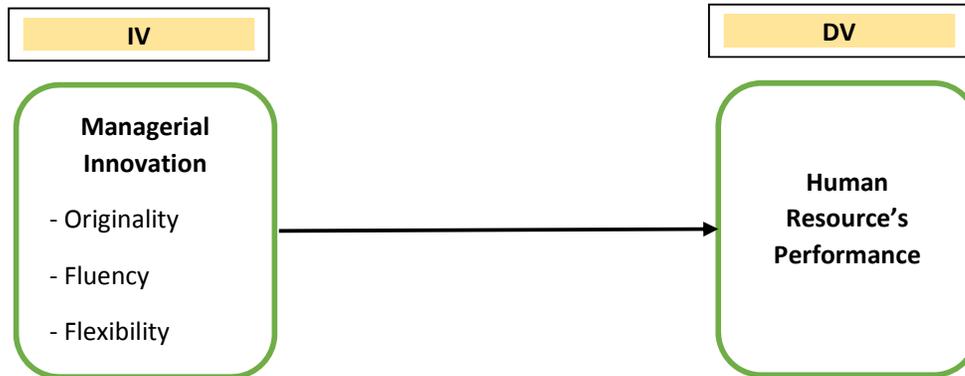


Figure 1: The Framework of Research

3. Research Methodology

3.1 Sampling Design

The research used a quantitative approach to determine managerial innovation (the independent variable), influence on human resource performance (the dependent variable), at Bahrain Sport Federations. The population of this study includes all administrative staff at Bahrain Sport Federations. A total of (170) questionnaires were distributed and (162) responses were retrieved. Four questionnaires were not completed in the analysis. The total number of final questionnaires was (158), the response rate (93%).

3.2 Participants

The demographic data sort from the respondents included the percentage of males (74.7%), while the percentage of females (25.3%). This reflects the nature of the functional distribution of workers in Bahrain Sport Federations. The percentage of age (from 36-45 years) was (37.3%). The largest number was followed by age (46 years and over) of (34.2%). The lowest number was 25 years and less (7.6%). According to the qualification level, there is a convergence in the distribution of the sample of the study on the first three categories, where a qualified bachelor degree (33.5%) of the sample and a qualified campaign form a diploma (31.0%) of the sample and a general secondary qualification campaign (27.2%), While the qualifying campaign form a graduate ratio (8.2%). The percentage of experience (11 years and over) reached (48.8%) and was the largest number, followed by the experience rate (6 years - 10 years) was (37.3%).

4. Result

Table 1 presents the internal consistency reliabilities (Cronbach's Alpha), means, standard deviations, and Pearson correlations of variables for the 158 participants. As shown in Table 1, the Cronbach's Alpha for the human resource performance measure was .89. The three sub-scales of the 21 items for the independent variable managerial innovations (originality, fluency and flexibility) also have satisfactory reliability values ranging from .72 to .82. To conclude, managerial innovations (originality, fluency and flexibility) were significantly positively correlated with human resource performance ($p < 0.01$). This result implies that the higher the originality, fluency and flexibility provided by the organization, the higher the human resource performance among the participants.

Table 1: Reliability statistics, descriptive statistics and correlations

Variables	α	M	SD	1	2	3	4
1. Originality	.72	4.05	.55	-			
2. Fluency	.82	4.19	.59	.76**	-		
3. Flexibility	.75	4.21	.55	.72**	.85**	-	
4. Human resource performance	.89	4.03	.53	.50**	.56**	.50**	-

Note: n=158; **p<0.01; α = reliability; M = mean; SD = standard deviation

Table 2: Regression analysis

Model	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
				R Square Change	F Change	df1	df2	Sig. F Change
1	.326	.313	.4393	.326	24.839	3	154	.000

a Predictors: (Constant), IV1, IV2, IV3

As shown in the above table, it is clear from the results that there is a positive and statistically significant relationship between the originality, fluency and flexibility and human resource performance among employees. Increasing the level of originality in the sports federations for the employees leads to improving the performance of human resources in them.

5. Discussion

The research found that; there is positive statistically significant influence of managerial innovations on human resource performance at Bahrain Sport Federations. It is clear from the results that there is a positive and statistically significant relationship between the originality, fluency and flexibility and human resource performance among employees. Increasing the level of originality in the sports federations for the employees leads to improving the performance of human resources in them. This result is consistent with previous studies such as (Prajogo, 2006), where the results showed that managers working in the ministries of Gaza exercise the element of originality as one of the elements of administrative innovation at a very high level. The empirical analysis shows that the managerial innovations can play an important role in enhancing positive outcomes for organization and employees.

6. Practical Implications

To examine the influence of managerial innovation on human resource's performance. Based on empirical evidence, our model offers several guidelines for top managers, CEOs and practitioners for determining their strategies and policies for superior human resource performance. We recommend business organizations to emphasize managerial innovation to enhance performance rather engaged in traditional practices and mass production. Organizations that are more likely to acquire a greater human resource performance can promote managerial innovation. Our findings provide valuable insights into the decision-making process and inform managers to make proper decisions e.g., invest in managerial innovation. The traditional approaches may not provide adequate results in the current era. Hence, business organizations, especially in marketplaces, need innovative practices to continue in the long term.

7. Conclusion, Limitations and Future Research

To sum up, in this paper, we investigate the relationship between managerial innovation (originality, fluency and flexibility). In order to improve the human resource's performance, should highly concentrate on originality, fluency and flexibility innovation activities.

Even though having some implications, this research is not free of limitations that should be considered in future studies. In particular, our review is limited to the significant types of innovation (managerial innovation) only. Though, there are numerous innovations; process innovation, product innovation, organization innovation, and marketing innovation etc. that may influence human resource performance.

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Innovative Field Applications of Fiber Reinforced Polymer Composite Reinforcing Bars in Civil Engineering Infrastructures

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Abstract

In the last decade, there has been a rapid increase in using noncorrosive fibre-reinforced polymers (FRP) reinforcing composite bars for concrete structures due to enhanced properties and cost-effectiveness. The FRP bars have been used extensively in different applications such as bridges, parking garages, tunnels and marine structures in which the corrosion of steel reinforcement has typically led to significant deterioration and rehabilitation needs. Many significant developments from the manufacturer, various researchers and Design Codes along with numerous successful installations have led to a much higher comfort level and exponential use with designers and owners. After years of investigation and implementations, public agencies and regulatory authorities in North America has now included FRP as a premium corrosion resistant reinforcing material in its corrosion protection policy. This paper presents a summary and overview of different recent field applications of FRP bars in different types of civil engineering concrete infrastructures.

Keywords: innovation, reinforced polymer, reinforced bars, fiber, civil engineering, applications.

1. Introduction

Electrochemical corrosion of steel is a major cause of the deterioration of the civil engineering infrastructure. It is becoming a principal challenge for the construction industry world-wide. An effective solution to this problem is the use of corrosion resistant materials, such as high-performance fibre-reinforced polymer (FRP) composites, (Benmokrane et al. 2002; Mohamed & Benmokrane 2014). The applications of FRP reinforcements in the last 10 years have been approved that the cutting-edge technology has emerged as one of the most cost-effective alternative solutions compared to the traditional solutions. The use of concrete structures reinforced with FRP composite materials has been growing to overcome the common problems caused by corrosion of steel reinforcement. The climatic conditions where large amounts of salts are used for ice removal during winter months may contribute to accelerating the corrosion process. These conditions normally accelerate the need for costly repairs and may lead to catastrophic failure.

Known to be corrosion resistant, FRP bars provide a great alternative to steel reinforcement. FRP materials in general offer many advantages over the conventional steel, including one quarter to one fifth the density of steel, no corrosion even in harsh chemical environments, neutrality to electrical and magnetic disturbances, and greater tensile strength than steel (Benmokrane et al. 2006; 2007).

The objective of this paper is to show that FRP bar is on its way toward gaining widespread acceptance in worldwide. Clearly, the most tangible successes are in the area of highway reinforced concrete bridges, tunneling, water tank, and concrete pavement in which the corrosion resistance of FRP reinforcements as well as their installation flexibility are taken advantage of. In the following sections, development of codes and guidelines, recent field applications of FRP bars in bridges, tunnels, and water storage tank are presented.

2. Design Codes And Guidelines

A number of committees from professional organizations around the world have addressed the use of FRP bars in civil structures. These have published several guidelines and/or standards relevant to FRP as primary reinforcement for structural concrete. The recommendations ruling the design of FRP RC structures currently available are mainly given in the form of modifications to existing steel RC codes of practice, which predominantly use the limit state design approach. Such modifications consist of basic

principles, strongly influenced by the mechanical properties of FRP reinforcement, and empirical equations based on experimental investigations on FRP RC elements.

In North America, several codes and design guidelines for concrete structures reinforced with FRP bars have been published from 2000 to 2014. In 2000, the Canadian Highway Bridge Design Code (CHBDC) [CAN/CSAS6-00, (CSA 2000)] has been introduced including Section 16 on using FRP composite bars as reinforcement for concrete bridges (slabs, girders, and barrier walls). Design manual (ISIS-M03-2001) for reinforcing concrete structures with FRP was presented by the Canadian Network of Centres of Excellence on Intelligent Sensing for Innovative Structures (ISIS). In 2002, CAN/CSA-S806-02 has been published by the Canadian Standards Association (CSA 2002) for design and construction of building components with FRP bars.

The American Concrete Institute (ACI) introduced the first, second and third guideline (ACI 440.1R) for the design and construction of concrete reinforced with FRP bars in 2001, 2003 and 2006, respectively. The ACI 440.1R design guidelines are primarily based on modifications of the ACI-318 steel code of practice (ACI 318-02, 2002). As a result of the valuable, enormous and great research efforts on different types of FRP-reinforced concrete structures in worldwide during the last decade, the aforesaid North American codes and design guidelines have been updated and modified to encourage the construction industry to use FRP materials [CAN/CSAS6-14; CAN/CSA-S806-12; ACI 440.1R-15].

Nowadays, the CAN/CSA-S806-12 (2012) is the most recently issued Canadian guidelines on the design and construction of building components with FRP. The CSA S806 has been completely revised. Many of its provisions have been improved based on the latest research results and experience in the field. The CSA S806-12 contains new provisions on: punching shear at slab-column connections with or without moment transfer, confinement of columns by FRP internal ties or hoops, design of FRP reinforced member for combined effects of shear, torsion and bending, reinforcement development length and detailing, strut and tie model for deep beams, corbels and brackets, shear strengthening of reinforced concrete members by externally bonded reinforcement, and FRP retrofit of reinforced concrete members for enhanced seismic resistance. The new standard covers all the basic design requirements for FRP reinforced and retrofitted structures.

In addition to the design of concrete elements reinforced or prestressed with FRP, the guidelines also include information about characterization tests for FRP internal reinforcement. As for the predominant mode of failure, the CSA S806-12 remarks that "all FRP reinforced concrete sections shall be designed in such a way that failure of the section is initiated by crushing of the concrete in the compression zone". In this code, new design equations are included for design punching shear capacity of FRP-RC flat slab. Also, it is of interest to mention that this code permits of using FRP bars in columns and compression members.

In order to establish stringent guidelines and values for FRP manufacturers and quality control mechanisms for owners to ensure a high comfort level of product supplied, ISIS Canada together with the manufacturer had initiated the "Specifications for product certification of FRP's as internal reinforcement in concrete structures". (ISIS Canada Corporation 2006) This document was the basis for the new Standard CSA S-807-10 on Specification for Fibre Reinforced Polymer (FRP). This Standard covers the manufacturing process requirements of fibre-reinforced polymer (FRP) bars or bars that are part of a grid for use in non-prestressed internal reinforcement of concrete components of structures (e.g., bridges, buildings, and marine structures). The FRP bars are classified on the basis of their fibres, strength, stiffness, and durability. Only FRP bars made with aramid, carbon, or glass fibres are considered in this Standard.

3. FRP Composite REINFORCING bars

3.1 Advantages

The technology of reinforced concrete is facing a serious degradation problem in structures due to the corrosion of steel bars. In North America, the repair costs are estimated to be close to 300 billion dollars. Several options have been explored, most notably the use of galvanized steel rebar, epoxy coated or stainless steel. The results, however, have been disappointing as these solutions have turned out to be less than effective or cost prohibitive. The FRP bars have proven to be the solution. Lightweight, corrosion resistant, and offering excellent tensile strength and high mechanical performance, FRP bar is installed much like steel rebar, but with fewer handling and storage problems. The material cost might still be higher compared to the costs of conventional steel products, but this fact is more than compensated with the lesser maintenance work involved during the lifetime of the structure. Also, the

weight of a FRP bar is only a fourth of its steel counterpart, having the same dimensions. Combined with the flexibility of the bars this allows an easy installation even in confined working space or where the support of lifting equipment is not available. The most commonly manufactured fibers employ glass and carbon. E-glass is the most common fiber because of its strength and resistance to water degradation. It is also used as an electrical insulator.

On the technical level, FRP products have important advantages. FRP reinforcement bars can be used in tunnel application as soft-eyes have a very high tensile strength which can reach far over 1200 N/mm². Besides flexibility, elasticity and the minimal environmental impact the GFRP bars can be cut with working tools like saws, piling/drilling equipment and TBM tools. This avoids damages to cutter heads and does not delay the work progress as piling or cutting through GFRP bars is unproblematic. The fiber bars are split in small pieces which do not harm slurry pipes.

3.2 Mechanical Properties

The mechanical properties of FRP bars are typically quite different from those of steel bars and depend mainly on both matrix and fibers type, as well as on their volume fraction, but generally FRP bars have lower weight, lower Young's modulus but higher strength than steel. The most commonly available fiber types are the carbon (CFRP), the glass (GFRP) and the aramid (AFRP) fibers. Table 1 gives the most common tensile properties of reinforcing bars, in compliance with the values reported by CSA S-807-10.

Table 1 Typical Mechanical Properties of GFRP Bars

Grade	Tensile Strength (MPa)	Modulus of Elasticity (GPa)	Ultimate Tensile Strain
I	588 - 804	40 - 47	0.0134 – 0.0189
II	703 - 938	50 - 59	0.0133 – 0.0179
III	1000 - 1372	60 - 69	0.0151 – 0.0211

4. Recent FRP Field Applications

4.1 Water Tank

Reinforced concrete (RC) tanks have been used for water and wastewater storage and treatment for decades. Design of these tanks requires attention not only to strength requirements, but also to crack control and durability. RC water treatment plant structures are subject to severely corrosive environments as a result of using the chlorine to treat the wastewater before it is released. So, the challenge for the structural engineer and municipalities is to design these structures using noncorrosive fibre-reinforced polymers (FRP) reinforcing bars. The first worldwide concrete chlorination water treatment tank totally reinforced with FRP bars was designed in 2010 and the construction started and finished in 2012. The project is located in Thetford Mines city, Quebec, Canada and it is considered as one component of water treatment plant for municipality. The volume capacity of the tank is 4500 m³, and it has the dimensions 30.0 m wide, 30.0 m length and 5.0 m wall height. The structural system of the tank is rectangular under-ground tank resisted on raft foundation that supports the vertical walls and top slab. The design of the tank was made according to CAN/CSA-S806-02, Design and Construction of Building Components with Fibre-Reinforced-Polymers. This included the use of High Modulus GFRP reinforcing bars (Grade III, CSA S807) as main reinforcement for the foundation, walls and top slab. The tank is well instrumented at critical locations for strain data collection with fiber-optic sensors. Figure 1 shows the FRP bar reinforcements in the vertical walls and overview of the complemented FRP tank. The field test results under actual service conditions for the strain behavior in the FRP bars at different location in the tank are indicated a significant value less the 1.0 % of the ultimate strain. In conclusion, the construction procedure, serviceability performance under real service conditions (water and earth pressure), and monitoring results of the FRP-reinforced walls and slabs of the tank, in terms of strain, cracking and deflection were very conservative and satisfactory when compared with the serviceability requirements and strength needed.



Figure 1: FRP-reinforced concrete tank, Qc, Canada.

4.2 Highway Bridge Structures

Corrosion of steel reinforcing bars stands out as a significant factor limiting the life expectancy of reinforced concrete infrastructure worldwide. In North America in particular, the corrosion of steel reinforcement in concrete bridges subjected to deicing salts and/or aggressive environments constitutes the major cause of structure deterioration, leading to costly repairs and rehabilitation as well as a significant reduction in service life. According to the 2013 Report Card for America's Infrastructure findings, ASCE, nearly one-tenth of the 607,380 bridges in the National Bridge Inventory were classified as structurally deficient. Of this total, over 235,000 are conventional reinforced concrete and 108,000 were built with prestressed concrete (NACE International). The report further states that \$76 billion are needed for deficient bridges across the United States for maintenance and capital costs for concrete bridge decks and for their concrete substructures. In addition, the United States Federal Highway Administration (FHWA) estimates that eliminating the nation's bridge deficient backlog by 2028 would require an investment of \$20.5 billion annually because of corroded steel and steel reinforcement. The report also states that "the nation's 66,749 structurally deficient bridges make up one-third of the total bridge decking area in the United States, showing that those bridges that remain classified as structurally deficient are significant in size and length, while the bridges that are being repaired are smaller in scale." Problems related to expansive corrosion could be resolved by protecting the steel reinforcing bars from corrosion-causing agents or by using noncorrosive materials such as fiber-reinforced-polymer (FRP) bars. Therefore, since the late 1990s, the Structures Division of the MT at different provinces has been interested in building more durable bridges with an extended service life of 75–150 years. For example, the MT at Québec (MTQ), Canada has carried out, in collaboration with the University of Sherbrooke, (Sherbrooke, Québec), several research projects utilizing the straight and bent non-corrodible FRP rebar in concrete deck slabs and bridge barriers (Mohamed et al. 2014; Ahmed et al. 2014; Mohamed and Benmokrane 2014). The use of FRP bars as reinforcement for concrete bridge provides a potential for increased service life and economic and environmental benefits.

In the last ten years, the FRP bars have been used successfully in hundreds bridge structures across Canada and USA, see Figure 2. These bridges were designed using the Canadian Highway Bridge Design Code or the AASHTO LRFD Bridge Design Guide Specifications for GFRP-Reinforced Concrete Bridge Decks and Traffic Railings. Straight and bent FRP bars (carbon or glass) were used mainly as internal reinforcement for the deck slab and/or for the concrete barriers and girders of these bridges. In general, all the bridges that included with FRP reinforcements though the ten years ago are girder-type with main girders made of either steel or prestressed concrete. The main girders are simply supported over spans ranging from 20.0 to 90.0 m. The deck is a 200 to 260 mm thickness concrete slab continuous over spans of 2.30 to 4.0 m. Most of these bridges have been reinforced with the glass FRP bars as a result of their relatively low cost compared to other types of FRPs (carbon and aramid). The FRP bars were used mainly as reinforcement to the deck slabs, barriers and girders.



Figure 2: FRP decks/app slabs/ barriers, Skagit River – BC MOT (2009).

Recently, the GFRP bars have been used as the main reinforcement in the deck slab of cable stayed bridges, Nipigon River Bridge, ON, Canada. The Nipigon River Bridge spans the Nipigon River in Nipigon, Ontario on Highway 11/17. A new four lane cable stayed bridge is replacing the old two lanes, four span plate girder structures. The new bridge includes cable-supported spans of 112.8 m and 139 m. The 36.2 m wide deck is comprised of concrete deck panels totally reinforced with GFRP bars and supported on transverse steel beams, see Figure 3. The objectives were to implement FRP bars in RC cable stayed bridge to overcome the steel expansive-corrosion issues and related deterioration problems; to assess the in-service performance of the FRP-RC bridge deck slab after several years of operation; and to design durable and maintenance-free concrete for cable stayed bridge. The deck slab was design to sustain significant axial compression force resulted from the cables and bending moment as resulted from the live and dead loads (Mohamed & Benmokrane 2012).



Figure 3: Cable stayed bridge, Nipigon River Bridge, ON (2015)

4.3 GFRP Soft Eyes in Tunnels

Building tunnels with Tunnel Boring Machines (TBM) is today state of the art in different ground conditions. Launching and receiving the TBM in shafts and station boxes has in earlier years required a considerable construction effort. Breaking through the steel reinforced walls of the excavation shaft with a TBM required extensive measurements and preparation works, (Mohamed and Benmokrane 2015; Schürch and Jost 2006). FRP is an anisotropic composite material with a high tensile strength in axial direction and a high resistance against corrosion.

The anisotropy of the material is quite advantageous at excavation pits for the starting and finishing processes at automated excavation like tunnel boring machine (TBM) and Pipe jacking. Therefore, using FRP bars in reinforced walls and piles of the excavation shaft allows the designer and contractor today to find innovative solutions for the well-known situation and save time and costs on site. Soft-Eyes consist usually of bore piles or diaphragm walls which are locally reinforced with GFRP bars and stirrups. The sections below and above the tunnel opening are reinforced steel bars. Depending on the designer and contractors preferences full rectangular sections are built out of GFRP bars or the fibre reinforcement follows more closely the tunnel section resulting in a circular arrangement of the GFRP links and similar adjustments for the vertical bars. Building the corresponding reinforcement cages out of GFRP bars on site requires the same working procedures as for an equal steel cage. Recently, GFRP bars have been used in different tunnel projects in Canada (South Tunnels, Keele Station, Hwy 407 Station-TTC Subway North Tunnels and Eglinton Crosstown LRT: Toronto, ON). Whereas, GFRP bars were used to reinforce

GFRP cages up to 19.0 m long (diameters ranged from 600 to 1100 mm). Highest grade 60 GPa 32.0 m vertical bars were used with #5 (16.0 m) 50 GPa continuous spirals with 150 mm pitch, see Figure 4 (Mohamed & Benmokrane 2015).



Figure 4: Handling and lifting the GFRP Soft-Eyes

4.4 Continuously reinforced concrete pavement with GFRP bars

Continuously reinforced-concrete-pavement (CRCP) designs are premium pavement designs often used for heavily trafficked roadways and urban corridors. Although CRCP typically is an effective, long-lasting pavement design, it can develop performance problems when the aggregate-interlock load transfer at the transverse cracks has degraded. The prevalence of wide cracks in CRCP has frequently been associated with ruptured steel reinforcement and significant levels of corrosion. This has generated recent interest in identifying new reinforcing materials that can prevent or minimize corrosion-related issues in CRCP. Glass-fiber-reinforced-polymer (GFRP) bars are one product being investigated for use in CRCP instead of conventional steel bars.

Since the early 1990s, the Ministry of Transportation of Quebec (MTQ) has renewed emphasis on building long-lasting concrete pavements suited to local traffic and climatic conditions. In 2000, these efforts led to the construction of Canada's first roadway with continuously reinforced concrete pavement (CRCP). Five years later, however, concerns were raised about the long-term performance of CRCP, as portions of this initial installation were found to have insufficient cover over the bars and core samples showed that the longitudinal reinforcement was corroding at transverse cracks (Thébeau 2006). These observations, coupled with the knowledge that up to 60 tonnes (65 tons) of salt per year can be spread on a 1 km (0.6 mile) long stretch of a two-lane pavement in Montréal (nearly three times the amount of salt used on roads in the State of Illinois), led the MTQ to select galvanized steel as the standard reinforcement for subsequent CRCP projects and to continue investigating other systems with enhanced corrosion resistance. As part of these investigations, the MTQ and the University of Sherbrooke has been studying the use of glass-fiber-reinforced-polymer (GFRP) bars for CRCP since 2006. In September 2006, a 150 m long section of eastbound Highway 40 (Montréal) was selected as a demonstration project (Benmokrane et al. 2008), see Figure 5. Through the initial 18 months of pavement life, the maximum measured strain value in the reinforcement was 0.0041. This is within the design limit recommended in ACI 440.1R-06.

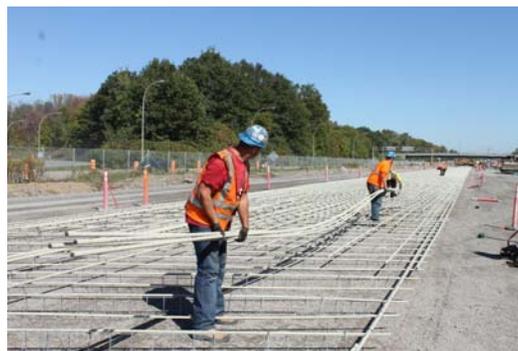


Figure 5: GFRP bar placement in center lane in Highway 40 (Montréal)-2013

5. Conclusions

The observations and the outcomes from the different field applications reported in this paper can be summarised into the following: corrosion resistance is without a doubt the main motive and attraction to use FRP over steel. Application of FRP reinforcement in different structures has been proved to be very successful to date. From the construction point of view it was felt by the construction personnel that the lightweight of the FRP reinforcements were easy to handle and place during construction. Concrete bridges, water tank, soft eye-tunnel application, and continuously reinforced-concrete-pavement provide an excellent application for the use of FRP in new construction.

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Section 2
Information Technology

An Agile Method to Promote Self-Organized Software Development Teams

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Abstract

Agile methods and tools are being widely adopted in many software companies. The irruption of the Agile Manifesto has induced a revolution in the field of Software Engineering with the introduction of many agile methodologies, techniques and tools. One of the most prominent principles of the Agile Manifesto promotes the wellness of the development team. The 11th principle establishes that "the best architectures, requirements, and designs emerge from self-organizing teams". This principle highlights the importance of human resources in software development teams. Among the most known agile methods are Scrum and eXtreme Programming (XP). This article describes Xcrum, an agile method that provides software teams with the required human resources elements to develop applications, by creating a positive and self-organized atmosphere. Xcrum allows software teams not only to organize themselves in an agile manner, but also it allows them to develop applications following both Object-Oriented and agile principles. The article describes Xcrum and provides practical information, by means of a case study, on how to develop a project using Xcrum and its implications in the human resources management of the development team.

Keywords: Agile, Scrum, Self-Organized Teams, Object-Oriented.

1. Introduction

The field of Software Engineering has solved its nth growth crisis with the emergence of agile methodologies. These methodologies seem to free the heavy burden development teams were suffering while were applying documentation-based methodologies.

On the other hand, the object-oriented programming paradigm is experiencing a second youth thanks to the new programming paradigms introduced by the Internet languages. Languages such as JavaScript, Python or Ruby are presented in many modern Web projects, and they are the appropriate technologies in projects where Xcrum is applied.

This article introduces Xcrum, a new agile proposal for the object-oriented development of software applications and services. The article describes the new proposal by describing its principles and the elements that comprises it. The final discussion analyzes the advantages of Xcrum.

The article is organized in the following sections. Section 2 presents a brief overview of the current landscape of software development. Section 3 presents the motivation behind the proposal. Section 4 presents the principles on which Xcrum is based. Section 5 presents the main elements of Xcrum. Section 6 makes a proposal of Xcrum support tools. Section 7 describes how Scrum promotes self-organized teams. Finally, Section 8 presents the conclusions and future work.

2. Recent Advances in Software Development and Agile Methodologies

One of the effects of this latest software crisis is the birth of agile methodologies. The appearance of the now famous Agile Manifesto (Agile Manifesto, 2001) is the starting point of this new era. In its genesis is a group of software engineers who decided to rebel in the "plan and document" style omnipresent in most development teams. At the time of the emergence of the Agile Manifesto, methodologies such as the cascade model, the Rational unified process (Rational Unified Process) (Kruchten, 2003), or Rapid Application Development (RAD) (Martin, 1990) dominated the development teams.

As noted by Fox and Patterson (Fox, 2014), the crisis of the 1960s led engineers to try to develop methodologies that made it possible to develop quality software and predictable and controlled budget. The results of this effort were a series of development processes based on planning and documenting (Plan-and-Document). Some strategies (process models) on which many of these development processes are based are well known: Cascade model, Spiral model and Iterative and Incremental models. In this last group, the RUP process should be located, which is a combination of the previous models. Development processes based on Planning-Document are tedious since they put a lot of emphasis on the preparation of documents, such as templates, memories and diagrams, which sometimes diverts attention from the software product that is intended to be developed.

The agile proposal tries to recover the lost prominence for the software product in favor of documents and diagrams. Alternatively, the Agile Manifesto also gives importance to the motivation of the development team, and to maintain fluid contact with the client.

Thus, agile methodologies began to emerge that tried to apply the principles listed in the Agile Manifesto. Among the best known we can mention Scrum (Schwaber, 2004) and Extreme Programming (better known as XP) (Beck, 2004).

From Scrum and XP, there are numerous agile proposals that have been emerging, although these are general proposals that are based on applying the principles contained in the agile manifesto. For example, DSM (DSM, 2014) is based on a principle in the integrates several statements of the Agile Manifesto: the best business value emerges when projects are aligned with clear business objectives, often visible results are released and involve motivated people. In this sense, Xcrum also applies the principles of the Agile Manifesto, as it is an agile method based on XP and Scrum.

Letelier, in (Letelier, 2017), presents a catalog (AgileRoadmap) to implement agile practices in development teams, without suggesting a specific agile method. The Xcrum proposal is like AgileRoadmap in that it promotes agile practices, although Xcrum is based on principles that come from Scrum and XP, to which the object-oriented vision of the solution joins.

In (Mekni, 2017), the authors summarize the best-known agile methods to point out the little attention paid to software architecture. The authors then propose a methodology to define software architecture in agile environments. In Xcrum, the software architecture is an essential element, since it is based on starting defining the solution as an object-oriented solution.

To conclude this section, Xcrum is related to most agile methods insofar as it applies the principles of the Agile Manifesto. However, it is novel in that it takes as reference two of them, Scrum and XP, to propose a synthesis of both.

3. Motivation of Xcrum

The definition of a new method must be accompanied by a justification. This section presents the reasons that have motivated the appearance of Xcrum. This explanation can also be the inception of Xcrum.

The review of agile proposals made in the previous section allows us to classify them into two conceptually wide groups:

- Those methodologies that are geared towards the agile management of the project, or even pose only principles to better manage a company. In this group, we can include Scrum, Kanban and Lean (Poppiendieck, 2003). We could tag these methodologies as management-oriented.
- Those methodologies that focus on applying an agile approach in obtaining the software product. In this group, we include XP. These methodologies could be tagged as development-oriented methodologies.

The management-oriented methodologies are, as its tag suggests, heavily influenced by the dynamics of management. Scrum promotes close contact between the people in charge of the development team and the client's representative, promotes the early delivery of value, and establishes two levels to define the requirements (with the language of the client and the team's language), for example.

These methodologies, however, often do not provide guidelines or principles that help the development team in its task of obtaining software products, beyond the general recommendations.

Another disadvantage of the management-oriented methodologies is that, to respond to all aspects of project management, they are no longer agile and become "heavy" proposals or closer to the methodologies of the Planning-and-Document style.

On the other hand, the development-oriented methodologies have the strong point of telling the team how they should work to achieve a quality product. For example, in XP it is indicated by the

activities of Exploration of the Game of Planning, how to proceed to establish the content of the next sprint.

Methodologies oriented to the development team usually contain many recommendations and may become inflexible. For example, XP reaches the level of detailing how the space in which the team works should be organized. In XP, the programming by pairs is promoted, something that is not feasible in many situations.

In relation to software development, the object-oriented approach is taken as a guide for the design and coding of the software product.

Therefore, it would be desirable to have an agile method that combines the management aspects of the project that Scrum provides, with the aspects that guide the team in the development of the software product that XP provides. If this method also maintains the principles of object-oriented development, the software products obtained will have the advantages of this type of solution (flexible, extensible, modular, etc.).

4. Principles of Xcrum

Being an agile method, Xcrum tries to apply most of the principles of the Agile Manifesto. In particular, Xcrum emphasizes the following principles of the manifesto: prioritizing the early delivery of value, accepting that the requirements change, involving the customer, prioritizing the tested and functioning software and valuing simplicity. Being a proposal inspired by two existing ones, its novelty lies in the way it combines them.

Xcrum is based on three principles:

- Apply the Scrum approach in terms of software project management
- Apply the XP approach in terms of the development team and obtaining the software product
- Use the Object Oriented approach to software development

The following sections explain in more detail the principles on which Xcrum is based.

4.1 Scrum as Project Management

Xcrum assumes Scrum in terms of project management. This means that it employs the same skeleton, artifacts and meetings:

- Skeleton: the skeleton of Xcrum is the sprint, which lasts from 1 to 4 weeks
- Roles: Scrum and XP roles are similar, so any of them can be adopted. Scrum explains the existence of a team leader (Scrum Master)
- Artifacts: Scrum artifacts such as the Product Backlog, Sprint Backlog, Sprint Burndown and the most important artifact are assumed, namely, the code tested and functioning
- Meetings: Scrum meetings are also held as the Sprint Preparation Meeting, the Daily Meetings (Daily Scrum), and the Sprint Review Meeting (review and retrospective)

4.2 XP for the Development Team

Xcrum assumes some of the ideas of XP regarding the management of the development team and the obtaining of the software product.

Xcrum assumes the basic activities of development:

- Encode: is the activity par excellence
- Test: this activity gives value to the tests
- Listen: it is an activity that helps to understand what is a
- Design: a good design is the key to obtain a good product

These activities are carried out through the Game of Planning with its three phases: Exploration, Commitment and Direction; and through the Planning of the Iteration, with its three phases: Exploration, Commitment and Direction. Each phase defines a series of activities.

5. Elements of Xcrum

This section defines the elements of Xcrum: roles, iteration, artifacts and meetings. Like any good agile method, the most important artifact in Xcrum is the code tested and working. All other elements are means to get the software product.

5.1 Roles of Xcrum

In the definition of the roles of Xcrum, we should consider the separation of responsibilities, business and techniques, suggested by the Agile Manifesto. There is separation and complementarity since it is about that both work together in obtaining the solution.

Thus, Xcrum uses Business and Development as terms to define the roles that identify two responsibilities. Business defines the user stories and the priority of them. Development is responsible for estimating stories and converting them into code.

The Business role of Xcrum is equivalent to the Scrum Product Owner. The Development role is equivalent to the Scrum Team role. The ScrumMaster of Scrum is the leader of the development team at Xcrum.

5.2 Iterations in Xcrum

The heart of Xcrum is the Iteration in the same sense that the Sprint is for Scrum. The Iteration in Xcrum lasts from 1 to 4 weeks. At the end of the iteration, the team must provide an increase in value in the form of code tested and functioning. The Xcrum Iteration is equivalent to the Scrum Sprint.

5.3 Xcrum artifacts

User stories: Xcrum is based on defining the system requirements (functional, non-functional and information) as user stories, in a similar way to other agile methodologies.

- List of System Histories: is the list of user stories defined by Business to describe a system. This list is equivalent to the Scrum Product Backlog.
- List of Iteration Stories: is the subset of stories that are assigned to an iteration. This list is equivalent to the Sprint Backlog.
- Progress Chart: is the diagram that in Scrum is called Sprint Burndown and that serves to measure the progress of the iteration (sprint).

As you can see, the Xcrum artifacts are basically those of Scrum.

5.4 Xcrum meetings

The Xcrum meetings follow the structure of Scrum, with incorporation of some XP activities. The following sections detail how XP activities are combined in Scrum meetings.

Iteration Preparation Meeting

The two roles, Business and Development, participate in this meeting. In Scrum the Sprint Preparation Meeting has two parts, in the first one it is carried out between Business and Development and its objective is to choose the functionality of the next Sprint. In Xcrum this meeting has the same objective, although it is proposed to incorporate the activities of the Exploration and Commitment phases of XP, namely:

- Write a story: Business writes a functionality
- Estimate a story: Development estimates the time
- Divide a story: If it cannot be estimated
- Sort the stories: Business order by value and Development by risk
- Choose field: Business chooses the end date of the Iteration or functionality (and Development date)

As you can see, this part of the preparation meeting of the Iteration takes advantage of the detail of activities that XP provides, while, in Scrum, it is left undefined.

The second part of the meeting corresponds to the team and consists of detailing the tasks in which each story is broken down.

Xcrum Daily Meeting

On daily basis, the team reviews the status of the project following the same scheme proposed by the Daily Scrum.

At this point some XP activities are proposed to obtain the increment:

- Accept a task: a developer chooses a pending task
- Implement a task: define the test cases, implement the task and integrate the code
- Recovery and estimation: these are activities to readjust the load, or the dates, with respect to the estimate.

These XP activities, incorporated into Xcrum, serve to give content to the daily task of the team. The only difference in relation to XP is that in Xcrum it is not necessary to implement the task through the technique of programming in pairs.

An important aspect of Xcrum are the tests. The team must write test cases so that the meaning of "finished" is demanding, not thinking about Business, but internally, thinking about the team.

In the day to day of development the third principle of Xcrum is put into play: Object Oriented Solution.

Iteration Review Meeting

In Scrum, at the end of the Sprint, two meetings are held: the Review meeting and the Retrospective meeting. The first is done with the Product Owner. The second is internal to the team.

In Xcrum, a similar scheme to Scrum is proposed. In the first meeting (Review) the increase in value of this Business Iteration is shown to check if it is what you requested. The second part is a review of the Iteration performed by the Development, to detect problems and find solutions.

6. Tools used in Xcrum

As for the Xcrum tools, any of the tools that support Scrum can be used. It is recommended to use Kunagi (Kunagi). Kunagi is a tool that supports all Scrum artifacts and, therefore, can also be used to track Xcrum.

Kunagi has the added advantage of including some artifacts from other methodologies, such as the task artifact (pending, assigned and done) of Kanban (Louis, 2006).

In a secondary level, since we are talking about agile methodologies, it is suggested to use tools for the modeling of UML artifacts such as StarUML. These tools are useful for the development team because they allow them to specify in a diagram (classes, sequence) a concept of the solution that allows to discuss it with the team, using that diagram, and adopt a solution.

The development team discusses different ideas, often expressed in a diagram, and adopts some of the proposed solutions. These tools are especially important for object-oriented solutions.

It is convenient to have a tool for version control and repository of the solution and other artifacts.

7. How Xcrum Promotes Self-Organized Teams

One of the Agile Manifesto principles establishes that "the best architectures, requirements, and designs emerge from self-organizing teams". This principle breaks the traditional hierarchical structure present in many software teams, where there are some people who defines the requirements, the deadlines and budget, and other people, the developers, that must follow the roadmap without hesitation.

The Xcrum mechanisms that help the formation of self-organized teams are the following:

- Well-defined and complementary roles
- The participation in the meetings with business responsible
- The Daily Meeting

The next paragraphs describe each mechanism.

The first mechanism to promote the initiative of the development team is derived of the well-defined roles. The agile philosophy introduces a new order of things. In the heart of this new conception we have the well-defined and independent roles: Business and Development. Each role has clearly defined tasks and it is important that each one respect the other role.

The participation in the meetings with business responsible is the main mechanism that can contribute to the formation of self-organized teams. In the Iteration Preparation Meeting, the development team has to interact with Business to limit the risk and to define a real deadline for the desired functionality. During the Iteration Review Meeting, the development team interact with Business to defend the increment obtained in the iteration. Meetings in Xcrum are one of the main means that promotes

participation of the development team. The team feels involved in the definition of the requirements as user stories, by assigning a risk value or forcing them to be divided into more simple user stories.

The Daily Meeting is an encounter of all members of the development team. In this meeting, each member explains the tasks performed during the last 24 hours, and what were the problems and challenges that appeared in that period. This meeting is also a mean to promote the personal initiative and creativity. The team can help members to solve problems, or even propose a change to Business.

All the mentioned mechanisms increase the responsibility and creativity of the development team. Whenever the opinion of the development team is considered, the project is more likely to success. Moreover, a motivated team receives the inevitable changes in the requirements with a positive attitude.

8. Conclusions

This article presents Xcrum, an agile and object-oriented method to promote self-organized software development teams. Xcrum has been inspired by Scrum and eXtreme Programming. The article presents the main mechanisms included in the proposal that are the key in the promotion of self-organized teams. In summary, Xcrum can be beneficial in those projects where you want to apply agile principles with an object-oriented approach to the solution.

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Towards Arabic Common Criminal Policy on Combating IT Offences

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Abstract

Information security is a crucial requirement for encountering the increase of international cybercrimes, which are the result of the increase in the use of the information technology (IT) and electronic developments. The Kingdom of Bahrain is considered as one of the pioneering countries in the development of IT infrastructure. On January 26, 2017, the Kingdom of Bahrain ratified the Arab Agreement in Combating IT Crimes in accordance with Law No. 2 of 2017 issued by the Official Gazette No. 3298. Previously, the kingdom enacted Law No. 60 of 2014 regarding IT Crimes, which was issued on October 9, 2014, by the Official Gazette No. 3178.

The objective of this study is to shed some light on the general framework of Arabic common criminal policy on combating IT offences for academics, legal advisers, and practitioners, not only in Bahrain but also elsewhere due to the international nature of IT offences. Towards achieving these aims, the legal methods of descriptive and exploratory studies were adopted.

The study found that as stipulated in the agreement, the common criminal policy will be based on a number of fields. The first field deals with the general provisions in terms of purpose, as well as the definition of terms related to information technology. The second field addresses the theme of criminalization and identifies a set of punishable acts. The third field states the procedural provisions. The fourth field deals with the legal and judicial cooperation in terms of jurisdiction, extradition, and other mutual supports.

Keywords: Information Technology Offences, Electronic Crimes, Cyber Crimes, Law, Crimes, Arab.

1. Introduction

Technological development has led to the increasing importance of information technology in various areas of a contemporary life. It is rare to find a branch of any activity that does not require the use of information technology. Such acceleration in the pace of technological progress nevertheless has been exploited by the perpetrators of cyber crimes (Al-Hiti, 2016). These crimes are no longer confined to the territory of one State but to the borders of States. Such invasion should be met with regional and international coordination to combat the innovative crime.

However, the inclusion of information technology crimes in traditional criminal descriptions proves to be challenging (Ghannam, 2013). The traditional laws are limited to accommodating this new criminal phenomenon by means of criminal prosecution (under national law) and international criminal prosecution. These limitations necessitate the development of a criminal legislative structure with regional and international coordination that reflects the due diligence at the legal level with the dimensions of the new technologies.

With the desire of the Arab States¹ to strengthen cooperation to combat information technology crimes. Such crimes threaten their security, interests and the safety of their societies, and for these reasons, they are convinced of the necessity of adopting a joint legislative policy that is aimed at protecting the Arab society from the crimes of information technology. Hence, on December 21, 2010, the Arab Convention on Combating Information Technology Crimes was released in Cairo, Egypt.

As provided for in the Convention, the common criminal policy will be based on a number of areas: general provisions, subject of criminalization, procedural provisions, and legal and judicial cooperation. The first area deals with general provisions in terms of purpose, as well as the definition of terms relating

¹States participating in the Convention: Algeria, Bahrain, Comoros, Djibouti, Egypt, Iraq, Jordan, Kuwait, Lebanon, Libya, Mauritania, Morocco, Oman, Palestine, Saudi Arabia, Somalia, Sudan, Syria, Tunisia, United Arab Emirates and Yemen. For more information visit website of the League of Arab States at: <http://www.lasportal.org> , accessed 25/1/2019.

to information technology. The second area deals with the subject of criminalization and defines a set of punishable acts. The third area provides procedural provisions, and the fourth area deals with legal and judicial cooperation in terms of jurisdiction, extradition, and other forms of mutual support.

2. General Provisions and Areas of Application of the Convention

As the first step in the unified fight against the crimes of information technology, it was necessary to agree to the unification of the meanings of some of the terms that characterize the criminal phenomenon. It was agreed in the second article of the Convention to unify the following nine terms: *information technology*,² *service provider*,³ *data*,⁴ *information programme*,⁵ *information system*,⁶ *information network*,⁷ *site*,⁸ *capture*,⁹ and *subscriber's information*.¹⁰

Many Arab laws have supplied the meaning of each of the terms indicated above. The Kingdom of Bahrain, for example, has defined the terms in the text of the first article of its laws,¹¹ and the law of the United Arab Emirates¹² provides additional definitions such as the definition of *electronic document*,¹³ *government data*,¹⁴ and *internet protocol address*.¹⁵

The third Article of the Convention specifies the scope of the application of the Convention:

Unless otherwise indicated, this convention shall apply to information technology offences with the aim of preventing, investigating and prosecuting them, in the following cases; (1) when committed in more than one State. (2) when committed in a State and prepared, planned, directed or supervised in another State or other States. (3) when committed in a State with the involvement of an organized crime group exercising its activities in more than one State. (4) when committed in a State and had severe consequences in another State or other States.

²According to Article (2/1) from Arab Convention on Combating Information Technology Offences the Information technology is: any material or virtual means or group of interconnected means used to store, sort, arrange, retrieve, process, develop and exchange information according to commands and instructions stored therein. This includes all associated inputs and outputs, by means of wires or wirelessly, in a system or network.

³According to Article (2/2) from Arab Convention on Combating Information Technology Offences the Service provider is: any natural or juridical person, common or private, who provides subscribers with the services needed to communicate through information technology, or who processes or stores information on behalf of the communication service or its users.

⁴According to Article (2/3) from Arab Convention on Combating Information Technology Offences the Data is: All that may be stored, processed, generated and transferred by means of information technology, such as numbers, letters, symbols, etc...

⁵According to Article (2/4) from Arab Convention on Combating Information Technology Offences the Information programme is: A set of instruction or commands which can be executed by means of information technology and intended to achieve a given task.

⁶According to Article (2/5) from Arab Convention on Combating Information Technology Offences the Information system is: A set of programmes and tools intended to process and manage data and information.

⁷According to Article (2/6) from Arab Convention on Combating Information Technology Offences the Information network is: The interconnection between more than one information system to obtain and exchange information.

⁸According to Article (2/7) from Arab Convention on Combating Information Technology Offences the Site is: A location where information is made available on the information network through a specific address.

⁹According to Article (2/8) from Arab Convention on Combating Information Technology Offences the Capture is: To view or obtain data or information.

¹⁰According to Article (2/9) from Arab Convention on Combating Information Technology Offences the Subscriber's information is: Any information that the service provider has concerning the subscribers to the service, except for information through which the following can be known: (a) the type of communication service used, the technical requirements and the period of service. (b) the identity of the subscriber, his postal or geographic address or phone number and the payment information available by virtue of the service agreement or arrangement. (c) any other information on the installation site of the communication equipment by virtue of the service agreement.

¹¹ Law No. 60 of 2014 Concerning Information Technology Crimes, which was issued on October 9, 2014, by the Bahrain Official Gazette No. 3178.

¹² Federal Legal Decree No.5 of 2012 on Combating Cyber Crimes

¹³A computer record or data to be established, stored, extracted, copied, sent, notified or received by electronic means through a medium.

¹⁴Means electronic data or information whether private or relating to the federal government or local governments of the Emirates of the State, or to federal or local public authorities or public establishments.

¹⁵A numerical label assigned to any information technology means participating in a computer network which is used for communication purposes.

Then, the concept of “safeguarding sovereignty” was clarified in the text of the fourth Article:
(1) Every State Party shall commit itself, subject to its own statutes or constitutional principles, to the discharge of its obligations stemming from the application of this convention in a manner consistent with the two principles of equality of the regional sovereignty of States and the non interference in the internal affairs of other States. (2) Nothing in this convention shall allow a State Party to exercise in the territory of another State the jurisdiction or functions the exercising of which is the exclusively right of the authorities of that other State by virtue of its domestic law.

3. Criminalization

The fifth article of the convention specifies the acts that should be criminalized in the laws of the states parties in accordance with its legislations and statutes. The aim of the article is to facilitate the pursuit and control of the crime, particularly those acts that should be criminalized under the Convention, e.g., Offense of Illicit Access.¹⁶ (Al-Ghafri,2011). The second paragraph particularly denotes that the punishment should be increased if the results of a particular offense are achieved. The Arab laws¹⁷ are specifically committed to the application of this article; for example, the text of the second article states that the Bahraini legislator criminalizes the Offense of Illicit Access. The fourth article notes that the UAE legislator¹⁸ also¹⁹ criminalizes the same act:

Shall be punished by temporary imprisonment and a fine not less than two hundred and fifty thousand dirhams and not in excess of one million five hundred thousand dirhams whoever accesses a website, electronic information system, computer network, or information technology means without authorization whether such access is intended to obtain government data, or confidential information relating to a financial, commercial or economical facility. The punishment shall be imprisonment for a period of at least five years and a fine not less than five hundred thousand dirhams and not in excess of two million dirhams, if these data or information were deleted, omitted, deteriorated, destructed, disclosed, altered, copied, published or re-published.

The same approach was followed by the Egyptian legislator and²⁰ the Jordanian legislator.²¹ Through the Convention, the states parties have committed to criminalize the offenses of “illicit interception”.²² This act is criminalized by the Bahraini legislator²³ and the UAE legislator as follows:

Shall be punished by imprisonment and a fine not less than one hundred fifty thousand dirhams and not in excess of five hundred thousand dirhams or either of these two penalties whoever, without authorization, deliberately receives or intercepts any communication through any computer network. Whoever discloses the information which he has obtained through illegal reception or interception of communications shall be punished by imprisonment for a period of at least one year.²⁴

¹⁶ According to Article (5/1) from Arab Convention on Combating Information Technology Offences: Illicit access to, presence in or contact with part or all of the information technology, or the perpetuation thereof.

¹⁷ The punishment shall be increased if this access, presence, contact or perpetuation leads to :a-the obliteration, modification, distortion, duplication, removal or destruction of saved data, electronic instruments and systems and communication networks, and damages to the users and beneficiaries .b-the acquirement of secret government information.

¹⁸ Law No. 60 of 2014 Concerning Information Technology Crimes

¹⁹ Federal Legal Decree No.5 of 2012 on Combating Cyber Crimes

²⁰ In the Article (14) from Law No. 175 of 2018 regarding Anti-Cyber and Information Technology Crimes, which was issued on August 14, 2018, by the Egyptian Official Gazette, No. 32 bis (c).

²¹ In the Article (3/a) from Law No. 27 of 2015 Electronic Crimes Law, which was issued on June 1, 2015, by the Jordanian Official Gazette, No. 5343.

²² According to Article (7) from Arab Convention on Combating Information Technology Offences: The deliberate unlawful interception of the movement of data by any technical means, and the disruption of transmission or reception of information technology data.

²³ Article (4) from Law No. 60 of 2014 Concerning Information Technology Crimes

²⁴Article (15) from Federal Legal Decree No.5 of 2012 on Combating Cyber Crimes

The Egyptian legislator²⁵ and Jordanian legislator also criminalize the offense of illicit interception.²⁶ The states parties have agreed to criminalize the offenses against the "integrity of data,"²⁷ and accordingly, the Bahraini legislator has criminalized this criminal attitude.²⁸ The UAE legislator stated the following measure:

*Shall be punished by temporary imprisonment whoever obtains, possesses, modifies, destroys or discloses without authorization the data of any electronic document or electronic information through the computer network, a website, an electronic information system or information technology means where these data or information are related to medical examinations, medical diagnosis, medical treatment or care or medical records.*²⁹

The same method was adopted by the Egyptian legislator³⁰ and the Jordanian legislator.³¹ The states parties agreed to criminalize the offence of "misuse of information technology means"³² and the matter has been criminalized by the Bahraini legislator accordingly.³³ The UAE legislator states,

*Shall be punished by imprisonment and a fine not less than two hundred thousand dirhams and not in excess of five hundred thousand dirhams or either of these two penalties whoever obtains, without legal right, a secret number, code, password or any other means to have access to an information technology means, website, electronic information system, computer network or electronic information. Shall be punished with the same penalty whoever prepares, designs, produces, sells, buys, imports, displays for sale or make available any computer program or any information technology means, or promotes by any means links to websites, computer program or any information technology means designed for the purposes of committing, facilitating or abetting in the commission of the crimes specified in this Decree-Law.*³⁴

The approach was later adopted by the Egyptian legislator.³⁵ The convention stipulates that it is necessary that all parties commit to criminalize the Offence of Forgery, and,³⁶ therefore, the Bahraini legislator stipulated the criminalization of forgery.³⁷ In addition, the UAE legislation states,

Shall be punished by temporary imprisonment and a fine not less than one hundred and fifty thousand dirhams and not in excess of seven hundred and fifty thousand dirham whoever commits forgery of any electronic document of the federal or local government or authorities or federal or local public establishments.

²⁵ In the Article (16) from Law No. 175 of 2018 regarding Anti-Cyber and Information Technology Crimes, which was issued on August 14, 2018, by the Egyptian Official Gazette, No. 32 bis (c).

²⁶ In the Article (5) from Law No. 27 of 2015 Electronic Crimes Law, which was issued on June 1, 2015, by the Jordanian Official Gazette, No. 5343.

²⁷ According to Article (8) from Arab Convention on Combating Information Technology Offences: (1) Deliberate unlawful destruction, obliteration, obstruction, modification or concealment of information technology data. (2) The Party may require that, in order to criminalize acts mentioned in paragraph 1, they must cause severe damage.

²⁸ In the Article (3) from Law No. 60 of 2014 Concerning Information Technology Crimes.

²⁹ Article (7) from Federal Legal Decree No.5 of 2012 on Combating Cyber Crimes

³⁰ In the Article (17) from Law No. 175 of 2018 regarding Anti-Cyber and Information Technology Crimes, which was issued on August 14, 2018, by the Egyptian Official Gazette, No. 32 bis (c).

³¹ In the Article (4) from Law No. 27 of 2015 Electronic Crimes Law, which was issued on June 1, 2015, by the Jordanian Official Gazette, No. 5343.

³² According to Article (9) from Arab Convention on Combating Information Technology Offences: 1- The production, sale, purchase, import, distribution or provision of: (a) any tools or programmes designed or adapted for the purpose of committing the offences indicated in Articles 6 to 8. (b) the information system password, access code or similar information that allows access to the information system with the aim of using it for any of the offences indicated in Articles 6 to 8. 2-The acquisition of any tools or programmes mentioned in the two paragraphs above with the aim of using them to commit any of the offences indicated in Articles 6 to 8.

³³ In the Article (6) from Law No. 60 of 2014 Concerning Information Technology Crimes.

³⁴ Article (14) from Federal Legal Decree No.5 of 2012 on Combating Cyber Crimes

³⁵ In the Article (22) from Law No. 175 of 2018 regarding Anti-Cyber and Information Technology Crimes, which was issued on August 14, 2018, by the Egyptian Official Gazette, No. 32 bis (c).

³⁶ According to Article (10) from Arab Convention on Combating Information Technology Offences: The use of information technology means to alter the truth of data in a manner that causes harm, with the intent of using them as true data.

³⁷ In the Article (7) from Law No. 60 of 2014 Concerning Information Technology Crimes.

*The punishment shall be both imprisonment and a fine not less than one hundred thousand dirhams and not in excess of three hundred thousand dirhams or either of these two penalties if the forged documents belong to an authority other than those mentioned in paragraph one of this Article. Shall be punished by the same penalty decided for the crime of forgery, as the case may be, whoever uses this forged electronic document with his knowledge that the document is forged.*³⁸

The convention has also criminalized fraud,³⁹ (Al-Tawalba, 2008), which in turn, led the Bahraini legislator to criminalize the same act.⁴⁰ This behavior is also criminalized by the Egyptian legislator. It is reported in the UAE that such crime⁴¹

*Shall be punished by imprisonment for a period of at least one year and a fine not less than two hundred and fifty thousand dirhams and not in excess of one million dirhams or either of these two penalties whoever takes over a personal property, benefit, deed or its signature whether for oneself or for other persons and without legal right, by resorting to any fraudulent method or by adopting a false name, or false personation through the computer network, or an electronic information system or any information technology means.*⁴²

The convention, as well as the Bahraini legislator, has also criminalized "offensive pornography."^{43 44} The UAE legislation particularly states,

*States the following Shall be punished by imprisonment and a fine not less than two hundred and fifty thousand dirhams and not in excess of five hundred thousand dirhams or either of these two penalties whoever establishes, manages or runs a website or transmits, sends, publishes or re-publishes through the computer network pornographic materials or gambling activities and whatever that may afflict the public morals. Shall be punished by the same penalty whoever produces, draws up, prepares, sends or saves for exploitation, distribution, or display to others through the computer network, pornographic materials or gambling activities and whatever that may afflict the public morals. If the subject of the pornographic content involves a juvenile under eighteen years of age, or if such content is designed to seduce juveniles, the principal shall be punished by imprisonment for a period of at least one year and a fine not less than fifty thousand dirhams and not in excess of one hundred and fifty thousand dirhams.*⁴⁵

In addition, the provisions of Article 18 of the UAE legislation states the following measure:

Shall be punished by imprisonment for a period of at least six months and a fine not less than one hundred fifty thousand dirhams and not in excess of one million dirhams whoever has deliberately acquired pornographic materials involving

³⁸ Article (6) from Federal Legal Decree No.5 of 2012 on Combating Cyber Crimes.

³⁹ According to Article (11) from Arab Convention on Combating Information Technology Offences :Intentionally and unlawfully causing harm to beneficiaries and users with the aim of committing fraud to illicitly realize interests and benefits to the perpetrator or a third party, through: (1) entering, modifying, obliterating or concealing information and data. (2) interfering with the functioning of the operating systems and communication systems, or attempting to disrupt or change them. (3) disrupting electronic instruments, programmes and sites. For More Information See: Ali Al-Tawalba, Electronic Crimes, University of Applied Sciences-Bahrain, Iss: 1, (2008) , pp.174 – 188.

⁴⁰ In the Article (8) from Law No. 60 of 2014 Concerning Information Technology Crimes.

⁴¹ In the Article (23) from Law No. 175 of 2018 regarding Anti-Cyber and Information Technology Crimes, which was issued on August 14, 2018, by the Egyptian Official Gazette, No. 32 bis (c).

⁴² Article (11) from Federal Legal Decree No.5 of 2012 on Combating Cyber Crimes.

⁴³ According to Article (12) from Arab Convention on Combating Information Technology Offences: (1) The production, display, distribution, provision, publication, purchase, sale, import of pornographic material or material that constitutes outrage of modesty through information technology. (2) The punishment shall be increased for offences related to children and minors pornography. (3) The increase mentioned in paragraph 2 of this Article covers the acquisition of children and minors pornographic material or children and minors material that constitutes outrage of modesty, through information technology or a storage medium for such technology.

⁴⁴ In the Article (10) from Law No. 60 of 2014 Concerning Information Technology Crimes.

⁴⁵ Article (17) from Federal Legal Decree No.5 of 2012 on Combating Cyber Crimes.

juveniles by using an electronic information system or computer network or electronic website or any information technology means.

Article 19 of the same legislation states the following punishment:

Shall be punished by imprisonment and a fine not less than two hundred fifty thousand dirhams and not in excess of one million dirhams or either of these two penalties whoever entices, aids or abets another person, by using a computer network or any information technology means, to engage in prostitution or lewdness. The punishment shall be imprisonment for a period of at least five years and a fine not in excess of one million dirhams if the victim is a juvenile under the age of eighteen years of age.

The same approach was adopted by the Egyptian legislator and⁴⁶ the Jordanian legislator.⁴⁷

The Convention also criminalizes other sets of behaviors, such as offences related to pornography,⁴⁸ offence against privacy,⁴⁹ offences related to terrorism committed by means of information technology,⁵⁰ offences related to organized crime include those committed by means of information technology,⁵¹ offenses related to copyright and adjacent rights,⁵² illicit use of electronic payment tools,⁵³ attempt at and participation in the commission of offences,⁵⁴ criminal responsibility of natural or juridical persons,⁵⁵ and increasing punishment for traditional crimes committed by means of information technology.⁵⁶ The commitment of the states parties to the convention has been noted in a number of different laws of every State.

4. Procedural Provisions

⁴⁶ In the Articles (25 and 26) from Law No. 175 of 2018 regarding Anti-Cyber and Information Technology Crimes, which was issued on August 14, 2018, by the Egyptian Official Gazette, No. 32 bis (c).

⁴⁷ In the Article (9) from Law No. 27 of 2015 Electronic Crimes Law, which was issued on June 1, 2015, by the Jordanian Official Gazette, No. 5343.

⁴⁸ According to Article (13) from Arab Convention on Combating Information Technology Offences: Gambling and sexual exploitation.

⁴⁹ According to Article (14) from Arab Convention on Combating Information Technology Offences: Offence against privacy by means of information technology.

⁵⁰ According to Article (15) from Arab Convention on Combating Information Technology Offences: (1) Dissemination and advocacy of the ideas and principles of terrorist groups. (2) Financing of and training for terrorist operations, and facilitating communication between terrorist organizations. (3) Dissemination of methods to make explosives, especially for use in terrorist operations. (4) Spreading religious fanaticism and dissention and attacking religions and beliefs.

⁵¹ According to Article (16) from Arab Convention on Combating Information Technology Offences: (1) Undertake money-laundering operations, request assistance or disseminate money-laundering methods. (2) Advocate the use of and traffic in drugs and Psychotropic Substances. (3) Traffic in persons. (4) Traffic in human organs (5) Illicit traffic in arms.

⁵² According to Article (17) from Arab Convention on Combating Information Technology Offences: Violation of copyright as defined according to the law of the State Party, if the act is committed deliberately and for no personal use, and violation of rights adjacent to the relevant copyright as defined according to the law of the State Party, if the act is committed deliberately and for no personal use.

⁵³ According to Article (18) from Arab Convention on Combating Information Technology Offences: (1) Any person who forges, manufactures or sets up any instrument or materials that assist in the forgery or imitation of any electronic payment tool by whatever means. (2) Any person who takes possession of the data of an electronic payment tool and uses it, gives it to a third party or facilitates its acquisition by a third party. (3) Any person who uses the information network or an information technology means to unlawfully access the numbers or data of a payment tool. (4) Any person who knowingly accepts a forged payment tool.

⁵⁴ According to Article (19) from Arab Convention on Combating Information Technology Offences: (1) Participation in the commission of any of the offences set forth in this chapter with the intention to commit the offence in the law of the State Party. (2) Attempt at the commission the offences set forth in Chapter II of this convention. (3) A State Party may reserve the right to not implement the second paragraph of this Article totally or partly.

⁵⁵ According to Article (20) from Arab Convention on Combating Information Technology Offences: Every State Party shall commit itself, taking into account its domestic law, to arrange for the penal responsibility of juridical persons for the offences committed by their representatives on their behalf or in their interest, without prejudice to imposing a punishment on the person who committed the offence personally.

⁵⁶ According to Article (21) from Arab Convention on Combating Information Technology Offences: Every State Party shall commit itself to increasing the punishment for traditional crimes when they are committed by means of information technology.

As noted in the convention, all parties agreed to the fact that each state party domestic's law has to apply the necessary procedures and legislations in order to specify the procedures and powers presented in the third chapter of the convention. Therefore, each State Party shall apply the procedures and powers as stated in the provisions of Article 29. The first paragraph particularly notes (1) the mentioned crimes in Articles 6–19 of the convention, (2) gathering evidence on offences in electronic format, and (3) the offences committed by means of information technology.⁵⁷

The Convention provides a set of procedures that states that parties can apply in their different laws to combat information technology crimes, for example, the procedures of expeditious custody of data stored in information technology. Such a measure is to enable expert authorities to obtain a prompt custody of information or issue orders. Also, each State Party has to apply the needed procedures, including information that was stored on an information technology for the purpose of tracking users, mainly if it is believed that this information could be modified or lost.⁵⁸

Paragraph 1 notes that each State Party has to commit itself to adopting the necessary procedures through means of issuing orders to a person, the purpose being to maintain the information technology information under his/her control or in his/her possession. This measure consequently requires such person to preserve the integrity of this information for a specified period (a maximum of 90 days) and it can be renewed. This procedure was to allow the expert authorities to investigate and search.⁵⁹

In order to demand that the person responsible for maintaining the information technology protect the secrecy of the procedures throughout the permitted period, each State Party domestic law has to apply the necessary procedures to do so.⁶⁰

Secondly, in regard to users tracking information (Procedures of Expeditious Custody and Partial Disclosure of Users Tracking Information), each State Party has to commit itself to applying the necessary procedures to ensure an expeditious custody of users tracking information, e.g., to identify whether this communication is transferred by a number service providers or by one service provider. In addition, each State Party has to apply the necessary procedures for ensuring that the disclosed amount of users tracking information is sufficient to the competent authorities or to a person appointed by these authorities so that the State Party can determine the transmission route of the communications and the service providers.⁶¹

Thirdly, in regard to the Procedures for Order to Submit Information, each State Party has to apply the necessary procedures to authorize the expert authorities to issue orders in its territory to any person to submit certain information in his possession that is a medium for storing information or stored on information technology. Any service provider offering his services to submit user's information related to that service is under the control of the service provider or in his possession in the territory of the State Party.⁶²

Fourthly, in regard to the procedures for inspecting stored information, each State Party has to apply the necessary procedures to enable its expert authorities to access or inspect (1) information technology or part of it and the stored information thereon or therein; and (2) the medium or storage environment which the information can be stored. In accordance with paragraph 1(a), the scope of inspection can be extended and the other technology accessed, in case it is believed that the required information is stored in another information technology or in part of its territory, and this information is available or legally accessible in the first technology. Each State Party has to apply the necessary procedures to enable the expert authorities to access or inspect a specific information technology or part of it.⁶³

Fifthly, in regard to the Procedures for Seizure of Stored Information, regarding Article 26, paragraph 1 of this Convention, each State Party has to apply the necessary procedures to authorize the expert authorities to preserve and maintain information technology information access. The authority in those procedures would (1) preserve and maintain the storage medium for the information technology information or the information technology or part of it, (2) preserve the stored information technology information integrity, (3) make a copy and keep it of the information technology information, and remove or prevent the access of such accessed information from the information technology. To complete the procedures mentioned in paragraphs 2 and 3 of Article 26 of such Convention, each State Party has to apply (1) the necessary procedures that enables the expert authorities to issue order to the one who is

⁵⁷ According to Article (22/1+2) from Arab Convention on Combating Information Technology Offences.

⁵⁸ According to Article (23/1) from Arab Convention on Combating Information Technology Offences.

⁵⁹ According to Article (23/2) from Arab Convention on Combating Information Technology Offences.

⁶⁰ According to Article (23/3) from Arab Convention on Combating Information Technology Offences.

⁶¹ According to Article (24) from Arab Convention on Combating Information Technology Offences.

⁶² According to Article (25) from Arab Convention on Combating Information Technology Offences.

⁶³ According to Article (26) from Arab Convention on Combating Information Technology Offences.

aware of the functioning of the information technology or (2) the applied procedures in order to protect the information technology to give the necessary information.⁶⁴

Sixthly, in regard to the procedures for expeditious gathering of users tracking information, each State Party has to apply the necessary procedures so the expert authorities may (1) register or collect using technical means in the State Party's territory; and (2) demand that the service provider, within the technical competence, register or collect by using technical means in the State Party's territory, or help and cooperate with the expert authorities to promptly register and collect users tracking information with the related communications that being transferred through the information technology means.⁶⁵

Seventhly, in regard to the procedures for interception of content information, each State Party has to apply the legislative necessary procedures regarding a series of crimes presented in the domestic law. In this regard, the expert authorities can register or collect by technical means in the State Party's, or help and cooperate with the competent authorities to promptly register and collect content information of the related communications that are transferred by information technology means.⁶⁶

Further review of the Arab laws uncovered that some extent legislators have organized the procedures within their different laws, for example, the Bahrain legislator,⁶⁷ a Jordanian legislator,⁶⁸ the Egyptian legislator, and some other Arab legislators.⁶⁹

The fourth chapter of the convention organizes the legal and judicial cooperation into competence,⁷⁰ extradition,⁷¹ mutual assistance,⁷² circumstantial information,⁷³ procedures for cooperation and mutual assistance requests,⁷⁴ refusal of assistance,⁷⁵ confidentiality and limits of utilization,⁷⁶ expeditious safeguarding of information stored on information systems,⁷⁷ expeditious disclosure of safeguarded users tracking information,⁷⁸ cooperation and bilateral assistance regarding access to stored information technology information,⁷⁹ access to information technology information across borders,⁸⁰ cooperation and bilateral assistance regarding the expeditious gathering of users tracking information,⁸¹ cooperation and bilateral assistance regarding information related to content,⁸² and specialized body.⁸³

5. Specialized Body

In regard to the basic principles of the State Party legal system, Article 43 stipulates that each State Party has to ensure that a specialized body is available full-time to ensure that timely assistance is provided for investigation, collection of evidence in electronic form concerning a particular offence, or procedures concerning offences of information technology. These assistances can be seen as implementing or facilitating the (1) provision of technical advice; (2) maintaining information regarding Articles 37 and 38; and (3) gathering evidence, giving legal information, as well as locating suspects.

Most Arab countries are committed to establishing specialized units to combat electronic crimes. The Command of the Jordanian General Security Service, for example, recognizes the fast development in all aspects of life. By extrapolating the current and future criminal situations, the time and space were proven to no longer have limits in preventing the crimes because of the revolution of communication and modern

⁶⁴ According to Article (27) from Arab Convention on Combating Information Technology Offences.

⁶⁵ According to Article (28/1) from Arab Convention on Combating Information Technology Offences.

⁶⁶ According to Article (29/1) from Arab Convention on Combating Information Technology Offences.

⁶⁷ In the second chapter from Law No. 60 of 2014 Concerning Information Technology Crimes

⁶⁸ In the Article (13) from Law No. 27 of 2015 Electronic Crimes Law and in the Provisions of the Criminal Procedures Law No. (9) of 1961

⁶⁹ In the second and fifth chapters from Law No. 175 of 2018 regarding Anti-Cyber and Information Technology Crimes, which was issued on August 14, 2018, by the Egyptian Official Gazette, No. 32 bis (c).

⁷⁰ Article (30) from Arab Convention on Combating Information Technology Offences.

⁷¹ Article (31) from Arab Convention on Combating Information Technology Offences.

⁷² Article (32) from Arab Convention on Combating Information Technology Offences.

⁷³ Article (33) from Arab Convention on Combating Information Technology Offences.

⁷⁴ Article (34) from Arab Convention on Combating Information Technology Offences.

⁷⁵ Article (35) from Arab Convention on Combating Information Technology Offences.

⁷⁶ Article (36) from Arab Convention on Combating Information Technology Offences.

⁷⁷ Article (37) from Arab Convention on Combating Information Technology Offences.

⁷⁸ Article (38) from Arab Convention on Combating Information Technology Offences.

⁷⁹ Article (39) from Arab Convention on Combating Information Technology Offences.

⁸⁰ Article (40) from Arab Convention on Combating Information Technology Offences.

⁸¹ Article (41) from Arab Convention on Combating Information Technology Offences.

⁸² Article (42) from Arab Convention on Combating Information Technology Offences.

⁸³ Article (43) from Arab Convention on Combating Information Technology Offences.

technologies (globalization of the economy and communications) and the emergence of new forms of crimes or innovative methods to commit crimes. In fact, this phenomenon has become a security obsession because of the acceleration of its development. Hence, the Criminal Investigation Department has adopted preparatory measures by supplying a group of officers that are qualified for tracking and prosecuting these crimes. Hence, the Department of Attribution and Technical Investigation was established at the beginning of 2008 in the Special Monitoring and Investigation Division. This section deals with the investigation of ICT crimes and the Internet (theft of the contents of the main servers of companies and institutions, the theft of bank accounts via the Internet, crimes of threats and extortion, piracy crimes, and various IT crimes. The section also provides technical support for all divisions and departments of the Criminal Investigation Department.⁸⁴

To keep abreast with the developments taking place at the local, regional, and international levels in the Kingdom of Bahrain and build the national economy, the Kingdom of Bahrain has established a basic structure that preserves these gains and promotes a safe economic environment to drive development and renaissance. On November 28, 2011, the General Directorate for Combating Corruption and Economic and Electronic Security was established. The committee includes a number of security departments that aim to preserve the pillars of the national economy. The committee also specializes in combating all electronic crimes, including theft, penetration of e-mail, abuse, defamation, insulting or extortion by means of electronic means, and tracking and detection. In addition, the committee poses a danger to the security of the individual and society. The departments is keen to provide employees with (i) the latest technical devices to help them obtain accurate information and increase productivity; and (ii) the continuous training of technical staff, seminars, and specialized conferences. Another purpose is to establish courses and workshops in the field of combating the crimes specialized by the administration.⁸⁵

Each State Party has to assist each other to the fullest extent for investigation purposes and for the collection of electronic evidence in offences or procedures, which are relevant to information and information technology crimes. It should be noted that paragraphs 2 and 3 of Article 43 point out that the specialized body of each State Parties has to communicate promptly with the parallel body of another State Party. If that body is not part of the authorities of that State Party, which is responsible of the international bilateral assistance, then the said body has to prove its ability to cooperate quickly with these authorities. In order to facilitate the work of the above mentioned body, each State Party has to ensure the existence of competent human resources.

Article 42 of the Convention points out that according to local laws and applicable treaties, bilateral assistance has to be provided by State Parties concerning the fast collecting of content information for a particular communication that is transferred through means of information technology.

Article 41 of the Convention requires that all State Parties give bilateral help among each other with respect to the fast collection of users tracking information that is related to a particular communications in their areas and that is transferred by the information technology. Such assistance has to be provided to similar offences or cases that involve the fast collection of users tracking information.⁸⁶

On the other hand, the convention has pointed out and with respect to Article 37, any State Party can ask each other to access, investigate, seize, disclose, or secure the saved information technology information that has been maintained and found in the State Party that is being asked for help. In regard to the provisions of this convention, the State Party from which assistance was sought has to respond to the other State Party. In case the relevant information can be amended or lost, the answer to the request has to be provided promptly.⁸⁷

Furthermore, any State Party may ask the other State Party to obtain the prompt protecting of information kept on information technology that is found within that state party's territory. The information can be concerning issues about which the State Party was seeking help for mutual assistance to seize secure, disclose information, and investigate.⁸⁸

On the other hand, help can be refused in certain cases, according to what is stated in the fourth chapter of the Convention. The assistance has to be subject to the requirements set forth in the treaties of mutual assistance or in the law of the State Party, including the reasons on which the State Party from which help

⁸⁴ For more information see the website of the Jordanian Public Security Directorate at <https://www.psd.gov.jo/index.php/ar/2015-03-17-09-20-56>, Accessed 1-4-2019

⁸⁵For more information see the website of the Bahraini General Directorate of Anti-Corruption and Economic & Electronic Security at <http://www.acees.gov.bh/cyber-crime/about-cyber-crime/>, Accessed 13-4-2019

⁸⁶ According to Article (32) from Arab Convention on Combating Information Technology Offences.

⁸⁷ According to Article (39) from Arab Convention on Combating Information Technology Offences.

⁸⁸ According to Article (37/1) from Arab Convention on Combating Information Technology Offences.

was asked for may depend on to refuse giving help. The State Party from which help is sought must not decline the assistance. On the basis of what are set forth in the second Chapter, such request is relevant to a crime considered to be a financial crime.⁸⁹

In addition to the reasons for rejection that are set forth in Article 32, paragraph 4, the State Party can decline to assist in the following circumstances: (1) when such a request is relevant to a crime considered as a political crime in the law of the State Party from which assistance is sought; and. (2) when giving help may be considered as a violation of the State Party's security, sovereignty, basic interests.⁹⁰

6. Conclusion

In the modern era, the use of international information networks as a means of communication in various fields has increased to achieve the aims of humanity in terms of shortening time, distances, physical and mental effort. These networks contain information that does not fall within the limits of personal, economic, and scientific aspects, among others. The increasing use of these networks and information systems has also led to the threat of "cybercrimes," such as electronic fraud and forgery, crimes against morality and public order, theft of information, and penetration of secret systems.

The traditional penal texts appear to be inadequate in mitigating these technology-based innovative crimes, and neither the texts protect the freedom, honor, and reputation of people, as well as prevent aggression against money and public and private properties. Therefore, in supporting the international trends of combatting these crimes, and in compliance with the provisions of the Arab Convention for Combating Information Technology Crimes, most Arab countries have drafted their own law. The second chapter addresses crimes and penalties, such as the crime of illegal entry to a computer or information systems using one of the means of information technology. The second paragraph specifically states the requirement of increasing the penalty in certain cases, such as an entry that resulted in the cancellation or destruction of personal information data, and a crime that was committed during or due to the performance of the task.

Other articles deal with the criminalization of forgery acts or the destruction of electronic, customary, governmental or bank documents, including those related to medical examinations, as well as the use of any means of information technology to threaten or blackmail people. Other articles criminalize those who deliberately obstruct or disrupt access to websites; or anyone who eavesdrops on what is transmitted through the information network, or anyone who has established a site that violates public morality or incites prostitution and immorality. On the other hand, anyone who reached and accessed credit card data to obtain third party funds through any IT means is punished.

Penalties in various laws have required the punishment of anyone who used any of these means to promote people trafficking or narcotics, facilitate contact with terrorist organizations to promote their ideas, or launder money. The articles include general provisions, including cases of impunity, the confiscation or closure of the premises or location, the criminal liability of the person, and the jurisdiction of the public prosecution to investigate and prosecute these crimes. The States Parties which are to be sought to find specialized bodies to combat this type of crime are equipped with trained human cadres and modern equipment.

However, it is noted that to combat the crimes of information technology, the convention focuses on the provisions of bilateral assistance among the States Parties through their internal apparatus. At the same time, the convention does not organize partial establishment of a unified Arab apparatus to operate under the management and supervision of all internal apparatus specialized in member states.

Therefore, this study recommends that the idea of establishing a unified Arab apparatus be organized to combat the crimes of information technology within its competence. The existence of an Arabic specialized body, which is available for twenty-four hours, has to work as much as possible to standardize the laws to combat the IT crimes among the States Parties and the coordination among specialized apparatuses in States Parties. The specialized apparatus have to be able to communicate promptly with the parallel body in any other State Party, and in the Coordination among specialized apparatuses in States Parties, the purpose being to give a fast assistance for the aims of investigation. In addition, the Coordination among Specialized apparatuses in States Parties are to collect evidence in electronic form concerning a specific crime or provide fast procedures relevant to information technology crimes. The Coordination among Specialized apparatuses in States Parties is to provide legal information, facilitate

⁸⁹ According to Article (32/4) from Arab Convention on Combating Information Technology Offences.

⁹⁰ According to Article (35) from Arab Convention on Combating Information Technology Offences.

gathering evidence and locate suspects, and finally work on facilitating provision of technical advice, in the field of combating it crimes.

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- Website of the League of Arab States at: <http://www.lasportal.org>

Quality of Service Monitoring of Wireless Networks Based on Combined Active-Passive Measurements

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Abstract

Wireless network performance is of vital importance for both the service provider and the customer. Therefore, the process of network performance evaluation must be accurate, simple and fast enough to reflect the network performance in a timely manner. In general, methods for monitoring and measuring quality of service (QoS) and network performance are classified as either active or passive monitoring techniques. The aim of this work is to devise techniques that can be used to infer the performance of wireless ad hoc networks by considering the QoS requirements of multimedia applications based on the ideas of both active and passive assessment approaches. QoS measurement is employed to assess the network performance and satisfying the requirements of user's applications. This approach uses an in-service measurement method in which the QoS of the actual application (user) is estimated by means of dedicated monitoring packets (probes). Afterwards, these parameters are combined to produce and assess the application's overall QoS using the fuzzy logic assessment and based on the measured QoS parameters estimated using the probe traffic. This approach combines both active and passive monitoring methods. The active scheme is used to generate monitoring probe packets which are inserted between blocks of target application packets at regular intervals. While the passive monitoring is utilised to act as a traffic meter which performs as a counter of user packets (and bytes) that belong to the application (user) traffic flow that is subjected to monitoring. After simulating and experimenting the developed monitoring technique, it offered a good estimation for the delay, throughput, packet losses and the overall QoS when using different probe rates. Nevertheless, this technique demonstrated some limitations in the delay variation estimation which will be directly reflected on the evaluated QoS.

Keywords: Quality of Service, network monitoring, passive measurement, active measurement, fuzzy logic.

1. Introduction

The performance of a computer or communications networks and their QoS are of vital importance for both the service provider and the customer. Therefore, the process of assessing and evaluating them must be simple and accurate. In addition, this process must be fast enough so that it can reflect the network performance in a timely manner. In general, methods for monitoring and measuring QoS and network performance are classified as either active or passive monitoring techniques.

Passive measurement is a traditional technique used to obtain measurements of QoS parameters related to a certain network element (Jing, et al., 2018), (Aouini, 2017) (Al-Sbou, 2012). It is based on monitoring the performance of packet streams through a network by tracking the traffic passing by a measurement point without creating or perturbing it. Passive measurement methods collect information from the ongoing traffic and the results are taken directly after some calculations without disturbing network operation or interfering with operational network traffic (Al Mamun, 2015). So, the packet's statistics can be gathered without adding any new traffic. This can be done by collecting traffic flow data, from routers, switches or end-point hosts. Moreover, in passive measurement, traffic may be collected by adding a stand-alone server at the location of interest (e.g., core or edge) of the network, which acts as a traffic meter or a monitoring device by storing information about the crossing traffic. The main disadvantage of passive measurements is the huge amount of data generated and need to be analysed to obtain the accurate measurement results.

Another method of monitoring the network performance is the active measurement. This method is becoming increasingly important due to its great flexibility, ability to achieve end-to-end measurements, and freedom from the need of accessing the core of network (Jing, et al., 2018) (Shibuya, et al., 2014). In this method, QoS and the performance of a network are measured by injecting of some artificial probing packet streams into the network and monitoring them from a source to a destination. Active measurements

can determine the QoS experienced by the probe flow for a particular path and then measure the QoS as it is seen by applications (Oniovosa, et al., 2016). The purpose of these probing packets is to provide some insight into the way the user traffic is treated within the network. The QoS and performance of the probe-packet stream are monitored to infer the performance of the user's packets and the network directly. Based on this, the drawback of active method is that it disturbs and overloads the network by injecting additional artificial probe traffic into the network.

In order to overcome some of the disadvantages of both active and passive approaches, several studies were carried. Some of these studies were based on a combination of active and passive methods. Change-of-measure based active/passive monitoring (CoMPACT) has been devised (Aida, et al., 2003), (Ishibashi, et al., 2004). This method was only used to estimate the actual user delay. Another technique has been proposed which combines passive and active methods (Lindh, 2002), (Lindh, 2001). In this technique, a router sends active probe packets at regular intervals. The passive monitoring method is used to count the number of user packets passing through the router. This approach has been used to estimate the QoS parameters only over wired networks.

In this paper, a techniques was devised to infer the performance of wireless ad hoc networks by considering the QoS requirements of multimedia applications based on both active and passive methods. In this study, the aim of QoS monitoring and measurement was to assess the network performance for satisfying the requirements of user's applications. This approach used an in-service measurement method in which the QoS of the actual application (user) is estimated by means of dedicated monitoring packets (probes) (Choi and Hwang, 2005). Afterwards, these parameters are combined to produce and assess the application's overall QoS using a fuzzy logic assessment system and based on the measured QoS parameters estimated using the probe traffic. This system was developed to evaluate the QoS of multimedia applications transmitted over wireless networks (Al-Sbou, 2017) (Al-Sbou, 2010) and (Al-Sbou, 2006).

This paper is organised as follows: Section 2 describes the monitoring approach description and the experimental simulation set up and settings. Section 3 presents the experimental results. Section 4 provides a conclusion of the paper.

2. *Experimental Approach*

2.1 Approach Description

The aim of this work is to design a single monitoring system that can monitor and estimate the main actual user QoS parameters (delay, delay variation (jitter), packet loss and throughput) and the overall QoS/performance based on an artificial probe packet stream (monitoring packet stream). This approach combines both active and passive monitoring methods (Lindh, 2002). The active scheme is used to generate monitoring probe packets which are inserted between blocks of target application packets at regular intervals as shown in Figure 1. Based on these monitoring packets, the actual user delay and the jitter are estimated. While the passive monitoring is utilised to act as a traffic meter which performs as a counter of user packets (and bytes) that belong to the application (user) traffic flow that is subjected to monitoring. The combination between active and passive is utilised to infer the actual packet loss ratio and the throughput of the multimedia application. Active methods are not reliable for these measurements due to two drawbacks. Firstly, active methods inject a large number of probes to detect packet losses in the network which has a non-negligible load on the network. Secondly, the estimated packet losses based on probe packets may not be identical to that occurred to user packets. As a result, packet loss and throughput are passively measured depending on the active probes position. The method introduces the monitoring block, as can be seen in Figure 1, as a concept to attain higher resolution than the long term averages over the measurement period.

The probe packets are generated by a periodic single packet generation process. Periodic generation is quite attractive because of its simplicity and ease of implementation. The sending monitoring node generates a monitoring packet after every M number of user packets on average or within specific time intervals as depicted in Figure 1 (Lindh, 2001). M is the number of actual traffic packets monitored between two successive monitoring packets. The generation process of the monitoring packet is a function of the selected monitoring block size or duration.

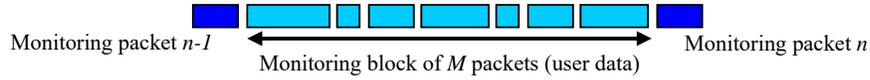


Figure 1: Two monitoring packets enclose a monitoring block that consists of M user packets.

In this work, in addition to the generation of the multimedia application, the transmitting node will be used to inject the monitoring packets. These packets are interspersed with the user packets regularly to gather QoS information. For every monitoring packet generated, the sending node counts and then inserts the number of user packets sent so far and the timestamp at which this monitoring packet was generated. At the receiving end, the receiver node needs to maintain a counter for the number of the received user packets. In addition, it should: detect the monitoring packets, place a timestamp in every monitoring packet which shows the current time at the receiving end, and insert the current value of the counter that keeps track of the cumulative number of the received user packets. To achieve accurate timing between the sender and the receiver ends, clocks needs to be synchronised. This work is based on a simulation study, so all nodes are already synchronised. But, in reality, a synchronisation tool may be used to keep the nodes synchronised. Current solutions are to synchronise nodes to a specific reference time like the Coordinate Universal Time (UTC) using the GPS receivers, or Global Time Base (GTB) (Jiang, et al., 2000).

At the end, every monitoring packet should have, a sequence number, sending and receiving timestamps and the number (cumulative) of sent and received user traffic packets. The difference between the number of user sent packets on monitoring packet n and monitoring packet $n-1$ gives the number of packets sent in the n^{th} monitoring block and correspondingly for the number of user received packets as illustrated in Figure 1. Consequently, the difference between the sent and the received packets in the same monitoring block is the number of lost packets in that block. Lost monitoring packets are detected by the missing sequence number. If a monitoring packet is lost, the monitoring block will be extended up to the next monitoring packet that succeeds to arrive at the receiving node. In addition, a sample of the packet delay between the sending and the receiving nodes is given by the difference between the sending and the receiving timestamps of the monitoring packets. Jitter is calculated from the delay results. After measuring these parameters, they are fed to the fuzzy system to assess the user application QoS using the same procedures discussed in networks (Al-Sbou, 2017) (Al-Sbou, 2010) and (Al-Sbou, 2006).

2.2 Network Topology and Traffic Characteristics

To demonstrate the effectiveness of the proposed system, NS-2 was used to simulate the wireless ad-hoc network (NS-2, 2019). The nodes were arranged in random positions and the arrangement was made in such a way that it satisfied the single hop condition with an area of (250m x 250m). The traffic characteristics are illustrated in Table 1 with 500 second simulation time. As an example of multimedia applications videoconferencing was used. The network used in the simulation had six pairs of fixed source/destination. One of the pairs is used for videoconferencing application transmission and the others were used for the cross-traffic.

The monitoring packets were CBR packets transmitted using the UDP protocol with a packet size of 64 bytes. The rate at which monitoring packets were sent is important. Too few packets result in inaccurate results and too many results in the network traffic being disturbed. Therefore, in order to examine the effect of probe rate on the QoS assessment, several probing rates were used ranging from low to high probe rates. Probe packets were transmitted periodically with monitoring block sizes (M) between the probe packets. M was selected to be 375, 186, 93, 47, 31 and 25 packets (i.e. ratio between probe and traffic packets is $1/375$, $1/186$, $1/93$, $1/47$, $1/31$ and $1/25$).

Table 1 Network traffic characteristics.

Traffic type	Packet Size [byte]	Generation Rate [Kbps]
Videoconferencing	512	384
Background traffic1	400	300
Background traffic2	370	360
Background traffic3	420	330
Background traffic4	350	300
Background traffic5	600	450

All simulation experiments were repeated several times by using different seed values for the random number generator of the NS-2 simulator. Changing the seed random number essentially runs the same traffic, but will produce different timing for the simulation. The resulted values of the different runs of the same simulation have been averaged to get the actual values. In addition, each simulation was run twice for each seed; once with probe switched on and once with probes switched off. This allowed for testing the effect of the probe presence on the user and network behaviour.

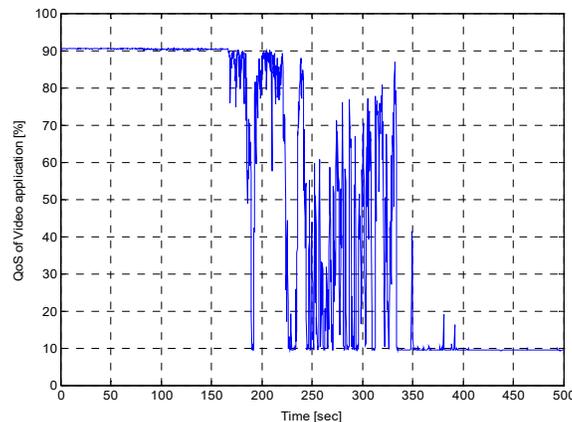
3. Results and Discussions

The performance of the monitoring procedure using the concepts of monitoring packets has been evaluated. This evaluation has been done for various probe rates and distances between the monitoring packets (i.e. the length of monitoring block).

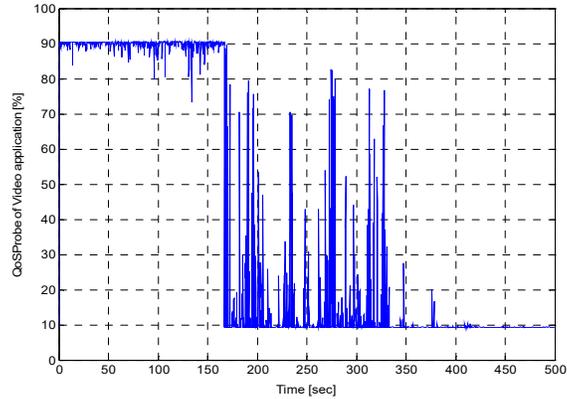
The service quality was evaluated in terms of one-way delay and delay variation, packet loss rate, throughput and finally the overall assessed QoS. There are two comparisons that needed to be considered when assessing how good the probes are performing. Firstly, to assess how accurate the probe results are and secondly, to know how much the traffic is being affected by these probes (biasness).

3.1 Accuracy

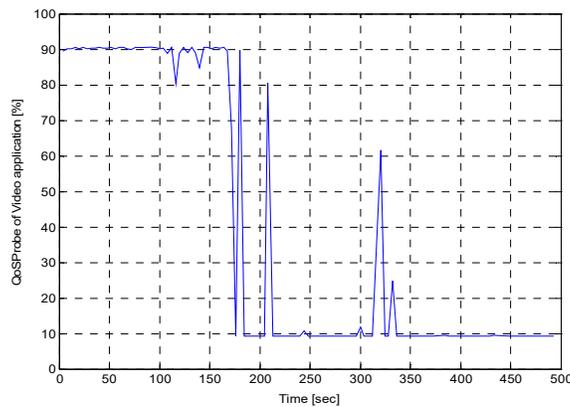
The most important QoS parameters that affect the videoconferencing performance are the delay, delay variation and the packet loss. These parameters can be estimated (as described earlier) by probing the network. Delay and delay variation can be taken (estimated) directly from the probe traffic and packet loss is estimated using the monitoring block concept. After measuring these parameters, they were fed to the fuzzy system to produce the estimated overall QoS of the videoconferencing application based on the results obtained from the monitoring packets. In addition and in order to check the accuracy of the estimated overall QoS result, these parameters were measured for the actual user with the probe traffic switched off. The actual traffic parameters were averaged using the blocking technique for $M = 25$ and $M = 374$ packets. Fuzzy system outputs of the estimated QoS using the probe and the actual user overall QoS are shown in Figures 2 (a)-(c).



(a)



(b)



(c)

Figure Error! No text of specified style in document.2: Measured overall QoS of the: (a) actual traffic, (b) Monitoring traffic of $M = 25$ packets and (c) Monitoring traffic of $M = 375$ packets.

It can be observed from Figures 2 (a)-(c) that the QoS of the monitoring probe packets can infer the actual user overall QoS during the periods of light and heavy loaded network situations. On the other hand, during the partially loaded state, the probe QoS could not estimate the actual user QoS especially when using the $M = 375$ monitoring block size. However, the probe gave a better estimation of the actual overall QoS using the $M = 25$. This means that the QoS estimation was affected by the probe rate (i.e. number of samples). In addition to that, the poor QoS estimation was, mainly, due to jitter. As the network load is increased, the jitter will increase and in particular the probe jitter as explained earlier. The probe jitter will be higher than the actual traffic jitter. Occasionally the probe jitter will exceed the limits of the required QoS while the actual traffic jitter may stay within these limits. Due to this, the probe QoS will underestimate the actual traffic QoS and especially during the partially loaded situations because during the heavy loaded state periods both the probe and the traffic parameters will go beyond the required values and so the overall measured QoS will be poor.

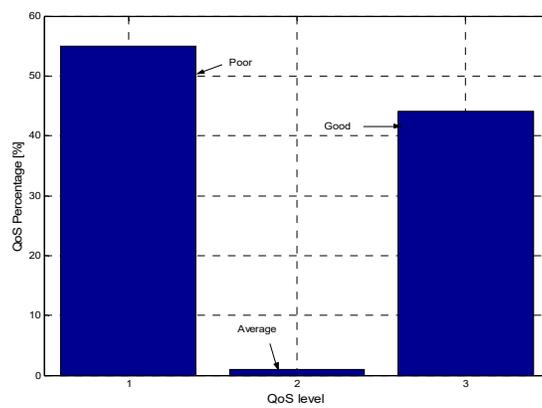
Table 2 illustrates the long-term statistics (mean, standard deviation, maximum and minimum) that characterise the overall QoS values for the actual user traffic and the estimated values using different monitoring block sizes. This table reveals that as the monitoring block size increases the estimated QoS is enhanced compared with the actual QoS value. Increasing the block size will provide more samples to be evaluated using the fuzzy system which will monitor the network more accurately. The estimated overall QoS standard deviation, maximum and minimum are mostly the same as the actual values. This means that the long-term average QoS estimation using monitoring packets is a good approximation of the actual QoS.

To compare the levels when the overall QoS was poor, average and good, for both the actual and the probe traffics ($M = 25$ and 375), a bar charts distribution was used. The length of the bar was representative

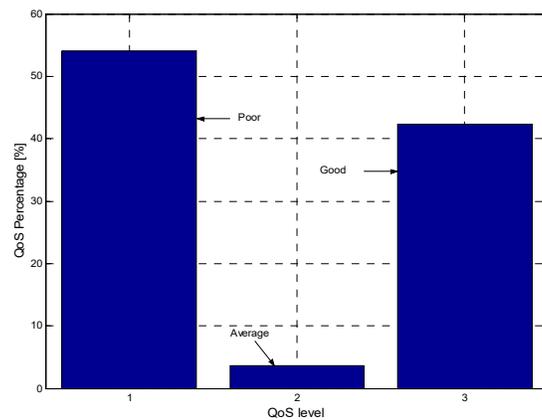
of the percentage of each QoS case. Figures 3 (a)-(c) show the bar charts of both application's overall QoS. Monitoring traffic using $M = 25$ was closer to the actual overall QoS regions. That was due to the fact that the network was subjected to more assessments over the measurement period using this rate which will result in a higher precision in the QoS estimation than the $M = 375$ probe rate.

Table 2 The actual and the estimated values for overall QoS using different block sizes M .

units: [%]	Actual values	$M = 375$	$M = 186$	$M = 93$	$M = 47$	$M = 25$
Evaluated QoS	52.74	40.94	40.51	42.14	43.24	44.51
Absolute error		11.8	12.25	10.6	9.5	8.25
QoS Std. Dev	37.09	38.96	38.49	38.79	38.84	38.66
Maximum QoS	90.48	90.52	90.52	90.52	90.52	90.52
Minimum QoS	9.30	9.27	9.27	9.27	9.27	9.27



(a)



(b)

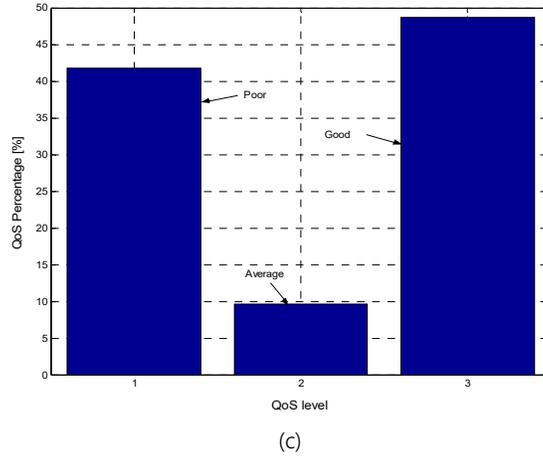


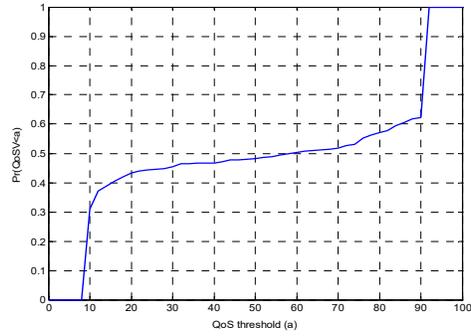
Figure 3: The overall QoS bar chart for: (a) Monitoring packets using $M = 375$ packets, (b) Monitoring packets using $M = 25$ packets, (c) actual traffic.

In order to quantify how much the overall QoS of each application was; poor, average or good, the variation of these values, mean and standard deviation were calculated. Table 3 illustrates these statistics that characterise each region of each the traffic overall QoS values for the actual user traffic and the estimated values of $M = 25$ and 375 monitoring block sizes. Table 3 exhibits that the probe rate of $M = 25$ had better QoS approximation of the actual overall QoS because all of its estimated statistics are closer to the actual values.

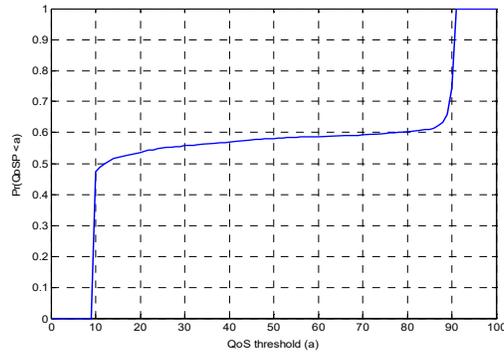
Table 3 Statistics of actual and estimated overall QoS region for $M = 25$ and 375 .

Units: [%]	Actual values			M = 375			M = 25		
QoS	Poor	Average	Good	Poor	Average	Good	Poor	Average	Good
Mean	11.8	51.9	88.1	9.8	38.8	89.7	10.5	46.2	89.5
Std. Dev.	5.4	9.9	5.2	2.6	0	2.2	4	7.8	2.5

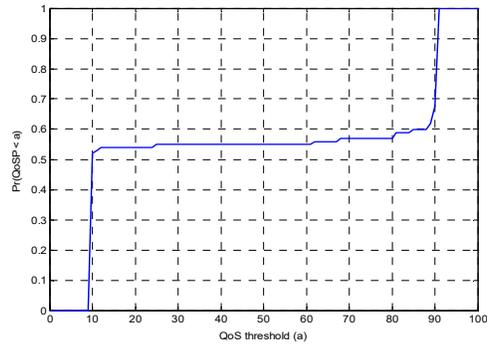
So as to obtain a more specific picture about the actual and the estimated overall QoS for each application without classification of the QoS values into good, average and poor regions, probability distribution functions have been generated of each QoS. These distributions are shown in Figures 4 (a) and (b). The Figures illustrate the cumulative distributions, $\Pr\{X < a\}$, where the random variable X denotes the end-to-end QoS. The usefulness of this method stems from the fact that it gives the percentage that the QoS is less than any threshold value (a). Using these types of distributions, for example, it is very easy to assess the probability of the QoS. In addition to that, it can be observed that the minimum and maximum values of the QoS can be found from these figures. It is apparent that the monitoring packets could, to some extent, estimate the actual QoS cumulative distribution. For example, it can be seen from the figures that it is very easy to assess the probability that the QoS was less than 40%. It is from the actual traffic 0.47, 0.57 and 0.55 using the monitoring traffic of $M = 25$ and 375 respectively. In addition to that, it can be observed that the minimum and maximum values of the QoS can be found from these figures. The minimum value for both traffics (actual and monitoring) was 9.3%. The maximum value for the actual traffic was 90.5% and 90.5% for $M = 25$ and 375 probe traffic.



(a)



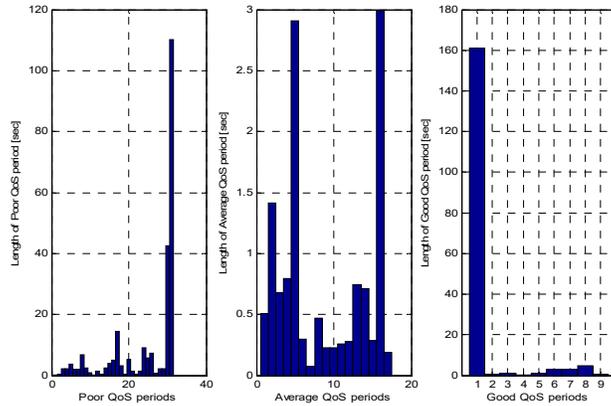
(b)



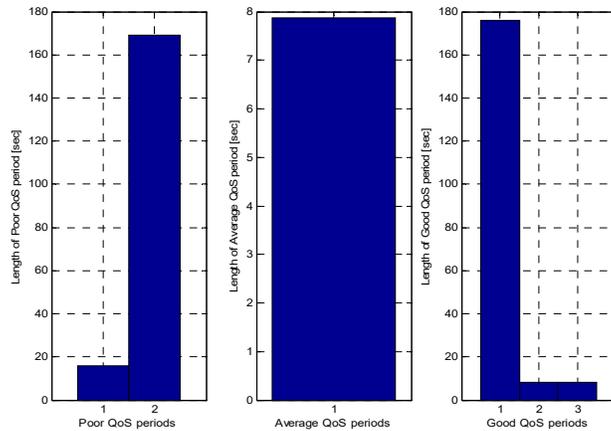
(c)

Figure 4: The overall QoS distribution for: (a) actual traffic, (b) Monitoring packets using $M = 25$ packets, (c) Monitoring packets using $M = 375$ packets.

An additional valuable metric can be achieved using the concept of monitoring blocks. This concept makes it possible to define time intervals in which the QoS was good, average and poor. These intervals are defined as the number of consecutive monitoring blocks which have the same QoS level. The period length is determined by the difference between the timestamps of the monitoring packets. For example, good QoS period is computed in terms of the number of successive monitoring packets that have QoS values larger than 67%. The length of this period is the time difference between the first monitoring packet and the last monitoring packet. The same principle is applied for the determination of poor and average QoS periods. This is illustrated in Figures 5 (a) and (b) which characterise the length of the periods for Good, Average and Poor QoS (in seconds) for $M = 25$ and 375.



(a)



(b)

Figure Error! No text of specified style in document.5: The length of Poor, Average and Good QoS periods versus time during the measurement period using monitoring block of: (a) $M = 25$ and (b) 375.

It is clear from the Figure that the $M = 25$ monitoring block provides more details of variations of these periods than the $M = 375$ monitoring block. In addition, this representation demonstrates how many Good, Average and Poor QoS periods have taken place during the measurement period. Monitoring block ($M = 25$) shows that there were 31 Poor QoS periods, 17 Average QoS periods and 9 Good QoS periods over the monitoring period. While the monitoring block ($M = 375$) exhibits that there were 2 Poor QoS periods, 1 Average QoS period and 3 Good QoS periods over the same measurement period. The ratios between the Poor, Average and Good intervals and the total measurement period are: 48% and 37% for Poor QoS, 2.6% and 1.5% for Average QoS and 35% and 26% for Good QoS using $M = 25$ and $M = 375$ monitoring blocks, respectively.

3.2 Biasness

The biasness is measured by comparing the actual traffic parameters and the QoS results when the probe traffic is switched on and when it is switched off. This will be done using the long-term results in both cases. To check the effect of adding probe traffic on the actual traffic overall QoS, the difference between the evaluated actual overall QoS values in both cases with and without probe traffic were calculated. Table 4 shows the actual overall QoS statistics. It is obvious that increasing the probe rate will increase the distance (error) between the evaluated QoS values (with and without probe traffic). In spite of these differences the QoS is still in the same region (i.e. Average QoS). The standard deviations, maximum and minimum QoS are in the same range for the actual traffic in both cases (with and without probe traffic).

Table 4 The effectiveness of the probe traffic presence in the actual overall QoS measurement results.

Units: [%]	Without probe	With probe			
	Actual traffic	Actual traffic with $M = 375$	Actual traffic with $M = 186$	Actual traffic with $M = 93$	Actual traffic with $M = 25$
Evaluated QoS	52.7	52.1	51.1	50.2	48.6
Absolute Error		0.7	1.7	2.6	4.2
QoS St. Dev.	37.1	36.8	37.3	37.3	37.8
Maximum QoS	90.5	90.5	90.5	90.5	90.5
Minimum QoS	9.3	9.4	9.4	9.3	9.3

Comparing the results in Table 3 and 4 confirms that there were no large differences between the probe traffic QoS and actual traffic overall QoS (in both cases).

4. Conclusions

This paper focused on developing a new approach for estimating the overall application QoS based on the QoS parameters obtained from the probe traffic packets. The simulation results showed that this approach provided a wide range of metrics that can be used to monitor the actual traffic measurements using different probe rates. Furthermore, these measurements were also tested and examined in terms of its accuracy and biasness to be representative of the actual traffic results. The proposed approach provided good accuracy in estimation of the overall QoS and the QoS parameters but showed drawbacks in jitter estimations. In the next chapter, a new estimation method is proposed to overcome some of the shortcomings of probe-based approach based on standard sampling schemes.

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A Method of Word Spotting for Machine-Printed Arabic Text Documents

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Abstract

Large volumes of scanned printed document offered in digital format for use by information storage and retrieval systems. This paper presents a method to spot Arabic words from printed text images. The proposed method aims to find relevant words from a corpus of digitized pages depending on the image features only. This starts with extracting word images from Arabic text images based on their statistical measures. Their corresponding features based on the bag of visual words model are then calculated and indexed. Finally, words matching, in which features from the query image are compared to features from each image in the collection, then candidate words are retrieved and ranked. The proposed method is evaluated using samples of Arabic scanned documents from the ALPH-REGIM-database; and the results proved that the bag of words approach is a promising strategy for spotting of Arabic printed keywords.

Keywords word spotting, text image, Bag of Features, SVM

1. Introduction

Due to the evolution of information and communication technologies, enormous quantities of scanned and digitally available content material are continuously discovered. Content searching strategies are not relevant to searching for images through these documents, and this becomes a very challenging task.

Optical character recognition (OCR) systems are considered main data recovery systems based on text images. However, these systems are restricted to great quality text images. Furthermore, The OCR approach requires a long time for the large number of images in digital libraries of papers (Doermann 1998). To minimize these issues, researchers have suggested another methodology named keyword spotting.

In keyword spotting method, the domain of searching is just the word images. This approach enables a variety of OCR-based applications to extend their operation to image documents such as SPAM detection from the image, reading an advertisement for blind people, search and index document which contains an image and enhancing OCR. In this approach, the major advantage is the lesser time required for execution, and the robustness to ambiguous documents (Yue Lu and Tan 2002) (Y. Lu and Tan 2004)

Keyword Spotting can be considered as an example of "Content-based picture retrieval" (CBIR). Its aim, given a query, is to retrieve the most appropriate instances of words in an assembly of scanned documents (Giotis et al. 2017). The searching may be a text string (by spotting the string), or an image word (by locating the keyword instance).

This paper is organized as follows: First, the Challenges in spotting Arabic words are depicted in Section 2. Next, Section 3 gives the related works. The proposed technique overview system is presented in Section 4. Experimental results are introduced in Section 6. Lastly, Section 7 concludes the work.

2. Challenges in spotting the word image in Arabic text

There are more than 450 Arabic fonts (F. Slimane et al. 2010). Fig. 1 demonstrates ten of the most frequently used fonts, the ones we used in our study. Also, Fig. 1 demonstrates the variety of shapes based on the font. Many fonts have no or few overlaps and ligatures (Andalus, Tahoma). While, some other fonts are more complicated, richer in overlaps, ligatures and flourishes (Fouad Slimane et al. 2013).

A : نقده في هذا البحث قاعدة بيانات الكلمات العربية
 B : نقدهم في هذا البحث قاعدة بيانات لكلمات عربية
 C : نقدهم في هذا البحث قاعدة بيانات لكلمات عربية
 D : نقدهم في هذا البحث قاعدة بيانات لكلمات عربية
 E : نقدهم في هذا البحث قاعدة بيانات لكلمات عربية
 F : نقدهم في هذا البحث قاعدة بيانات لكلمات عربية
 G : نقدهم في هذا البحث قاعدة بيانات لكلمات عربية
 H : نقدهم في هذا البحث قاعدة بيانات لكلمات عربية
 I : نقدهم في هذا البحث قاعدة بيانات لكلمات عربية
 J : نقدهم في هذا البحث قاعدة بيانات لكلمات عربية

Figure 2: Examples of Arabic fonts

“(A) Andalus, (B) Arabic Transparent, (C) Advertising Bold, (D) Diwani Letter, (E) DecoType Thuluth, (F) Simplified Arabic, (G) Tahoma, (H) Traditional Arabic, (I) DecoType Naskh, (J) M Unicode Sara.” (F. Slimane et al. 2010)

It has been noted in (Alghamdi and Teahan 2017) that the accuracy of Arabic OCR schemes were affected by font type. The low precision rate for all assessed schemes was the Diwani Letter font, due to the multifaceted nature of this font, which involves overlaps. Most of the accuracy levels assessed by Arabic OCR schemes were below 75%, suggesting continuing need for improvements in the recognition of printed Arabic script.

In (Pourasad, Hassibi, and Ghorbani 2013), researchers demonstrated that one of the primary difficulties in methods of spotting keyword is the font type and size dissimilarities between an image of Arabic document and query word. To overcome these difficulties, they identify the font type and size in the document image, before they look for the keyword and then change the font type and size of the keyword accordingly. Such characteristics for Arabic scripts are challenging. Therefore, this work introduces a feature-based searching technique, invariant to rotation and scale, which is SURF.

3. Evolution of the related works

Many literatures can be found on the subject of word spotting, but the majority of these articles are written for English (Latin letters). There are only a few papers dealing with word spotting in Arabic, most of which are about the Arabic handwritten documents. For example (Srihari et al., 2006) represented in 3 scripts, Arabic, Devanagari, and Latin, a system for word spotting in scanned text images. The input request for the scheme can be either a text or a picture phrase in this scheme. The candidate words are searched and retrieved in the documents and placed using a standardized correlation similarity measurement. In (Pourasad, Hassibi, and Ghorbani 2013), researchers First, identify the font face and font size in the image of the document, before they look for the keyword and then change the font type and size of the keyword according to that of the document. In (Saabni and El-sana 2008) authors use two algorithms, Dynamic Time Warping (DTW) and Hidden Markov Models (HMM) for feature extraction, to spot Arabic handwritten text. However, the dataset includes some high-quality Arabic printed documents. In (Ataer and Duygulu 2006) they first segments text images into word images and then utilizes a hierarchical matching technique to find similar word images instances. Table 1 summarises this literature.

Table 1 Sources of texts addressed by the methods of word spotting

Publications	Script	Results
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(Pourasad, Hassibi, and Ghorbani 2013)	Farsi, Arabic	87.6%
(Srihari et al., 2006)	Latin, Arabic, Devanagari	68%
(Saabni and El-sana 2008)	Arabic	85%
(Ataer and Duygulu 2006)	Ottoman, Arabic	85.2%

CBIR techniques can generally be divided into two groups which use local and global features. Global features are extracted over a whole image, while local features are calculated on explicit pieces of the image. As per the recent papers, local features give marginally preferable recovery adequacy over global features (Ali et al. 2016). Due to the special challenges of printed Arabic document image, in this study, we employ a local feature based searching method, features that are invariant to the font type and size.

3.1 Word spotting system structure

An overall structure for word spotting system involves two distinct parts: training and the testing as represented in Fig. 2. A detailed description of the different stages of both parts is as follows.

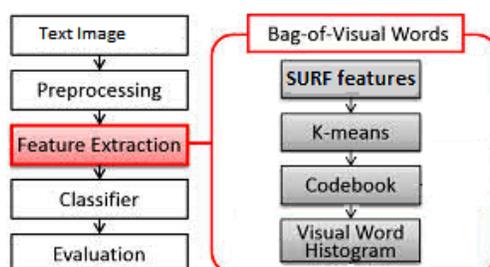


Figure 2: General word spotting system structure.

3.2 Pre-processing

Commonly, the step of pre-processing in word spotting in the text image has processed as follows: binarization, removal of noise, the segmentation of text image into text lines and words. The pre-processing step is used by many word spotting systems in one form or another (Peake and Tan 1997). The output from pre-processing stage is shown in figure 3.

أظهرت تجارب الدول العربية أن الانتقال نحو مجتمع المعلومات يتطلب أن تعمل الأطراف الرئيسية كأدوات نشر بالتكنولوجيا، وبمقدور المنظمات غير الحكومية تهيئة المناخ اللازم للتغيير إلى مجتمع المعلومات؛ وذلك من خلال طريقتين: أولهما أن هذه الجهات تستطيع التحول إلى الأساليب القائمة على المعلومات لمساعدة جمهور المتعاملين معها وبذلك يشعر المواطنون بمنافع تكنولوجيا المعلومات والاتصالات مثل أن يكون بمقدورهم طباعة نموذج إلكتروني من الإنترنت بدلاً من تحويل المواطن إلى مكتب آخر ليحصل عليه بنفسه. ثاني هاتين الطريقتين هو أن هذه الجهات تستطيع إعلام المواطنين بنقاط النفاذ المتاحة للمعلومات مثل مراكز الاتصال المجتمعية أو تقديم التدريب لهم على استخدام أدوات تكنولوجيا المعلومات والاتصالات.

Figure 3: Pre processing of image text

3.3 Segmentation

Segmenting image document into text lines then words is an important step in word spotting system. Therefore, we employed a method proposed in (Al-Dmour and Fraij 2014) for the segmentation of Arabic handwritten text into lines and words. Text lines segmentation is addressed by a adapted well-known technique; the horizontal projection profile, HPP; While, words are extracted using columnar projection profile, CPP. As shown in figure 4 below.

4. Classification

Finally, the resulted histogram representing the features of K words is used for the training of linear SVM classifier for recognizing image word. The SVM (Chang and Lin 2011) discover a linear hyperplane which maximizes the margin in this higher dimensional space. The vectors x used for training are mapped into a higher dimensional space by a kernel function $k(x, y)$, here we used linear kernel defined as follows:

$$K(x, y) = x^T y.$$

To spot a sample image, the preprocessing technique is first implemented. Extract SURF features from this test image, and then discover the nearest word to each feature in the codebook. Visual word occurrence frequency shapes the region's histogram representation. Finally, the SVM classifier utilizes this representation as an input feature vector to predict this region's label.

5. Experimental evaluation

In this section, the data set used is outlined and experimental findings identified by the proposed method are discussed. The approach used in this study has been executed on dual-core 2.4 GHz Pentium PC utilizing MATLAB programming software.

5.1 Dataset

For evaluation purpose, the dataset given by (Ben Moussa et al. 2010) was used, which is ALPH-REGIM. In this database, more than 5000 image words are incorporated. The larger part of the database is accessible on the web. Typeset text in Arabic is composed in 10 or more typefaces of Arabic, to establish the second half of this database named "Arabic Font Base" (AFB). For Latin documents, Typeset is composed of almost 8 typefaces (Bookman, Arial, Comic, Century, Impact, Courier, Time New Roman, and Modern).

6. Results and Experiments Performance Evaluation

This section gives insights regarding the conducted experiments to evaluate the performance of the proposed system. The proposed system is evaluated on ALPH-REGIM, SURF is utilized for features extraction, and SVM is utilized as a supervised classifier. Precision is used to decide the performance of the proposed system. Use of Precision is to decide the number of relevant images recovered in response to the test image.

$$Precision = \frac{\text{Number of relevant images retrieved}}{\text{Total number of images retrieved}}$$



Figure 6: Sample of Qualitative results. Query and top ten retrieved words.

Figure 1 shows the accuracy of the spotting of the proposed method over several image fonts. Clearly, Arabic's word spotting technique is affected by the document font type. The low precision level of the Diwani Letter font in the assessed system is a direct effect of this overlapping font's multifaceted nature.

Briefly, the accuracy of Arabic word spotting schemes is about 82 %, in which a 10-page dataset was used in Arabic printed documents and the link between the accuracy of Arabic word spotting techniques and Arabic document font is highlighted.

Unfortunately, we could not find much literature to compare our results, so we decided to compare our findings with Arabic handwritten text. In (Srihari et al. 2006) the accuracy rate for handwritten Arabic texts was 68%. And with (Saabni and El-Sana 2008) in which a 40-page dataset was used in Handwritten Arabic that included more than 8000 words; 10 of those 40 papers were high-quality Arabic printed documents. The writers revealed an average precision rate of 85 %.

7. Conclusion and Future Directions

In this paper, we have presented a method for spotting words from a machine-printed Arabic Text Documents based on BoW. This method is consistent with the characteristics of Arabic printed text, particularly variations in font face and size. The efficiency of proposed method is shown experimentally on 10 different Arabic fonts and different font sizes. As demonstrated by the results of experiments, we can conclude that, the SURF's visual words can produce promising performance of spotting the desired images with the added advantages of scalability and fast indexing. Our future work includes (i) improving the segmentation stage of the image document into text lines and words (ii) to evaluate our system for handwritten Arabic text image.

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Cloud-Based ERP Systems Implementation: Major Challenges and Critical Success Factors

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Abstract

Cloud-based ERP systems are substantially expanding, which expected in the near future to demonstrate a significant impact on the current business model. Identifying the Critical Success Factors (CSFs) and the major challenges of the cloud-based ERP systems implementation will pave the pathway for prospective clients to adopt cloud ERP systems and take advantage of this novel IT-based cloud revolution.

Keywords: Cloud-based ERP System, Critical Success Factors.

1. Introduction

Many companies forced to restructure their business model in order to satisfy their customers and achieve a competitive advantage over other competitors. This requires adopting the cutting-edge advancements in technology to grasp the potential opportunities and to be in line with the companies' business partners and suppliers. Cloud-based ERP systems are able to reduce the cost that associated with the ERP implementation infrastructure such as software licenses and update, application operating costs, hardware, consultation, maintenance, and many other related costs (Elragal & El Kommos, 2012).

Cloud computing is similar to an electric company that providing service to public on-demand and pay for based on usage. Companies do not generate electricity on their own but rather get it from a provider, which is in this case the electric company. Likewise, the cloud service providers provide services such as, Software as a Service (SaaS), Infrastructure as a Service (IaaS), and Platform as a Service (PaaS). Cloud-based ERP Systems has become the new emerging technology and the paradigm shift that has made a fundamental change in business model and in the way in which ERP system implemented and used (Stine et al, 2015; Turban, 2012; Astri, 2015, Mijač, 2013).

Organizations need to move forward from the in-house ERP model to the new cloud-based ERP model to be efficient, flexible, and innovative; and eventually, gain a competitive advantage over other rivals in the marketplace. This would be possible by identifying the major challenges in the organization and then provides solid solutions for them throughout promising technologies such as cloud-based ERP solution. However, identifying the critical success factors (CSFs) would extremely contribute to the success of cloud-based ERP systems implementation (Akinola, 2012, Alharthi et al, 2017).

2. Literature Review

2.1 Cloud Computing

Cloud computing is just like a public utility owned by a provider and shared by many users, where the access to the cloud service and resources is available on-demand basis. Cloud computing refers to a computing infrastructure platform that contains all required hardware and networks to host systems software, database, and many other applications to be dynamically provisioned as a service to the end-users. This new cloud-based business model enables companies to minimize the efforts and the burdens that associated with IT resources implementation. This model does not require companies to own the IT resources physically, but rather they can use them over the internet at any convenient time without the involvement in any resources management, upgrade, or maintenance because the cloud service providers will handle all these matters (Akinola, 2012, Astri, 2015).

According to the official NIST definition, "cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction." "The NIST definition lists five essential

characteristics of cloud computing: on-demand self-service, broad network access, resource pooling, rapid elasticity or expansion, and measured service. It also lists three "service models" (software, platform and infrastructure), and four "deployment models" (private, community, public and hybrid) that together categorize ways to deliver cloud services" (NIST Tech Beat, 2011).

There are many advantages of cloud computing such as cost reduction, use of up-to-date IT resources, better collaboration among the team members, premium quality control over resources, availability of mobile access anytime via any device, and easy data recovery in case of unexpected disaster. However, there are many challenges such as security and privacy, network downtime, potential attacks from cybercriminals, and hard to change from one cloud provider to another. This increasing attention to the new IT infrastructure approach will strengthen the cloud model and overcome all barriers to totally moves to the cloud-based IT environment. Firms adopt cloud computing mainly to reduce the hardware and software license cost, to cut the total cost of ownership and operating expenses, lower the IT department and personnel requirements, and to improve scalability and communication with customers and vendors (Astri, 2015; Mijač, 2013; Hofmann, 2010; Suciu et al, 2012; Salleh et al, 2012).

2.2 Cloud-Based ERP Systems

Cloud-based ERP system is a core part of the cloud-computing model that provides comprehensive functionalities to support all business functions in the organization. Recently, cloud-based ERP systems considered as one of the most important trends in the enterprise information systems field because it presents a new model that is widely accepted and implemented by many firms. Cloud ERP is a multi-users application that provides services to several users with different needs; it has multiple functionalities in a single application that supports all business needs such as manufacturing, accounting, supply chain, storage, database, distribution, business intelligent, HRM, CRM etc. (Hao & Helo, 2014).

Cloud ERP technology remains as fast-growing technology, and it has reached an important level in the in the information systems field (Usman et al, 2017). Cloud ERP solutions are in line with the future concept of making all needed materials available online to work anywhere and anytime. A study on cloud ERP systems implementation in education sector demonstrates that, the reasons for adopting the cloud ERP solutions are, replacing aging legacy system (30%), then improve service to customers (21%), transforming institution operations (16%), modernize campus IT environment (12%), keep institution competitive (7%), increase efficiency (5%), better teaching & learning process (5%), and finally accountability and regulatory compliance (4%) (Deshmukh, 2014).

Web-based architecture is the platform of the cloud ERP systems that consist all required solutions to manage the entire business needs effectively. Pay-as-you-go model is the payment method for the usage of the cloud ERP services. Users of the cloud service should pay based on their usage only, so that there will be no wasted resources and they will receive a bill similar to that they usually receive for the usage of other utilities. Nowadays, evolving enterprises are looking for the most agile business model to remain competitive in the current fierce business environment; cloud ERP is the robust platform for this new approach that helps to derive impressive business outcomes. Moving to cloud ERP solution has substantial benefits to firms such as information richness, efficient performance, agile operations, cost reduction, improve productivity, and increase profitability. However, prior to implementing cloud-based ERP systems, firms must clearly identify the CSFs and the challenges related to cloud adoption and implementation (Alharthi et al, 2017; Mijač, 2013).

2.3 Major Challenges

In order to achieve a successful cloud ERP implementation, all relevant challenges must be defeated. One of the major challenges is the vendor bargaining power where the entire governance and control over the cloud ERP system are in the provider's hand. The vendor can simply lock-in the cloud ERP resources since they have full dominance over the entire cloud IT resources that will help them to put some pressures on the companies by raising the prices, lowering the quality, or reducing the quality of the provided services. There are many challenges of cloud ERP systems identified in literature. However, this research will summarize only the top ten cloud ERP challenges. These challenges include security, cost, governance, compliance, competencies, vendor dominance, integration, customization, migration, and organizational culture (Akinola, 2012; Astri, 2015; Suo, 2013).

Security is the major concern not only for the cloud ERP but also for the entire cloud-computing technology. Ensuring the security of cloud ERP resources is not an easy task, it requires a very complex

process and high safety requirements. Hidden costs also considered as a challenge to many organizations due to lack of transparency in the cost section of the contract such as coordination cost, monitoring costs, and transition costs. Lack of governance and control over the cloud IT resources will definitely decline the braining power of customer to shift to another cloud provider. Compliance is another challenge where organizations must adhere to technology standards and regulations and strictly follow the policies that placed by the providers. Moving to cloud-based ERP system will lead to a huge loss in IT competencies and creates firm resistance in IT department due to the great dominance of the service providers over most of IT resources, and privileges (Abd Elmonem et al, 2017; Suo, 2013)

Currently, few cloud providers dominate the cloud market such as Google, IBM, Microsoft, and Amazon. The full control over the IT resources will give the cloud providers the ultimate power to put pressure on the end-users such as increasing the subscription fees, reducing the quality of the service, and lock-in data and applications in order to prevent the customers to switch to other providers. Integration with legacy systems and with some applications might make the adoption of cloud computing a challenge to many organizations. The cloud ERP systems offer very limited customization to prevent major changes on the cloud packages. This restriction does not provide many options to the end-users to modify the cloud ERP system to match their business processes. However, organizations need to change their business processes to fit with the cloud ERP systems functionality, which might not be appropriate for several organizations (Abd Elmonem et al, 2017; Motiwalla & Thompson, 2014; Shatat 2016).

Migrating to the new cloud ERP systems is not an easy task since the in-house ERP systems are entirely different from the cloud-based ERP systems. Moreover, moving among cloud service providers is not that easy due to several dissimilarities within the cloud ERP packages. The process of adopting the new cloud ERP systems may force organizations to accept the major changes in the business processes and may create change resistance among the end-users. Change of business rules and policies and eliminate the boundaries between functional departments will make huge confusion and resistance towards the new cloud ERP systems. However, top management support, employee involvement, and change management champion will extremely help in the preparation of the major business changes. Change management team should work closely with the end-users on implementing and accepting the new changes in the business processes throughout day-to-day communication and extreme training courses to end up with successful cloud ERP project (Motiwalla & Thompson, 2014; Shatat 2016; Suo, 2013).

2.4 Critical Success Factors

Many critical success factors of ERP implementation presented in literature, but very few CSFs of cloud-based ERP implementation reported in similar studies. Kronbichler *et al.* (2009) reported 78 CSFs of the in-house ERP systems implementation that classified into 15 major categories. Yu (2005) suggests to evaluate carefully the ERP software, vendors, and consultants, and to pay attention to the major CSFs such as top management support, teamwork and composition, business plan and vision, effective communication, project champion, and project management, to end up with successful ERP systems implementation.

Stine et al (2015) determined the success factors of cloud business model by analyzing 45 firms with their business models. The study revealed 39 success-related critical business model characteristics such as manifold width, one-time charge, database service, monitoring, consolidation, print media, knowhow transfer, administration, knowhow resource, consulting activities, etc. However, the most popular firms with the highest implementation rate of the critical business model characteristics are Microsoft rating 68% of the critical business model characteristics, followed by Amazon's AWS (65%), then IBM (65%), CenturyLink / Savvis (64%), Cisco (64%), and finally VMware by (64%).

Nah and Lau (2001) noted that in order to implement the ERP systems successfully, companies should involve CSFs such as top management support, teamwork and composition, business plan and vision, effective communication, change management program, business process reengineering, project management, project champion, and monitoring & evaluation of performance. After extensive review in the literature, Shatat (2015) classified the CSFs of the ERP systems implementation by the scope of citation in literature, which categorized into three main categories i.e. highly cited in literature, medium, and low citation. Table 1 presents the scope of CSFs citation in literature.

Table 1 CSFs of In-house ERP Systems

CSFs in literature	Scope of citation in literature	References
Top Management Support	High	Ang et al.(2002); Al-Mashari et al. (2003); Yusuf et al.(2004)
Project Management	High	Umble et al. (2003); Yusuf et al.(2004); Al-Mashari et al. (2003)
Business Process Reengineering	High	Hong and Kim (2002); Malbert et al.(2003); Yusuf et al.(2004)
User Training & Education	High	Mandal and Gunasekaran (2002); Umble et al. (2003); Sum et al. (1997)
User Involvement	High	Bingi et al. (1999); Burns and Turnipseed (1991); Cox and Clark (1984); Zhang <i>et al.</i> , (2002)
Business Plan & Vision	Medium	Loh and Koh (2004); Somers and Nelson (2004)
Careful Package Selection	Medium	Wei and Wang (2004); Shehab <i>et al.</i> , (2004)
Change Readiness & Culture	Medium	Hong and Kim (2002)
Clear Goals & Objectives	Medium	Umble et al. (2003); Yusuf et al. (2004)
Learning Competency	Medium	Zhang <i>et al.</i> , (2002)
Minimal Customization	Medium	Somers and Nelsons (2001)
Monitoring & Evaluation Of Performance	Medium	Holland <i>et al.</i> (1999)
Project Champion	Medium	Akkermans <i>et al.</i> , (2000)
Strategic IT Planning	Medium	Somers and Nelson (2004);
Teamwork & Composition	Medium	Loh and Koh (2004); Remus (2006)
Vendor Support	Medium	Motwani et al. (2002); Yusuf et al. (2004)
Appropriate Business & IT Legacy Systems	Low	Holland <i>et al.</i> (1999)
Data Analysis & Conversion	Low	Zhang <i>et al.</i> , (2002)
Education on new Business Processes	Low	Woo (2007)
Partnership with Vendor	Low	Somers and Nelsons (2001)

Source: Shatat (2015)

In literature, the cloud-based CSFs classified into two main categories technological and organizational factors, the technological factors include technology readiness, security, complexity, and cost. The organizational factors include top management support, firm size, compatibility, and relative advantage. However, compatibility ranked as the top influential factor with a frequency of 27, followed by relative advantage with a frequency of 25, then top management support with 24, and eventually security with 23. These four factors are the most important and frequent factors in literature, besides the other factors such as cost, technological readiness, complexity, competitive pressure, government regulations, and finally firm size (Usman et al, 2017). Cost reducing, flexibility, virtually, availability, collaboration, scalability, efficiency, redundancy, and reliability are found to be the CSFs that positively affect the adoption of cloud computing in many organizations. However, cost reduction rated as the most CSFs, then redundancy, and reliability rated as the least CSFs of cloud computing adoption (Astri, 2015).

The citation of the CSFs of cloud-based ERP systems in literature is limited comparing to the CSFs of the in-house ERP systems. Therefore, this study will identify the top ten CSFs of the cloud-based ERP systems implementation. However, due to the limitation of cloud ERP systems CSFs citation in literature, this research will classify the scope of citation in literature by frequency and classification of the influential factors in literature. Table 2 presents the scope of citation in literature of the cloud-based ERP systems CSFs.

Table 2 CSFs of Cloud-Based ERP Systems

Influential Factors	Frequency	Classification
Compatibility	27	Technological
Advantage	25	Organizational
Top Management Support	24	Organizational
Security	23	Technological
Technology Readiness	17	Technological
Complexity	16	Technological
Competitive Pressure	15	Technological
Government Regulation & Support	13	Environmental
Teamwork & Composition	13	Environmental
Firm Size	9	Organizational

Source: Usman et al. 2017

ERP research studies consist of critical factors that lead to successful ERP systems implementation such as top management support, employee involvement, training for end users, and users' acceptance. ERP research address topics about change management, risk management, and implementation stages like pre-implementation stage, implementation stage, and post-implementation stage. The other part of ERP studies in literature includes ERP organizational internal and external impact on strategies, regulations, business processes, firm environment, and economic impact. Figure 1 below demonstrates details of ERP research studies (Grabski et al., 2011, Shatat, 2015).



Figure 1: ERP Research Overview, Source: Grabski et al. (2011)

3. Finding and Conclusion

The primary goal of this research is to investigate the major challenges and the CSFs of cloud-based ERP systems implementation. The existence of the critical success factors has contributed tremendously to the implementation of the cloud ERP systems in many firms. The below ten factors considered in the literature as the most important factors in the three implementation phases of the cloud ERP systems. However, factors such as top management support, project champion, and readiness are critical success factors in the pre-implementation phase. Whereas, project management, user involvement, vendor support, business process reengineering, and change management are critical success factors in both phases implementation and post-implementation phases. Figure 2 demonstrates the impact of the top ten critical success factors on cloud-based ERP systems implementation to ensure the success of the cloud ERP among business firms (Shatat, 2016).

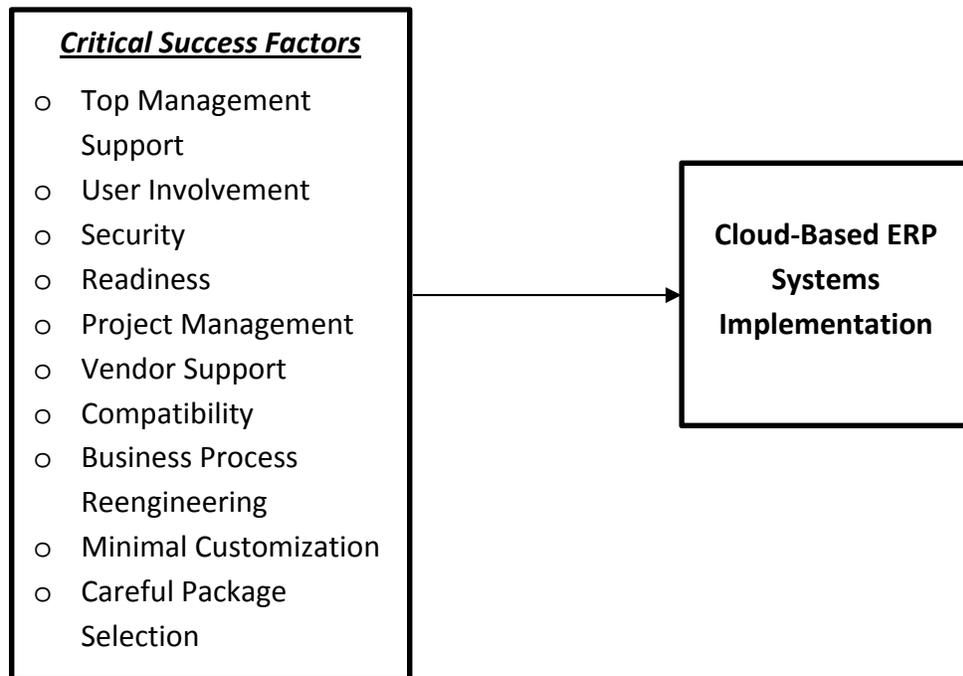


Figure 2: Theoretical Framework

The role of critical success factors is to ensure appropriate implementation of the cloud ERP systems and reduce the likelihood of systems failure. The continuous success of cloud-based ERP systems extremely depends on the involvement of the critical success factors during the implementation stages of ERP systems. The lifecycle of ERP systems passes through three main implementation stages i.e. pre-implementation stage, implementation stage, and post-implementation stage. Each factor of the above critical success factors must occur in one of the three stages of cloud ERP systems implementation to contribute to the success of the implementation in each stage of the ERP systems lifecycle. After extensive classification of the CSFs in literature, the above ten CSFs are the most important factors among several CSFs that have been identified in the literature, these factors can tremendously help many firms in achieving successful implementation of their cloud ERP systems.

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Empirical Study in Image Denoising Using Total Variation Based On Color Space

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Abstract

Image noise has various types which has an effect on image quality while noise removal is an important action in processing digital images in order to retain an image quality. In general, clean images have a strong impact on the quality of image processing techniques, features extraction methods, and their analysis. Many noise removal algorithms work efficiently in processing gray image images. However, it is not easy to apply these algorithms to processing color images. Different algorithms are applied to colored images because colored images deal with 24 bits rather than 8 bits or 16 bits for a gray image. In this research, we will study the removal of noise from color images depending on the color spaces RGB, YCbCr, and CMY, The noise selected here is rain streaks using the techniques, total variation algorithm and bilateral filter. A statistical analysis of the sensitivity and consistency of image quality is performed to measure image noise reduction from different color spaces.

Keywords: Noise, Color space, Rain streaks, YCbCr, CMY, Total variation.

1. Introduction

Color space is a mathematical representation of a range of colors; it is used to estimate the colorimetry of images. A large amount of color spaces proposed for different purposes. In addition, RGB color space is a basic color space that is widely used and other color spaces are usually selected by converting the RGB color space. This paper focuses on removing noise from the image in RGB and other color spaces (CMY, HSV). Color space used in (Albiol et al, 2001) (Al-Tairi et al, 2014) to skin detection and to define which color space is the best for skin detection. In (Paschos, 2001), the researchers proposed color texture analysis in RGB, lac, and HSV. Likewise, Color space was used in image segmentation and that performed in RGB, HSV, YIQ, XYZ, LAB, and LUV color spaces (Mignotte, 2008). In (Wesolkowski et al, 2000) the authors conducted a comparison study between edge detectors in various color spaces such as RGB, XYZ, CIELAB, CIELUV, rgb and others. In (Nanniand Lumini, 2009), it proposed a method for ear authentication in different color spaces such as JPEG-YCbCr, YIQ, XYZ, and LCH. The authors in (Busin et al, 2009) proposed a method to improve face recognition using color configurations across color spaces; in addition, (Singh et al, 2003) proposed a method to ensure face detection used RGB, YCbCr, and HIS color spaces. Moreover, in (El-Latif et al, 2013) the color space (RGB, YCbCr) used image encryption to protect the information. They (Sawicki and Miziolek, 2015) proposed a method for skin detection using CMYK color space

Moreover, there are some researchers that have used color spaces to perform the methods and techniques in order to enhance the image and to remove different type of noises. The (Lian et al, 2006) proposed an optimal color space to image denoising performance. While (Dabov et al, 2007) used YCbCr color space to apply grayscale BM3D in order to remove noise from images.

This work goes further to apply the color spaces on rain streaks images and shows a good output in color image. In this study, we will apply total variation method to remove rain steaks from a single image, the methodology being to convert RGB into other color spaces (CMY, YCbCr), then apply total variation and statistical measurements. The main contribution of this article is to remove rain streaks from single images using color spaces (CMY, YCbCr).

The rest of this article is organized as follows, part two is color space, part three is total variation, part four is CMY Experiments, part five is YCbCr Experiments, and part six is the conclusion. Finally, references is in part seven.

2. Color space

RGB color space is a standard color representation (Süsstrunk et al, 1999). It is used mostly in the transformation of other color spaces. RGB (Red, Green, Blue) that is represented in 24 bits means 8 bits for each color (R= 8 bits, green= 8 bits, Blue= 8 bits) see Figure 1. In multimedia applications, the RGB (see figure 1) is defined as the default color by IEC 61966-2-1 (website). Several applications such as Photoshop, Adobe RGB, and Color management systems (CMS) support RGB as the default color space such as ICM, Postscript, and ColorSync. Moreover, most of the file formats use RGB in their specification such as PDF, PNG, EPS, PICT, JPEG, and TIFF. In the different color spaces as human perceptual color spaces, the HSV and the HSI used in the human vision system is in a sense that the color defined is hue, saturation, and brightness, Hue and saturation define chrominance, whilst intensity or value specifies luminance (Shih and Liu, 2005). The (Ben-Shahar and Zucker, 2003) used Hue-Saturation-Value (HSV) color space to ensure image denoising.

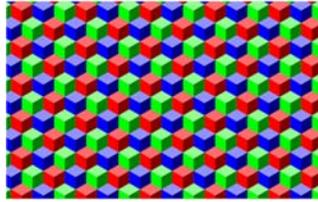


Figure 1: RGB Color space

3. Total variation

Total variation (TV) was proposed for the first time by Rudin and others for noise removal from images (Rudin et al, 1992). TV method was applied on color spaces for image denoising in (Chan et al, 2001). It is used in the removal of rain streaks from single images in (Shorman and Pitchay, 2018). TV is considered as a good method of preserving the edges and subtle details in the images. It is successful in reducing different types of noise such as added or natural noise. In this study, we will use a relative TV (Xu et al, 2012) to remove rain streaks from a single image.

In the following section, we will present experiment results for images using different color spaces. The result shows minored references among color spaces CMY and YCbCr.

4. CMY Experiments

CMY is a color space that contains three-color coordinates Cyan, Magenta, and Yellow (see figure 2) which is used in printing (Sawicki and Miziolek, 2015).



Figure 2: CMY Color space

The colors used to represent an image are derived from RGB color using some equation as the following (Nishad et al, 2013) (Ibraheem et al, 2012) [18] [19]:

$$\begin{aligned} R+G+B &= \text{White} \\ R+G &= \text{Yellow, } Y = 255 - B \\ R+B &= \text{Magenta, or } C = 255 - R \\ G+B &= \text{Cyan, } M = 255 - G \end{aligned}$$

To get RGB color space from CMY, follow this forms ($C + Y = \text{Green}$, $C + M = \text{Blue}$, $M + Y = \text{Red}$ and $C+M+Y = \text{Black}$).

5. Quality Measures

These experiments conducted for these trials are to get the best results, each experiment used (MatlabR2013a) (Cleve, 2004). Therefore, the experiments used a statistical analysis on the mean square error (MSE), peak-signal noise ratio (PSNR), and visual information fidelity (VIF) measurements (Shorman et al, 2017). The ratios for the following measurements are PSNR and VIF where the highest value is considered but MSE is considered as the lowest.

6. CMY Experiments

The experiment performed on converting an RGB image into CMY color space (see figure 3).

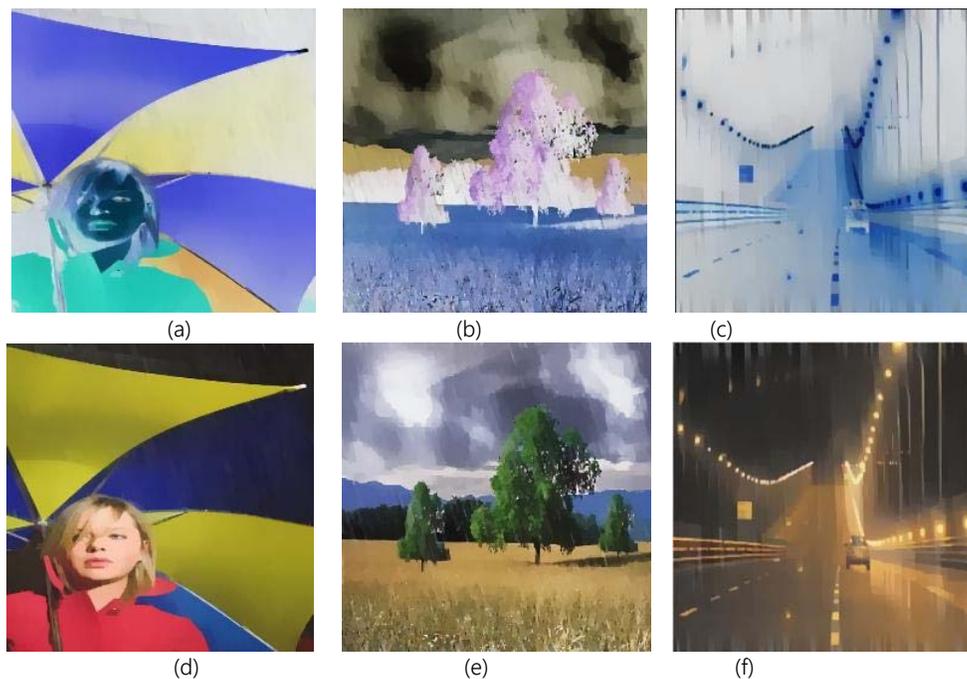


Figure 3: CMY Experiments (a) (b) (c) are TV result of CMY color space and (d) (e) (f) are the TV result of RGB color space

In Figure 3 (a) (b) (c) shows the experiment images in CMY color space, while the Figure 3 (d) (e) (f) demonstrate the output of the TV method.

Table 1 CMY results

Measurement	Figure 4 (d)	Figure 4 (e)	Figure 4 (f)
MSE	0.0128	0.0089	0.0206
PSNR1	67.1025	68.6506	65.0195
SSIM	0.9982	0.9991	0.9978
VIF	0.3885	0.1628	0.1772

7. Ycbr Color Space

The YCbCr color space was created as part of the ITU-R Recommendation B.T. 601 2 for digital video standards and television transmissions. In YCbCr, the RGB is divided into luminance (Y), chrominance blue (Cb), and chrominance red (Cr) (Dabov et al, 2007). The value of color are Y = 220 grade between 16 to 235 while the Cb, Cr = 225 grade between 16 to 240.

$$\begin{bmatrix} Y \\ Cb \\ Cr \end{bmatrix} = \begin{bmatrix} 16 \\ 128 \\ 128 \end{bmatrix} + \begin{bmatrix} 65.4810 & 128.5530 & 24.9660 \\ -37.7745 & -74.1592 & 111.9337 \\ 111.9581 & -93.7509 & -18.2072 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

Figure 4: YCbCr color space

Figure 4 shows the relation between YCbCr and RGB, it explain how to convert the RGB into YCbCr.

8. YCbCr Experiments

The experiments were performed using Matlab code to convert RGB into YCbCr as in figure 4

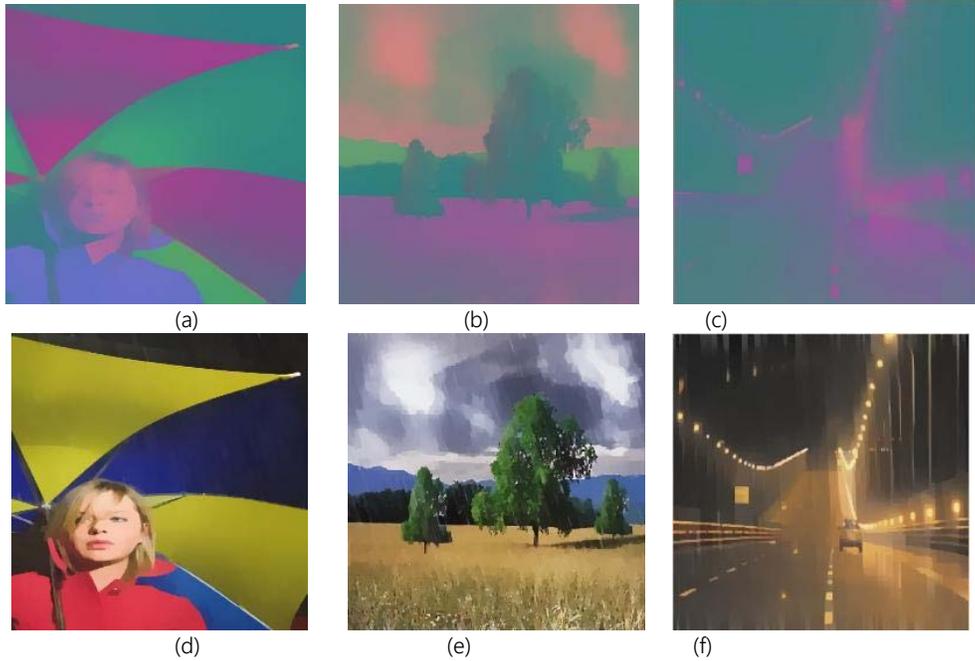


Figure 5: YCbCr Experiments (a) (b) (c) are TV result of YCbCr color space and (d) (e) (f) are the TV result of RGB color space

Table 2 YCbCr results

Measurement	Figure 5 (d)	Figure 5 (e)	Figure 5 (f)
MSE	0.0126	0.0087	0.0203
PSNR1	67.1517	68.7524	65.0804
SSIM	0.9982	0.9992	0.9979
VIF	0.3824	0.1630	0.1729

The result of experiments present in table 1 and table 2 are for removing rain streaks using TV method. The experiment shows that the result for YCbCr is superior to CMY results. Therefore, Table 1 and Table 2 show results of CMY and YCbCr in three measurements which include MSE, PSNR, and VIF. The outcomes for CMY experiments are MSE is 0.0128, 0.0089 and 0.0206, PSNR is 67.1025, 68.6506, and 65.0195 and third VIF is 0.3885, 0.1628 and 0.1772 on Figure 4 (d), (e) and (f). On the other side, the YCbCr experiments are MSE is 0.0126, 0.0087, and 0.0203, PSNR is 67.1517, 68.7524, and 65.0804 and VIF is 0.3824, 0.1630, and 0.1729.

From the result, the YCbCr is a better CMY in MSE and PSNR for all images in figure 4 and 5. While the result in VIF measurement is a fluctuation between YCbCr and CMY, the CMY is better in two results which are 0.3885 and 0.1772 in Figure 4 (d) and (f), but YCbCr is better in Figure 5 (e).

9. Conclusion

This study is to demonstrate the effect of color space CMY and YCbCr on performing removal rain streaks from single images using total variation technique. The results display the simple effect of color space in removing rain streaks. This led to a dependence on YCbCr to perform the experiments; the dataset image in RGB was then converted into CMY and YCbCr. In the future, we will expand the results in order to include more of color spaces to explain the effect of individual color space on rainy images.

10. Acknowledgements

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Scientific Research Online Management System Proposed System for Applied Science University - Bahrain (Case Study)

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Abstract

Scientific research plays a massive role considering it's an essential pillar that gives power, strength and support of any university's success. The importance of scientific research is unquestionable these days; playing a very important role in academic promotion and universities ranking. This requires a systematic method to reflect upon the compelling vision of scientific research, providing comprehensive control over the publications to be able to record and manage them. Universities nowadays compete with each other to further improve their ranking, taking that into consideration, the universities management has no choice except pay more attention to research management. Research management is the core of any academic management system, which helps the university by providing meaningful reports about researches, generating helpful statistics of published research under the name of any university to give indicating ratios about publications, authors, research categories. Applied Science University - Bahrain recently obtained the 45th rank in the QS Arab Region which highlights the university's position amongst others. To improve that rank and fulfil the necessity of managing the research, there is a need to build a new system that overcomes the limitations and problems. Also, to improve the existing system by providing new processes and functionalities to manage the publications at (ASU). A research carried out with many types of testing have been implemented after building the scientific research online management system to ensure that all functionalities are working correctly. Developing a new system will support the university's research management, resulting in a system that has the ability to manage the process of publications in general. One of the key features in the online management system is the search function, which aims to decrease the time and effort when searching for any publication. In addition, another important function is providing more details about each publication such as the abstract, keywords and full document if available. The system also provides the process of online submission, which assists the staff by enabling them to submit their publications in a more convenient way, rather than the traditional way. Last but not least, the method of generating reports for publications will help obtain proper documentation about rates of research at ASU. Therefore, these statistics can be indicators to areas of improvement, which could help the university to keep moving forward and attain more achievements.

Keywords: Research, University Rank, Publication, Management System

1. Overview and Problem Statement

Research is a powerful way to develop academic institutions, firms, technology, and healthcare fields. Research help to Figure out the evidence for multiple issues where that could generate the best results for therapy many life problems.

Applied Science University (ASU) supports scientific research greatly and considered it as an essential pillar in the university where it is stated clearly in ASU strategic plan (ASU-STRATAGIC-PLAN, 2015-2020). Scientific research plays a vital role in any academic institution. Researches can be a reason for full accreditation and give an excellent reputation to the university and classified it within the strong universities in term of ranking. However, currently, there is no computerized system to control the mechanism of publications which may be a reason to limit the way of access and achieve a good rank in ASU, besides the difficulty of managing the processes when acting with the publications. To solve this issue, build a new system is required, which results to develop the publication management's process. In short, promoting the publications management system will support many functions such as search, online submission, and generating reports. Publication management system aims to decrease the time and effort applying of multiple services related to publications, gives indicators of publications improvement by analyzing the presented statistics and enhance the faculty members to control their publications in flexibility and most comfortable ways.

2. Literature Review

2.1 Research Definition

The scientific research is one of the most critical scientific life today; there is no doubt that most of the university and advanced education depend on it as a means to develop and richness the knowledge as well as in life in general. The scientific research crossed many ways until reached the current state of consciousness. Note that all scientific research is research but not all research is scientific. Research defined as a problem faced by society and seeking to solve it through scientific methods to prove the validity of existing knowledge and generate new prediction to solve existing problem (Naidoo, 2011). Depending on what American sociologist "Earl Robert Babbie" said, "Research is a systematic inquiry to describe, explain, predict and control the observed phenomenon. Research involves inductive and deductive methods." (Bhat, 2018).

2.2 History of Research

In human history, the improvement of scientific research and basic of thinking have taken many centuries, Ancient Egypt and Greece were the first to establish the idea of research and theoretical reflection in an abstract and workable form. Followed by Arabs where they used monitoring and experimentation as one of the tools of scientific research widely. Therefore, they are the first who observed the approach of experimental and discover the evidence and search for it which have led to improved and grew the scientific progress exceptionally. In the modern era or what called a renaissance era the Arabs scientific and ideological heritage had been transmitted to the European countries by multiple scientists such as "John Stuart, Mel Claude, Francis Bacon, and others. (Wefaak, 2017)". So, I can say that scientific research methods have been developed and still in an evolution until now for thousands of years.

2.3 Research Type

The types of research would be classified depending on your purpose and other features of your study as shown in (Figure 1)

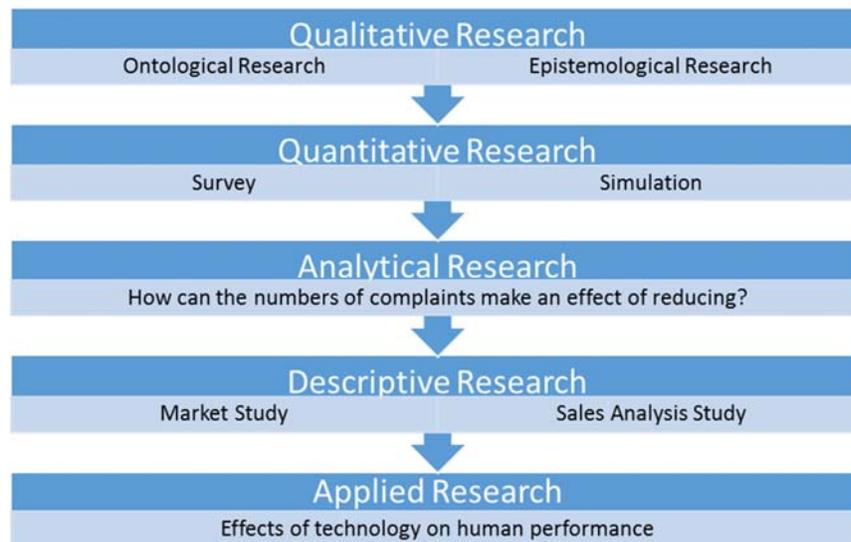


Figure 1: Research Types with Example

Research Types generally with example. It supposed you to determine the type of research regarding of the following classified:

Firstly, there is a general classified for the research types: research could be qualitative or quantitative

Qualitative research is research depending on the words, emotions, sounds and other components which is non-numerical and can't be determined, while quantitative analysis is research that interacts, describes and solved a problem by using numerical data and the summary of these data from a charts

Looking at the type of research from the side of the nature study indicates that the kinds of research will be classified into two groups one of them called analytical research, and the other is descriptive research. Analytical research focuses on the way of the search where the researcher should use available information and facts that already exist and analyzing them to evaluate the study. While the descriptive research is studies and polls usually leads to determine the facts or in another word, describe the current state as it now and there is no control on the variables in the descriptive research.

Now, the methods of research depending on the aims of the study it will be a different thing, research methods will divide into two parts applied research and essential research and sometimes indicated to the applied research as practical research and the essential research as pure research (RT, 2018).

2.4 Research and publishing

Researchers seek to find a good environment to publish their knowledge and their experiences, and they are trying to use tools make them able to get extensive knowledge. Research and publishing is a success way to meet the needs of each researcher, and therefore there are many research publishing websites established and achieved a perfect reputation recently. In the following will list the most important and most famous of them:

SCOPUS It is the biggest database that uses the abstract and citation for literature that has been reviewed by peers containing books, conferences, and journals. It offers a general review of the results of global research in many different fields such as science and technology, medical and, social studies. Any content in Scopus could be followed by more than five thousand publishers easily to track and analyzed. Scopus characterized by using intelligent tools to followed, analyzed and vision the researches and supporting the researchers aims to be always the best and delivers comprehensive requests and improve the probability of getting cash financing (Scopus, 2018).

ISI International Scientific Indexing (ISI) is a server outfits indexing the journals and necessary International procedures, where the author can obtain information about the effects factors on research papers and data about upcoming proceedings. All periodicals contain references to publisher web pages that are integrated into ISI flow pages (ISI, 2018).

ACM: Association for Computing Machinery (ACM) is digital library that published computing research which has a high impact and, reviewed by the counterparts, including functional and theoretic applications. Its obtainable in both cases either online or for print, ACM provide an elevated quality of scientific research in many different fields. Combining them allowed producing an archive of computing innovation with high quality and inclusiveness. ACM features include data mining and management, design, accessibility, programming languages, code engineering, graphics, networking, net technology, process logic, storage problems, and computer-human interaction through several different specialties (ACM, 2018).

IEEE "The world's largest technical professional organization for the advancement of technology", gives an extensive variety of publications with high quality that make the transfer of specialized Knowledge and data available among innovation experts (IEEE, 2018).

2.5 Impact of Research

The research was and still impact on many fields in either scientific or nonscientific areas, and these impacts play a role in increasing the evolution of the Renaissance. The effects of research resulted to solving many problems occurred in our life, where scientists analyze and visualize these events, issues, phenomena, and statistics aiming to find solutions, explanations, and shreds of evidence that lead to the development of what has discovered before or exploring the new facts.

Research and Industry

The performance of research and development has been active greatly in the industrial fields and still play a massive role in the evolution of an industry. In industrial, the new productions, accessories, or mechanism need to spend lots of money on the research in the part of sales. With the understanding that the section of sales is facing a decline phase and requires a deep of study which leads to an accurate new production aiming to develop new applications and expansive the markets and to progress the producing processes. While analyzing the reasons for low-sales which leads to solving the facing problems, the rate of spending

on research will become low with high profit in the sales. The scope of applied research in some industries such as petroleum, alchemical, and electrical leads to a possibility of adding some fundamental exploration to the scientific base that may causes to prevent low sales rate although of rapid development of productions. Essential metal research and development seems to grow since a basic rate of the metal research and development budget is going to fundamental work (Nelson, 2015).

Research in academic life

In the last ten years, there were some issues with quality research. Various studies and explanation have shown the need for amelioration in the transparency, repetition and meaningful research result reporting (Begley, 2012) (Chalmers et al, 2014). Today, the strength of any state is depending on the volume of its level and progress in the practical inventions and also on the amount of spending and investment in the field of scientific research. Scientific research today occupies a significant place in improving the educational renaissance where academic institutions and universities are the leading centers for the scientific activity because they have a primary role in encouraging and enhance the scientific research. The interest of scientific research in education fields has been beginning in most countries if not all long ago. They started to teach it as a primary subject in different colleges for many disciplines, also provide deanship scientific research in most of the universities to get proper attention in scientific research believing that scientific research has an important role to improve and grow the process of education (Mohsen, 2016).

o University/Institute Ranking

Numerous college managers depend on ranking systems as points of growth over time and comparison with different institutions. Colleges encourage the improvement of ranking as proof of advancement in the academic and research domain while asking for subsidizing from government sources. (Aguillo et al., 2010). In Shanghai and Times Higher Education, the evaluation of system ranking was carried out, and this evaluation contained about seventy simulations to repeat the rankings. One of their results obtained was the lack of accuracy during the calculation of overall outcomes (Saisana et al., 2011). The results emphasize the need to focus on evaluation and improve the quality of research on an ongoing basis. Based on the firm belief that research affects not only scientific credibility but also affects efficient innovation. The evaluation of the ranking system in the most of the universities today is depending on several standards, the most critical criterion is evaluating some measures of research outcomes and performance of the academic research. Until now there is no monocular ranking system supply an overall estimate of research and academic quality. Therefore, the best criteria for measuring the performance of university research should explore through inclusive and unified indicators in the future (Vernon et al.,2018);

o Academic Staff Promotion

In each university, there is a promotion system to evaluate the performance of faculty members and decide if he/she deserves the promotion or not and like every system, there are some criteria should be followed to approve the application of promotion. In UK universities, to know and locate to what extent they are admitting the research and teaching equivalently they did analyze on these criteria. The outcome of these analyzed displayed that universities have adopted mainly formal equality in the standards for the senior and principal teachers. However, most universities require faculty to be excellence in research to accept their submitted promotion not only on the teaching experiences. Also, there is a big difference between the criteria of promotion before 1992 and the promotion system today regarding the adoption of scientific research, with potentially of recognizing research and teaching equally by modern universities. One of the categories of promotion is that the applicant is a researcher with excellence in other matters. This category requires the researcher to provide evidence of their proficiency in the research with the acceptance of any other features such as teaching or management. The primary key to accepting the promotion process in this category excellence of research, with a low level of acceptance of excellence in other scopes. For example, applying with proof of excellence in local research instead of international with a high distinction in teaching level (Parker, 2008).

3. Proposed Method

The primary objective of the study is to highlight the importance of building a system able to reflect a compelling vision about the scientific research at Applied Science University aims to provide a recommendation about how scientific research can develop and observe the weaknesses points to achieve the best level and rank in the future due to previous reasons.

The development of the scientific research depending on technological advancement documents.

The massive development of technology that witness by the world in the last century in technological fields and enormous growth in the communication and other development leads to negative and positive effects on the human life. For example, you have to adapt to working faster mainly on writing scientific research, permanently needing to learn and interact with other people from other society. In another word, the development of technology is the two-edged sword, scientific research, education, and technology all of these words leads to one conclusion which is a significant development technology. Information Technology make the world as a small village which make it easier of publish information process and make it done in a perfect speed. It plays a role in developing scientific research by collecting information from these technology methods such as an internet or connecting with appropriate people. The scientific research in a considerable development in light of the development of technology. Therefore, the usage of technology in the research can save effort, time and cost related to that research without influence on the quality. Besides the several knowledge, experiences and skills that lead to do a competitive scientific research. Moreover, developing the confident aims and creative thinking to the researchers. Last but not least, technology guides researchers to be creative and inventive in their research.

Reasons for using information technology in the scientific research:

- Eliminate the traditional way of doing research that depended on the large books which need more time, effort and cost.
- Helped the researchers to realize the new concepts in an easy, straightforwardly ways and appropriate with their intelligently and abilities.
- Achieve a high-quality standard in scientific research.
- Spread the research between a massive numbers of people through communication technology.
- The rate of achievement profoundly increased among researchers and their studies (Consulting, 2017).

The steps for proposing the new systems are shown in figure 2, which it explains the methodology of this study.

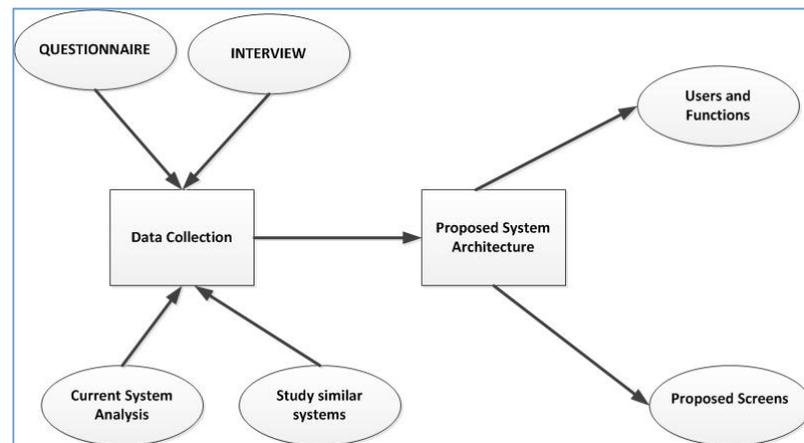


Figure 2: Proposing System Methodology

3.1 Data Collection

In this study, the data has been collected by using two main ways, which are the secondary and primary way aims to achieve the goals and develop academic research. The secondary way helps to gather the necessary information about research in general and educational research in specific. These details are helpful to the reader to understand how research impacts our lives and how it is important, and useful to the researcher too to investigate and comprehensive the needing to develop the current situation of academic research.

While the primary data is collected by using two strategies which are interview and questionnaire. The study is entirely relating to the academic institutions' environment, specifically in the domain of Deanship of Scientific Research, so the meeting has been done with these domain members. The academic staff is the main factor in developing the existing situation of academic research; therefore, the questionnaire has targeted them.

3.2 Sampling Design

Depending on the Black and Champion (1976), the sample of the questionnaire should not be less than thirty and not large than five hundred of the populations. Taking into consideration the sample of this study are the staff of Applied Science University (ASU) and most of the academic staff are answered the questionnaire. The interview includes the academic research dean, the dean's assistant, and some of the other academic staff.

3.3 The Questionnaire Survey

The questionnaire of this study delivers a close and open types of questions which list a group of choices aims to gather the right and direct answers to achieve the purposes and requirements of developing the academic research system in ASU.

The questionnaire divided into two different parts; both of them has the same content with a different language (Arabic & English). The questionnaire contains some of the questions which lead to collect information about the current website's weaknesses and determine to what extent the staff is satisfied with it. On the other hand, some of the questions allow the staff to give their opinions to tell what are the needs and missing services to be compensated in the established system.

Upon the questionnaire had been distributed to ASU staff, an analysis took place which results in: Majority think the current website is not attractive, need to be replaced or enhanced, absence of statistics, absence of searching option, the necessity to add searching option in the developed website, necessity to generate statistical reports. Therefore, the decision to redesign the current system and building the functionalities that lack in the current one is inevitable, which will increase the progress of improving the scientific research in ASU in general.

3.4 The Interview Survey

For this study, the interview has been accomplished in order to achieve the main goals to develop the research mechanism in ASU where an interview is the best technique that allows to communicate with the right person and come out with the best results.

The interview had been done with the scientific research dean face to face to gather the main requirements and guides to develop this study. Moreover, meeting with the dean assistant to ensure that all requirements have been collected and avoid any shortcomings.

3.5 Need for the new system

Based on collected data from questionnaire, Interview and analysis of the current website, the study results in a clear idea about the limitations of the current system: poor interface, static website, unavailability of searching facility, no dynamic display for the contents. The importance of this study is clearer and it's a necessity to improve scientific research website. Improving scientific research website will replace the existing system, solve weakness and add new features.

The new system will play a significant role in developing the reputation of scientific research at the ASU. First, the site will be restructured to become more attractive and useful for the user. The search engine will be provided to make it easy for the researcher to reach his query in a few seconds. Reports related to the published material will provide on request, such as a report of all research published under the name of a specific faculty member. The system will provide a control panel to allow the administrator to fully control the records such as delete, modify and add. That means the website will completely convert from the static to the dynamic webpage. The site will support the PDF option to allow the user to download the full papers, books or any publications.

3.6 The proposed system architecture:

The proposed website map for the new research website is shown in the figure 3

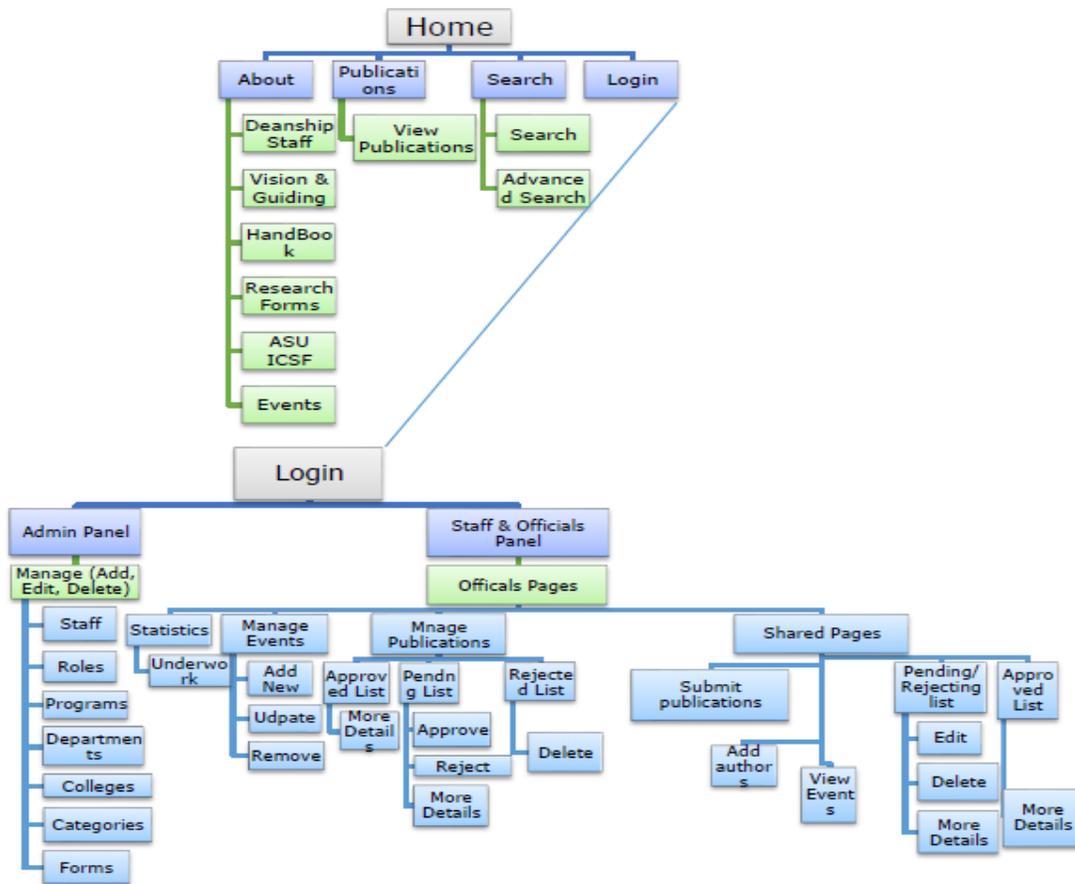


Figure 3: Scientific Research Website Map

The function of the proposed system are divided into two categories:

Open access functions: the functions available for all the visitors of the system: general information, browse publications, searching. Authorized function: the function that needs a valid login which it also divided to two sub categories: Admin functions: the admin of the system functions such as: adding a new publication, add event, approve publication, add forms, ...

Staff and Panel Functions: add publication in order to be displayed on the site, add authors, browse contents, search, ...

In order to show a clear illustration of who are the main users of the system and their actions, a use case diagram had been developed. Use Case diagram is a method used to analyze the system to determine and explain and control the requirements of the system (Rouse, 2015). Figure (4) shows the use case diagrams which explains each functions and actors who will interact with the website. Website can be used by four actors (End user, Staff, Admin and Dean), each actor has several functions such as end-user can search and browse website including download documents. Use Case Diagrams designed online by using Creately website (Creately, 2018).

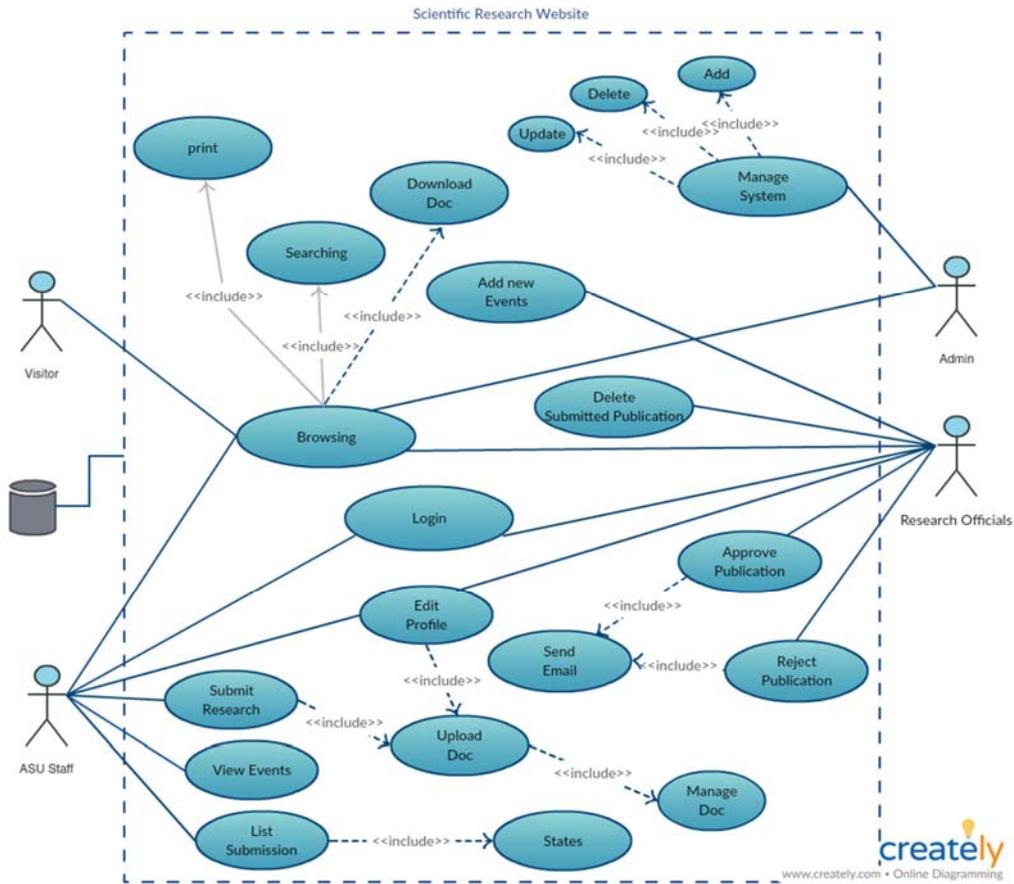


Figure 4: Use Case Diagram for Proposed system

The proposed system will be able to show the statistics of the publication in several ways, for example, the rate of the publications rely on years to discover the progress of the publications and to what extent developed during the years. The proposed system able to show publications statistics for each faculty member, college, and department too as figure 5 shown.

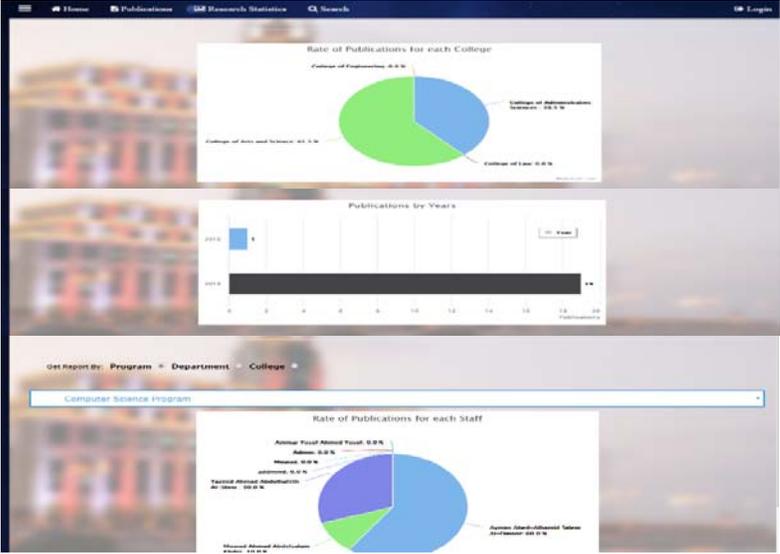


Figure 5: statistics proposal

The system will have the ability to provide an advanced search engine where can search for any publication. The search can be by several options such as by program, department, college, staff, or even years as figure 6 shown.

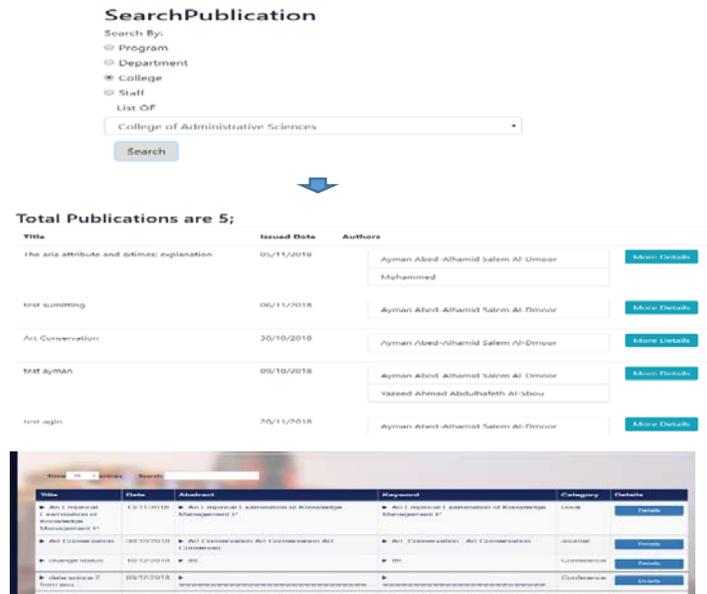


Figure 6: Search proposal

4. Contribution of the Study

This study provides the ability to use its finding to expand the capabilities of academic research and improve them. Besides the ability to access and evaluate the research ratio of each program, department, college, and even for each staff, which leads to discover and analyze the weaknesses points to overcome it in the future. Therefore, as research play a role in achieving a good ranking and reputation for any university, this study allows the potential of obtaining this achievement.

5. Conclusion

The research plays a massive role in academic institutions and can be a reason for increasing the rank of the university. Therefore, it should be taken into consideration the importance of this point. Applied Science University needs a system to be able to manage the process of publications in general. One of the most important processes need in that system is searching process which aims to decrease the time and effort when trying to find any publication. Another important procedure is providing more details about each publication such as the abstract, keywords and full document if available. The system also provides the process of online submit which support the staff to be able to submit their publications by using an easier and faster way. Finally, the method of generating publications reports which will help to obtain proper documentation about rates of research at Applied Science University. Therefore, these rates could be a reason for improving the university rank among local, regional and international universities, and other features the university could get from these rates

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Real-time Website Security

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Abstract

Website becomes the backbone of business, e-commerce and communication. In addition, Website design and its contents give an overview and a clear image of the company, organization or personal level who owns this website and makes the main changes on the number of visitors and the first factor on profits ratio especially on e-commerce systems. The importance of website takes to spend money, time, and efforts to improve it by enhancing of the contents through including professional images and attractive architecture design. So, we must save these efforts from been stolen and protect them from plagiarism which may be done by opponents that affect the level of our business and decrease the profits.

Real-time Website security is an adaptive solution to protect the website from unsafe visiting and website copier tools, which spread used recently. It depends on the user behavior while it is normal as human browsing nothing need. If we have abnormal use of the website or its contents and recourses, we change the security plan level by hiding the design, images and any important content, also disable any unwanted connection to sensitive data like prices tables.

The target of Real-time Website security is to protect the small business websites and web services, which cloud hosting with limited and high-cost hardware security options. It is easy on implementation and while it works dynamically by compares the current user speed with the security threshold of a majority to decide the necessary security plan and compute a new security threshold that does not affect the performance of the website.

Keywords: Adaptive security, Business Website, Real-time Security, Website evaluation Website security, Web Design, Website quality.

1. Introduction

These days, almost any business or project must have a website. It is becoming difficult to imagine a reason for any company of any size without a website. Your website can sell products or delivery your information at any time. Potential customers are not restricted to business hours. Instead, they can go online and purchase products whenever they want Chen & et al. (2010). A website with an online shop can provide direct boost in sales. However, to reduce the cost most of the business refers to online hosting services which cheaper but limited on security and monitoring options Bursztein & et al. (2011).

Websites Content stealing is becoming a serious concern problem for information and e-commerce websites. This practice known as web fetching or web scraping, a stealer tools use boot simulates a human web user to extract desired content of the victim's website. A stealer uses the content normally stripped of copyright or authorship information and rendered as belonging to the stealer, on a different site Chiou & et al. (2010).

Traditionally, web server has physical layer of security such as a firewall, but this solution is impossible on online hosting or may be too expensive and need to upgrade periodically. On another hand may be the same web server or network has many web services and websites with different level of importance and use, also the hardware layer is difficult to apply Grossman. J. (2007).

Many websites use different techniques to verify the human user and it has different level of security "a computer program or system intended to distinguish human from machine input, typically as a way of thwarting spam and automated extraction of data from websites" Knox & et al. (2006). However, this solution makes discomfort the visitor and makes the limitation on his/her browsing while the main need of the websites is to increase the number of visitors and extend their browsing time. The enhancement of other systems was the tracking incoming action. If detect any abnormal use or content plagiarism take the proper action which mostly cost a time and money Bishop. M. (2003).

2. The Proposed Solution

Real-time Website Security System is a treatment of an abnormal use directly, detect any unwanted action on the website as stealing design files, images directory or make too many unjustified requests on the database Jiang & et al. (2013). These abnormal actions effect on website performance, both other normal users and may be up to the point of denial of service completely. It compares the request action and decide the level of secure, which must face this user depending on his/her habits in browsing. If its act as normal human visitor, then he/she can be browsing every page normally, see the real image, query the actual database, and enjoy with amazing design, but if its act un-normal visitor, then blocking any sensitive data, images, and design lee & Kozar. (2006).

Real-time website security system uses a session which stores information (in variables) and use it across multiple pages, and it's separate to every user and it's stored and compute on the server side, also the user cannot access them Pogy & et al. (2007). But at over this competition doesn't complex or compound to affect the website server performance and the normal user does not feel their existence at all. At the same time its act perfect on saving the website content and sensitive data from stolen, without needing any cost to add external services or install new specific purpose hardware to protect website Stuttard & Pinto. (2007).

The Real-time Website Security System is too simple as we can see in the Figure 1 it contains clear small step as the following:

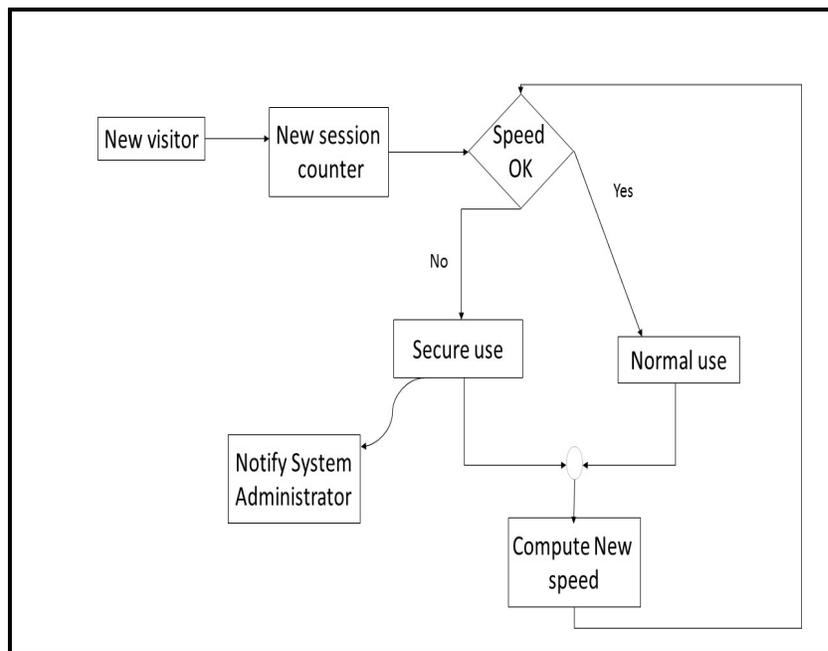


Figure 1: Real-time Website Security System flow chart.

1. New Visitor

At first when received a request from a new visitor we create a new counter information belong to him/her on server session, it is too simple contains a unique identifier for this visitor connected with requests counter and duration time.

2. Calculate Visitor used Speed

At every new request from identified visitor, we calculate accumulated, his/her speed and compare it with the security threshold. If the request speed still acts as normal human speed, it means a normal access to everything on the website. If the speed exceeded a threshold then the Real-time Website Security System, take them to secure browsing and notify the system administrator. This means he/she will see a different design, access a different database and see a specific range of images.

This new value of visitor speed adds to accumulate values of all website visitor's statistics, which acts as the main factor to calculate threshold. Threshold calculated by the following threshold equation as

in Figure 2. It calculated after ten requests from the new visitor that did not exceed the darkness-adopted previously. We obtained a general impression of the speed of browsing and the normal period of use of the site and did not break the level of safety in it.

$$T = C + S + U * (\sum_{k=1}^n V_k) / n$$

T : Threshold value.
C: Website content value.
S : Web server speed.
U : User effect Ratio.
n : Number of total visitor.
 V_k : User k Browsing Speed.

Figure 2: Real-time Website Security System threshold equation.

The computing of threshold after ten normal requests keep threshold value dynamically change depend on the website hosting server speed, the value and size of website content and the most important attribute is browsing speed of the website clients. All Real-time Website Security System were written in the php server-side language, and the tests were performed on an Intel(R) Core (TM)i5 Processor with the clock speed of 2.50GHz., and with 8GB of RAM as local offline server, and another time tests on godaddy domain hosting.

3. Experimental Results

When we test Real-time Website Security System on local server, it gives good results in all cases. However, while test is on the high-speed server, it did not lead its purpose on websites with contents less than 60 files with total size less than 1 MB. Also, its act when we use Real-time Website Security System threshold equation on actual website that at normal status contains more than 100 files with total size more than 1 MB. It is prevent copying the website by stealing website tools and stop the overuse of requests the content of the website and sensitive query on the database. The amazing results when it applied on a huge site which includes thousands of images, with a total size of 1.5 GB, this happened without effecting the performance of server or another visitor browsing requests.

4. Conclusion and future works

The Real-time Website Security System is an adaptive system that give solution to stealing website contents. It designed to depend on the visitor habits on browsing. While the visitor browsing speed is normal, he/she still enjoy all website contents and features. If the system sense abnormal request, it is making the appropriate reaction on saving the website contents and its design files.

For future works, we suggest developing a system depends on client-side with a hidden secure value related to his/her hardware features to support them to a limited number of offline uses of web page, then it will be crash themselves.

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Section 3
Entrepreneurship

The Relationship between Entrepreneurial Leadership and Job Satisfaction: A Study of Small and Medium Size Manufacturing Enterprises in Kingdom of Bahrain

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Abstract

This study aims to examine the relationship between entrepreneurial leadership, autonomy, innovation, risk taking, strategic vision and job satisfaction. Data were collected from a sample of 366 employees working in small and medium size manufacturing enterprises (SMEs) in Kingdom of Bahrain. The study adopted the descriptive analytical quantitative approach, and multiple regression analysis was used to test the proposed hypothesis and to answer the research questions. The study population constituted from enterprises in the wooden furniture, aluminum, petrochemicals and plastic, food, garments and engineering sectors in the Kingdom of Bahrain ; a total of 169 enterprises employing 22000 workers. The results showed a significant impact of entrepreneurial leadership on job satisfaction. Furthermore, the implications of this study provide support for entrepreneurial leaders to highlight the contribution of their subordinates and their autonomous efforts they exert. Moreover the study suggests that entrepreneurial leaders give recognition for employees' innovative ideas to encourage continued generation of these ideas. In addition, understanding how entrepreneurial leaders are able to affect their subordinates suggests that it is necessary to set an operational plan that encompasses leaders' efforts and their subordinates' efforts in order to implement the strategic vision of the entrepreneurial enterprise.

Keywords: entrepreneurial leadership, job satisfaction, autonomy, innovation, risk taking, strategic vision

1. Introduction

Globalization, worldwide competition and rapid economic changes have led all countries to focus on their economies. Thus, the development of small and medium enterprises have become the central and most powerful element of the efforts to strengthen their economies. In this regard, the Kingdom of Bahrain is a pioneer and has established flexible and dynamic economic mechanisms to advance economic development focused on creation, development and rehabilitation of small and medium-sized enterprises as the vehicle of development and a national priority formulated in the strategies of stakeholders. This is in line with Bahrain's Economic Vision 2030 which aims at creating a breakthrough in production and innovation to achieve competitive advantage (Aradi, 2015).

The Bahraini industrial sector plays a major role in realizing the economic development envisaged by the Vision because this sector is one of the largest fields for the employment of national manpower (Annual Report of the Ministry of Industry, Commerce and Tourism, 2016). Therefore, it is a good resource for manpower and better human resource autonomy. The current research problem was driven by reviewing several previous studies which agreed that although the scope of entrepreneurial projects had undergone extensive research, there are still only a few studies on entrepreneurial leadership (Tarabishy, 2006; Fernald et al., 2005). In addition, the criteria and dimensions of entrepreneurial leadership and its relationship with employees' job satisfaction have received attention only through a few of researches (McFadzean et al., 2005). This lack of research, which is particularly evident in Arab research studies, supporting the importance of studying it more deeply in order to enrich the scientific field with effective knowledge. According to Jensen & Luthans (2006), they indicated how entrepreneurial leadership is linked to job satisfaction and its impact on employee morale. In addition, leadership creates a performance-oriented work environment (Berson & Avolio, 2004), ultimately enhancing employee satisfaction (Nemanich & Keller, 2007; Scandura & Williams,

2004). Given the above discussion, this study aims to investigate the relationship between entrepreneurial leadership and job satisfaction in Bahraini SMEs.

2. Literature Review

2.1 Entrepreneurial Leadership

Entrepreneurial leadership is defined as a dynamic process that provides vision, creates commitment among subordinates and accepts risk when faced with opportunities that cause effective use of available resources in line with the leader's vision. Entrepreneurial leadership includes all the capabilities needed to create value for managers to achieve the establishment's objectives, and entrepreneurship is the basis for gaining a competitive edge, and even surpassing competitors (Lee & Venkataraman, 2006). Entrepreneurial leadership has been defined by many authors, but the most commonly used definition is Gupta, et al., (2004) definition, which is the leadership that creates visionary scenarios that are used to mobilize support from participants who are committed to the establishment's vision to discover and exploit the strategic value it possesses to influence employees and to strategically manage the resources available to stimulate opportunities and behavior seeking advantage (Ireland et al., 2003), entrepreneurs are able to stimulate innovation and identify opportunities available to their organization (Vecchio, 2003; Chen, 2007; Surie & Ashley, 2008). According to the more recent definitions, entrepreneurial leadership is the ability to influence others to manage resources strategically to focus on capturing opportunities and exploiting them before other similar projects. This definition includes the leadership aspect in terms of influencing others while at the same time incorporating the entrepreneurial aspects in terms of seeking for the available opportunities (Al Khalifah, 2014 and McCarthy et al., 2010). Entrepreneurial leadership seeks to demonstrate the emergence of a new pattern of leadership development that depends on the management of the organization through relations and culture, not through leadership and control. This requires knowledge of how to deal with the risks, uncertainties and ambiguities facing all entrepreneurial projects. Ahmed and Barham (2008) noted that the leader is the one who believes in change and practices it in his leadership process and is able to produce a number of entrepreneurs who have the ability to initiate and impact significantly on the economic and social fields. Entrepreneurial leadership is now embedded in the strategies of many companies that have found it impossible to redefine their markets, restructure their processes, adjust their business models, and learn thinking and leadership skills so that they can achieve the competitive advantage they seek.

Entrepreneurial leadership consists of many aspects and dimensions; however, the most agreed dimensions in the literature are independence, risk promotion, innovation, and strategic vision. Independence is the ability of workers to manage their work, solve problems and make decisions without constant supervision (Al Khalifah, 2014). The promotion of risk is to enable the leader his subordinates to make decisions so that they have the courage to face risks (Kempster & Cope, 2010; Strubler & Redekop, 2010; Chen, 2007; Okudan & Rzasa, 2006; Vecchio, 2003). Innovation is to motivate employees to creative, or to introduce new business aimed at innovating in providing the facility for services and products to their customers (Kempster & Cope, 2010; Surie & Ashley, 2008; Chen, 2007; Okudan & Rzasa, 2006). Strategic vision is the ability to predict future marketing opportunities as well as the risks or threats that the facility may face in the future (EL-Annan, 2013). Based on all the above we see that there is a difference and multiplicity in the crystallization of the concept of entrepreneurial leadership, and an identification of its dimensions, or can be called with the factors or characteristics. Entrepreneurial leadership can be summarized as: a set of entrepreneurial factors and behaviors that the leader believes, uses and employs in his leadership process of the workers in a way that transfers to and develops in the behavior of workers, which becomes a sustainable behavior over time and through application, and these factors of the alignment and balance combine to achieve the success entrepreneurship projects.

2.2 Job satisfaction

The most commonly used definition of job satisfaction is Locke (1976), which defines job satisfaction as a pleasant or positive emotional state resulting from a worker's assessment of a job or functional experiences (Judge & Klinger, 2008). Job satisfaction is also defined as the reactions of employees to their experiences in the work (Berry, 1997), it is an emotional state or reaction towards the work, and the extent of the positive felt by workers about their jobs, or aspects of their jobs (Landy & Conte, 2004). When the establishment meets the expectations of the worker, the individual feels positive feelings, these positive feelings refer to job satisfaction (Green, 2000). If the worker has positive feelings and being happy towards his work, it will appear and reflected in his behaviors and conducts indicating his satisfaction, and vice versa.

According to Wright & Kim, (2004), it represents the interaction among the worker and the working environment and what they want from their jobs. The more work meets the needs of workers, the higher the job satisfaction (Taylor & Westover, 2011). Moreover, Weiner, (2000) stated that job satisfaction depends on the nature of the job itself, which is integrated with many factors such as the challenges of work, degree of independence, skills and job scope. For this reason, the nature of the work itself has assumed the highest and most important place for researchers to look at the deep understanding of what makes workers satisfied with their work (Sedem, 2012). Another study went on to define job satisfaction from the aspect of satisfying the needs of workers and narrowing the gap between their desires, ambitions and what they actually get (Metwally & El-bishbishy, 2014).

From the foregoing, it is clear that job satisfaction is a self-defined term that is an implicit inner feeling that results from a set of elements affecting the worker himself or related to his work. The degree of reflection of these inner feelings on the external behaviors that appear in the form of conduct, behavior and how he performs in the work varies according to the individual. At first glance it is clear that job satisfaction is a simple concept, but in fact it is complex and related to every aspect of practical life. Job satisfaction is an important aspect to be taken into consideration in each establishment because the more the establishment meets the needs and desires of employees and the satisfaction of their values and personal needs, the higher the rate of job satisfaction (Ibrahim et al. and Zaim et al., 2012). It is an indicator and criterion of success at many levels, the most important of which are at the individual and organizational levels. It is evidence of organizational effectiveness and has a direct relationship with many organizational and personal factors (Lumley et al., 2011), by achieving the psychological and social alignment which will be reflected in its behavior. It can be said that projects, that place employee satisfaction among their priorities and seek to achieve their motives and needs, have contributed to the creation of a rich regulatory environment capable of acquiring and exploiting human capabilities and energies in a manner that achieves the objectives of the project at the same time.

2.3 Entrepreneurial Leadership and Job Satisfaction

The effective leader within the organization is the one who practices the appropriate leadership methods to integrate his followers in the work environment in order to influence their feelings, tendencies, and behavior, achieving the desired level of job satisfaction. The success of the organization is closely linked to the effectiveness of its leadership and the level of satisfaction of its employees. It is therefore expected that workers with a high level of job satisfaction will be more committed to the tasks assigned to them and thus work hard to achieve the objectives and interests of the organization in which they work (Ping, 2015).

The role of the leader is critical to the development of employees. There is a close relationship between managers and their employees to the extent that they contribute to improve the level of performance, and therefore it can be concluded that the ability of entrepreneurs to exercise good leadership skills with their employees increases the performance of these employees (Amabile & Gyskiewicz, 1987).

It is therefore expected that people in leadership roles will play a significant part in order to support subordinates, encourage them, and thus enhance job satisfaction, which in turn will improve the performance of the organization as a whole. Entrepreneurs are expected to exercise leadership properly in order to drive them to achieve the objectives of his entrepreneurial project (Olutade, et al., 2015). The effective entrepreneurial leaders are working on developing different types of relationships with their subordinates through high levels of mutual trust, respect, loyalty and commitment, as if they were partners in an entrepreneurial project (Ilies et al., 2007; Sias, 2005;

Gerstner & Day, 1997; Graen & Uhl-Bien, 1995), which will reflect on the way they perform their tasks and their level of job satisfaction.

In a study conducted by Olutade (2015), the influence of entrepreneurial leadership skills on employees' motivation and job satisfaction showed a relationship as well as a statistically significant effect of leadership on job satisfaction. The study concluded that maintaining the best talent is one of the most important issues facing entrepreneurs today. Business organizations are looking at different ways to invest in their employees in order to maintain their motivation to ensure the sustainability of these entrepreneurial establishments. The study recommended that leaders of these institutions should review ways to motivate employees and improve their level of satisfaction. However, to the best of this researcher's knowledge, very limited studies such as the above study of Olutade (2015), have focused on the relationship between entrepreneurial leadership and job satisfaction. Therefore, the present study attempts to overcome this gap by probing into the relationship between entrepreneurial leadership and job satisfaction in (SMEs) in Kingdom of Bahrain.

2.4 Hypotheses Development

The study model proposed in this study illustrated in Figure 1 goes further to explain the relationship between entrepreneurial leadership, autonomy, innovation, risk taking and strategic vision, and job satisfaction.

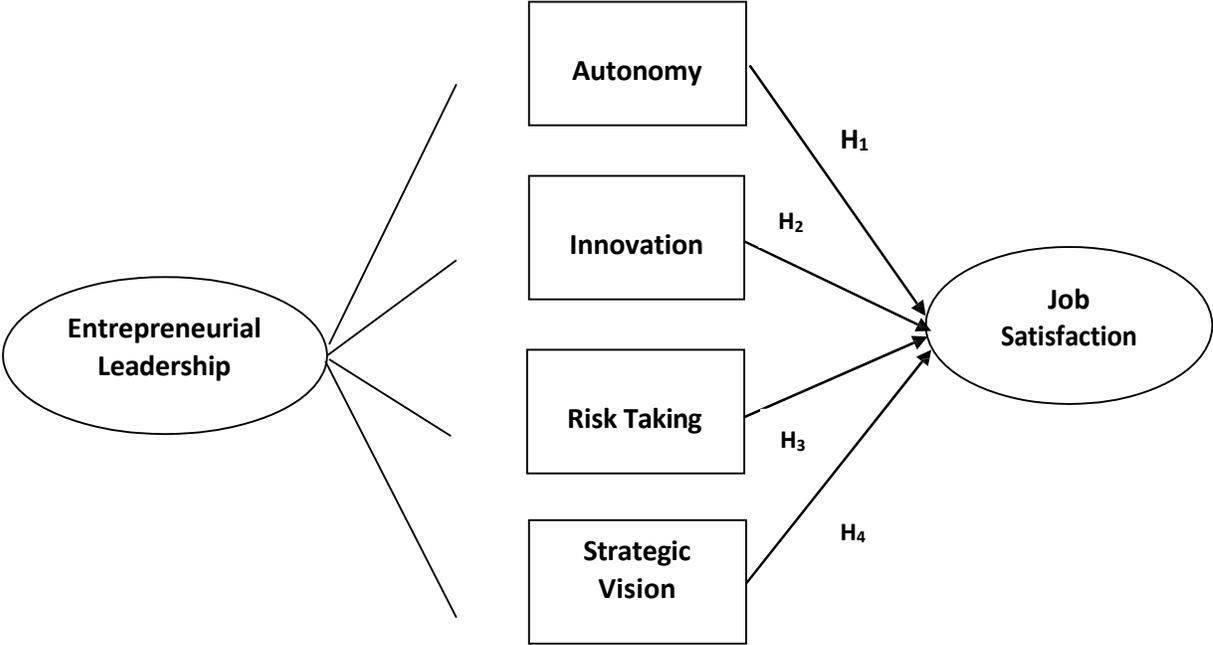


Figure 1: Study Model

Based on the above study model, the following hypotheses are proposed to examine the relationships between entrepreneurial leadership, autonomy, innovation, risk taking and strategic vision and job satisfaction:

- H1: There is a significant relationship between autonomy and job satisfaction.
- H2: There is a significant relationship between innovation and job satisfaction.
- H3: There is a significant relationship between risk taking and job satisfaction.
- H4: There is a significant relationship between strategic vision and job satisfaction.

3. Method

For the purpose of statistical analysis, the research adopted the descriptive analytical quantitative approach to answer the research questions and to test its hypotheses. The study population constituted from enterprises in the wooden furniture, aluminum, petrochemicals and plastic, food, garments and engineering sectors in the Kingdom of Bahrain; a total of 169 enterprises employing 22000 workers. The research used a questionnaire were distributed to 377 employees, while 366 questionnaires were collected constituting a response rate of 97%. The table (1) below shows the sample of each industrial sector according to (Morgan scale) using (the Stratified Random Sample).

Table 1 Sample of Each Industrial Sector

No.	Sector	Number of Factories	Percentage (Y)	Number of Employees / Sector = $Y * 377$
1	Wood furniture	12	7%	27
2	Aluminum	21	12%	45
3	Petrochemicals and plastics	49	29%	109
4	Food processing & Pharmaceuticals	29	17%	64
5	Garments and textiles	10	6%	23
6	Engineering	48	29%	109
	Total	169	100%	377

The SPSS software package version 23.0 was used in the study to analyse the data. Initially, the data were gathered using a questionnaire which included three sections. The first section was demographic information about the respondents, the second section was about the independent variable which is the entrepreneurial leadership and the third section is about job satisfaction which is the dependent variable.

To attain the objectives of the study, a list of items that measured the study variables was developed based on the existint literature. In addition, these measurements employed and validated in earlier studies and subsequently adapted to ensure they were suitable to measure entrepreneurial leadership and job satisfaction among employees in SMEs in Kingdom of Bahrain.

In this study, entrepreneurial leadership is defined as the set of characteristics and leadership effective behaviors in leading the staff, in a way that develops their behaviors to become sustainable behavior over time. Entrepreneurial leadership is measured through four main dimensions including autonomy, innovation, risk taking and strategic vision, including 29 items. The five-point Likert scale ranging from strongly disagree (1) to strongly agree (5) was employed in this study.

Job satisfaction is defined as an extent to which one feels positively or negatively about the intrinsic and extrinsic aspects of one's job (Bhuiyan & Mengue, 2002). The measurement Minnesota Satisfaction Questionnaire (MSQ) validated by (Marijani & Yohana, 2016), and the Overall Job Satisfaction Questionnaire were employed in the current study with a total number of 19 items to measure job satisfaction. The responses were rated on a five-point Likert scale ranging from strongly dissatisfied (1) to strongly satisfied (5).

The Cronbach's alpha were utilized in the calculation of reliability. The total Cronbach's alpha was 0.797, indicating that it has a high degree of stability which qualifies it for final approval since the acceptable standard is 0.60 and above (Almaani et al., 2012). Table (2) below shows the Coefficient Cronbach's alpha for each dimension in the questionnaire.

Table 2 Coefficient Cronbach's alpha

No.	Variables	Cronbach's alpha
Independent Variable: Entrepreneurial Leadership		
1	Autonomy	0.75
2	Innovation	0.84
3	Risk Taking	0.72
4	Strategic Vision	0.79
Dependent Variable: Job Satisfaction		
1	Job Satisfaction	0.76
	Total Cronbach's alpha	0.797

As shown in the above table, the Cronbach's alpha of autonomy, innovation, risk taking, strategic vision and job satisfaction were 0.75, 0.84, 0.72, 0.79 and 0.75 respectively.

4. Results

The respondents were 366 employees working in small and medium size manufacturing enterprises in Kingdom of Bahrain. Among the employees, 321 were male and 45 female. The distribution of the different age groups among the respondents was as follows: 176 were 30 years and below, 146 between 31 - 40 years, 43 were between 41 - 50 years, and finally 1 was 51 and above. In terms of the nationality: 185 were Bahrani and 181 were from other nationalities. For education, 11 were secondary school and below, 99 have High school diploma. The 245 employees were held bachelor degree and 11 held postgraduate degrees. In term of working experience, 178 of the sample have 5 years experience and below, 160 were between 6 and 10 years of experience, 27 were between 11 and 15, and only one had more than 16 years.

Descriptive statistics were computed for all data prior to the stage of conducting the detailed statistical analyses. The mean and standard deviation were computed. The autonomy mean is 3.80 (SD=0.791); the innovation mean is 3.82 (SD=0.778), the risk taking mean is 3.82 (SD=0.774), the strategic vision mean is 3.87 (SD=0.749), and the job satisfaction mean is 0.3.97 (SD=0.689). The Pearson coefficient correlation is used to explain the relationship between the study variables. The results are presented in Table 3.

Table 3 Pearson Correlation Coefficient

Variables	Entrepreneurial Leadership				Total Correlation
	Autonomy	Innovation	Risk Taking	Strategic Vision	
Job Satisfaction	.533**	.517**	.567**	.488**	.679**
	0.01	0.01	0.01	0.01	0.01
**Correlation is significant at the 0.01 level (2-tailed).					

Table 4 demonstrates the results for regression analysis. Hypothesis H1 states that there is a significant relationship between autonomy and job satisfaction. Based on the Beta coefficient in Table 4, the results show that the relationship between autonomy and job satisfaction is significantly indicative of $\beta = .61$ and it indicates that the p -value = $.001 < .05$. Therefore, hypothesis H1 is accepted. Furthermore, Hypothesis H2 states that there is a significant relationship between innovation and job satisfaction. The results in table 2 indicate significant relationship between innovation and job satisfaction as $\beta = .60$ at the p -value = $.000 < .05$. Thus, hypothesis H2 is supported. Hypothesis H3 states that there is a significant relationship between risk taking and job satisfaction. Based on the Beta coefficient in table 4, the results show that the relationship is significantly indicative of $\beta = .67$ and it indicates that the p -value = $.000 < .05$. Moreover, Hypothesis H4 states that there is a significant relationship between strategic vision and job satisfaction. The results in table 4 below shows that strategic vision is significantly indicative of $\beta = .31$ and the p -value = $.000 < .004$.

Table 4 The Results of Multiple Regression Analysis

Variables	Beta coefficient	T. value	Sig.
Autonomy	.61	6.68	.001
Innovation	.60	5.36	.000
Risk Taking	.67	6.98	.000
Strategic Vision	.31	3.16	.004

Dependent variable: job satisfaction

The above table shows the Beta coefficient value and the T-value test; it is clear that the most entrepreneurial leadership dimensions which have an explanation and effect on job satisfaction is the risk taking (Beta coefficient of .67 and T-value = 6.98), followed by autonomy (Beta coefficient of .61 and T-value = 6.68), and innovation (Beta coefficient of .60 and T-value = 5.36) and finally strategic vision with little impact, which also represents the least dimensions of the entrepreneurial leadership, with the impact on job satisfaction (Beta coefficient of .31 and T-value = 3.16).

5. Discussion and Conclusion

The results of the current study agreed with the results of the Olutade (2015), which shows a significant impact of entrepreneurial leadership skills on employees' job satisfaction. In the same way, previous studies also showed a strong relationship between leadership styles and job satisfaction (Khan et al., 2017; Tetteh & Brenyah, 2016 ; Metwally et al., 2014; Long et al., 2014; Loganathan, 2013; Mosadeghrad & Ferdosi, 2013; Omar & Hussin, 2013). Moreover, the results of the current study showed that there is a statistical correlation between all dimensions of entrepreneurial leadership (risk, independence, innovation, and strategic vision) and job satisfaction. However, in terms of risk being indicated as the dimension of entrepreneurial leadership that most showed a positive correlation and impact on job satisfaction, this differs with the study of Al-Khalifah, (2014) which showed a lack of importance of risk for entrepreneurs, and the study of Bojko, (2013) where risk had less impact on entrepreneurial behavior. The results of this study also showed that autonomy was the second dimension of entrepreneurial leadership which is positively correlated with job satisfaction.

Therefore, results of the current study agreed with the results of Vantilborgh et al., (2015) which confirmed the need for autonomy is the key to the growth of the new entrepreneurial projects. Moreover, the results of the current study showed that innovation was the third dimension of entrepreneurial leadership positively correlated with job satisfaction, which agreed with the results of Piirala, (2012) which confirmed that the innovation was the most influential in SMEs performance in Finland and Germany. In addition, the results of the current study showed that the strategic vision was the dimension of entrepreneurial leadership with the least positive correlation with job satisfaction. Thus, it differs with the result of Al-Khalifah (2014) which agreed that the strategic vision was one of the most important characteristics of entrepreneurs.

The present study has concluded that entrepreneurs empowered their subordinates to effectively perform their responsibilities. This may be attributed to the belief of these leaders in the importance of empowerment in enhancing the level of independence by granting them the powers that enable them to perform their assignments. The study also found a lack of appreciation of employees by their leaders towards their efforts at the individuals and teams levels. Therefore, leaders must highlight the contributions of their subordinates and their efforts and encourage their colleagues to follow this pioneering behavior rather than relying on the guidance of their leaders on an ongoing basis. It has been shown that the employees in do not feel that their leaders value their ideas and innovative solutions, which leads to lack of motivation to continue produce innovative ideas. In this regard, leaders need to encourage their employees at all levels for their new ideas and innovative proposals which will motivate them and also lead to develop the new products.

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Entrepreneurship as a Pillar of Economic Diversification*: Can a Growing Support for Tech Startups and a Flourishing Entrepreneurial Ecosystem Make Bahrain a New Regional Hub?

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Abstract

The Kingdom of Bahrain has been increasingly ramping up its efforts to attract foreign investments as a quintessential part of its development strategy and Economic Vision 2030 which aims to "*continuing to attract foreign investment, which is one of the key drivers of process innovation and best-practice transfer*". The most recent campaign led by EDB (Economic Development Board) labeled "Business Friendly Bahrain" makes a bold claim that the small Kingdom is the perfect gateway to the grand GCC's US\$1.5tn market and has, indeed, helped attract 92 companies and investments worth US\$830 million in 2018 alone.

This article takes that claim to the test by studying the attributes and dynamics of the entrepreneurial ecosystem in the Kingdom of Bahrain from different perspectives to see what makes it competitive and so advantageous for small businesses and big enterprises alike.

Keywords: Kingdom of Bahrain, Entrepreneurial Ecosystem, Digital Startups, Higher Education Council, Multidimensional Support, Foreign Investments, Regional Hub.

1. Introduction

The GCC countries are decidedly on a mission to diversify their economies and break free from heavily relying on oil and gas, although with various levels of urgency. They all suffered from the reduction in oil prices in recent years. The high volatility of oil prices poses strong challenges to the GCC economies, hence the need to economic diversification. There is no escape from this: not only the GCC countries are fully aware that their vast oil reserves will not last forever, but it has also been proven that, in the long run, diversified economies perform better than mono-sector economies (Lederman, 2006; Newfarmer, 2009).

Some GCC countries, such as Kuwait and Saudi Arabia (to some extent) are less pressured than others to do this (Hvidt, 2013). However, for Oman and particularly for Bahrain, there is more urgency to engage in economic diversification because they simply can no longer afford to remain at the mercy of the volatile oil prices. To put things in perspective, we can look at the fiscal budgets of Bahrain and Oman which both break even at around US\$100 per barrel, while Kuwait and the UAE need between US\$70-75 per barrel, and some other country needs only about US\$50 per barrel (IMF, 2015). Published literature reveals that Bahrain has been rather successful in its endeavor to diversify its economy: a recent study examined the share of nonoil real GDP to total real GDP as a measure of diversification to assess the extent of diversification in Bahrain and the results show that "*the shares of nonoil GDP increased from 64% in the beginning of this century to 80% in 2016 with an average annual growth rate of 6.2% for the period 2002-2016*", however, the author of the study also found a correlation between the two sectors and concluded that "*the nonoil sector has been very much dependent on the oil sector and neutralizing the dependence is required for the post oil era*" (Nakibullah, 2018).

In this context, not only Bahrain but all of the GCC countries rapidly grew aware that innovation and entrepreneurship are the main drivers to diversify and develop their economies independently from the oil sector (Miniaoui and Schilirò, 2016). Evidently, the important role of entrepreneurship in driving economic growth has been well documented for both developed and emerging countries where entrepreneurship is perceived as a key tool for economic development (Stel et al., 2005).

For the GCC countries, the body of literature substantiating the impact of entrepreneurship is growing. For instance, a study covering a 20-year period (1996-2015) conclusively demonstrates that entrepreneurship positively impacts economic growth in the United Arab Emirates (Hamdan, 2019). Bahrain is also heavily invested in and strongly committed to promoting entrepreneurship and innovation as evidenced by its economic vision Bahrain 2030 which stresses the fact that "*entrepreneurship and*

innovation will ensure the sustainability of a vibrant private sector" and pledges that "The Government and private sector will act as partners in this by creating an environment highly conducive to entrepreneurship and innovation". Indeed, since the launch of the economic vision Bahrain 2030 in 2008, the entrepreneurship ecosystem has drastically evolved (Al-Shakar, 2017), a meaningful development that is largely attributed to the consistent efforts of the Economic Development Board (Nakibullah, 2018) since its establishment in 2000 with the mandate of enhancing the investment climate in Bahrain.

This article presents some of the main advantages that set the kingdom apart from its neighboring countries and looks at its ongoing efforts to promote entrepreneurship nationwide with a focus on tech startups. It concludes by weighing the prospects of Bahrain to become an innovation and entrepreneurship hub in the region.

For the sake of being concise, the aforementioned points have been summarized under 10 key titles:

1.1 Active, Effective and Award-Winning Economic Development Board (EDB)

Since its inception back in 2000, Bahrain EDB has been very successful in its endeavor to make Bahrain more attractive to foreign investments. Foreign Direct Investments (FDI) are very important to any given economy and, in the case of Bahrain, it has been proven that "attracting FDI into the country will play a vital role in stabilising the economy and achieving long run economic growth goals for Bahrain" (Kreishan et al., 2018).

EDB is an award-winning body that won multiple awards. Just as an example, it has won the United Nations' Investment Promotion Award for excellence in boosting investment into sectors that will help meet the UN's Sustainable Development Goals thanks to its work with Amazon Web Services in 2018 (BNA, 2018).

To better illustrate the successful efforts of the EDB, we drew the following figure (Fig. 1) that shows the progress made in the past three years in terms of FDI, new and expanding companies and new jobs created. The numbers show formidable progress, especially when it comes to FDI. To put this in perspective, it is worth mentioning that Bahrain has won 1st place for the 2nd year in a row the Conway Global "Best to Invest Per Capita" Award in the MENA region.

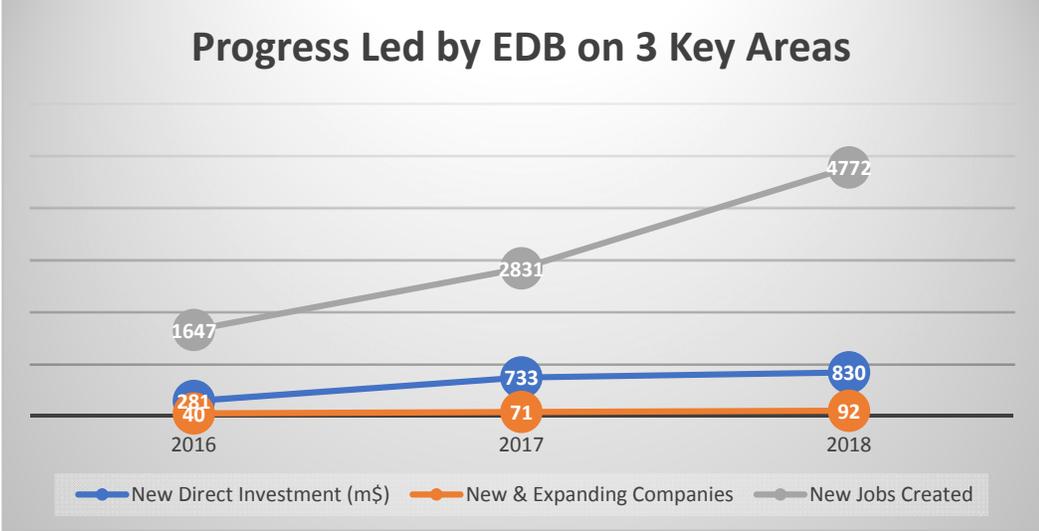


Figure 1: Development led by EDB in 3 key areas over the past 3 years

1.2 A Flourishing Entrepreneurial Ecosystem

As mentioned earlier, the entrepreneurship ecosystem in Bahrain has made significant progress over the past decade (Al-Shakar, 2017) and it has now all the components of a mature ecosystem: from incubators and accelerators, to funding institution, government support entities, co-working spaces, mentors, successful startups and role models and niche communities. This ecosystem is expected to develop further as, by definition, an ecosystem "is a complex, dynamic, emergent system that constantly adapts, sometimes

in unexpected ways” (Gobble, 2014). The Bahraini entrepreneurship ecosystem is particularly active with many recurring events such as Startup Bahrain Week which this year hosted the MENA region’s largest and most exciting innovation festival “Unbound”.

Most recently, the 2019 Global Startup Ecosystem Report (GSER) issued in May 2019 (produced by StartUp Genome in association with Global Entrepreneurship Congress) ranked the Kingdom as one of the top-10 countries with the best startup ecosystems, which is a massive feat considering how “young” the entrepreneurship ecosystem in Bahrain is.

1.3 Enabling Legislation

Reforms in Bahrain have been underway in the past years to create a more business friendly environment for entrepreneurs from Bahrain and abroad. As His Excellency, the Governor of the Central Bank of Bahrain (CBB), once put it: “Our role as regulators is to inspire, lead and remove any roadblocks to innovation” (EDB, 2019). Suffice to say here that Bahrain has been ranked in the 2017 Doing Business Report of the World Bank 2nd in MENA region and among Top 10 economies with the biggest improvements in business regulations. To name a few, key reforms and legislations aimed to enhance the investment climate include:

- 1.3.1 **100% Company Ownership by Foreigners:** in 2016, the Bahrain cabinet passed a new law to allow 100% foreign ownership in residency, real estate, administrative services, health and social work, information and communications, manufacturing, mining and quarrying, food, arts, entertainment and leisure, water supplying and professional, scientific and technical activities. The new is expected to “spur growth, generate rewarding jobs for citizens, and attract businessmen to invest in various economic sectors” (arabianbusiness, 2016).
- 1.3.2 **Minimum Capital Requirement:** The Ministry of Industry, Commerce, and Tourism (MoICT) abolished the minimum capital requirements for all types of companies and startups, resulting in lower costs and making it easier to establish and operate a startup in Bahrain.
- 1.3.3 **Virtual CRs (Sijili):** although this one is only for Bahraini nationals, Sijili is a unique Virtual Commercial Registration (CR) system that allows aspiring Bahraini entrepreneurs to launch their startups from home without renting a physical location, thus directing their funds to what their business actually needs.
- 1.3.4 **Bankruptcy Law:** a brave law that enables experimentation and innovation and improves outcomes of the bankruptcy process.
- 1.3.5 **Personal Data Protection Law:** the law will kick in next August and it gives assurance to both companies and individuals that Bahrain is on par with the developed countries when it comes to the protection of personal data.
- 1.3.6 **Regulatory Sandbox:** The Central Bank of Bahrain (CBB) introduced the Regulatory Sandbox Framework to enable FinTech-based startups, local and international, to test their new products and services in Bahrain with fewer restrictions and lower risks.

1.4 Lower Costs of Living and Doing Business

KPMG has recently (May 2018) issued a report titled “Cost of doing business in Bahrain -Financial services” that looks at the typical costs associated with operating a financial services firm in Bahrain, Dubai and Abu Dhabi with a focus on the cost of licensing and registration, commercial rental rates, occupancy costs, manpower costs, communication and utility expenses. The report concludes that, overall, “the total cost of doing business in Dubai and Abu Dhabi is significantly higher (50 to 55 percent) than that of Bahrain”.

The report also looked at the cost of living index which is based on the comparison of the day-to-day living expenses (housing, transportation, healthcare, utilities, etc.) and it concluded that the “cost of living index for Bahrain is consistently lower than the one for Abu Dhabi and Dubai. The current cost of living index of Bahrain is 20 percent lower than Dubai and 7 percent lower than Abu Dhabi”.

Numbeo, a leading online platform that constantly calculates and updates the costs of living worldwide, confirms these findings. A quick comparison between Manama and Dubai show how the living costs are considerably lower in the Kingdom's capital (Figure 2):



Figure 2: Comparison of living costs between Manama and Dubai (numbeo.com, June 2019)

1.5 Supportive Government, Engaged Private Sector

The Bahraini government is decidedly on a mission to support the ecosystem and enable its players. The role of the state in backing entrepreneurship and innovation ecosystems is not to be under-estimated, and there are studies substantiating its importance, be it in industrial countries like Germany (Fuerlinger et al., 2015) or even in the GCC countries (Saber and Hamdan, 2018).

In Bahrain, the formation of Tamkeen in 2006 was a key achievement. Tamkeen is the national labor fund focused on private sector development and "its activities include improving the working skills of Bahraini workers through training programs, creation of new enterprises, and supporting the existing ones" (Nakibullah, 2018). Just to name a few of its initiatives:

- Subsidizing 100% of the startup's cloud needs
- Subsidizing 50% of the startup needs in terms of accounting, marketing, etc.
- Subsidizing the workforce wages by 70%, and their training needs by 100%.
- A Minimum Viable Product (MVP) scheme with funds up to \$26,000.

In addition to Tamkeen, another notable body is Bahrain Export which is a stand-alone entity that helps the small and medium enterprises (SMEs) to promote and export their products and services abroad. With the emergence of high-quality startups and entrepreneurs across industries and niches in Bahrain, they are poised to play an ever-increasing important role.

On the other hand, the private sector in Bahrain is equally committed and socially responsible. While there is a need for more literature to document this, there are many examples of private companies getting onboard with governmental schemes or launching their own initiatives, such as "The Family Office" which, in cooperation with EDB, is sponsoring 100 Bahrainis to attend online programmes around digital transformation offered by Massachusetts Institute of Technology (MIT) and Columbia University as part of the MIT-Columbia Digital Transformation Online Education Programme.

1.6 Leading in ICT Infrastructure and Accessibility

Bahrain is leading the way in the region when it comes to ICT infrastructure and accessibility, which is of crucial importance for Tech Startups. This has been consistently confirmed by various global rankings such as the ICT Development Index (ITU), where Bahrain is ranked 1st in the MENA region and 31st Globally, beating the likes of UAE which comes distantly at the 40th place.

The Global Innovation Index for 2018 also backs this up where Bahrain beats UAE in terms of both ICT access and use (see Figure 2. Below, generated using the www.globalinnovationindex.org website).

INFRASTRUCTURE		Bahrain		United Arab Emirates	
The third pillar measures Information and communication technologies (ICTs), General Infrastructure, and Ecological sustainability.					
		Rank	Score	Rank	Score
Overall		33	54.07	28	57.39
Information and communication technologies (ICTs)		25	78.47	23	78.93
ICT access		21	81.40	23	81.10
ICT use		21	75.30	29	70.90
Government's online service		22	82.61	13	89.13
Online e-participation		32	74.58	32	74.58

Figure 3: Comparison between Bahrain and UAE in terms ICT as per the Global Innovation Index, 2018

1.7 Increasing number of Incubators and Accelerators

Incubators and accelerators play a major role in helping startups get off the ground and grow into profitable businesses (Cohen, 2013). Accelerators, in particular, represent a relatively new model of assistance for entrepreneurs that combines many features that in the past were typically provided separately (funding, mentorship, networking, access to market, etc.) (Cohen and Hochberg, 2014).

In Bahrain, while incubators have been here for a while, a surge in the number of the accelerating programs has been noticed in the recent years, which is poised to help create a new generation of locally-built, globally-oriented startups. Notable accelerators that are now present in Bahrain include: Brinc Batelco, C5 Cloud 10 Scalerator, Nest, and Flat6Labs.

It is worth mentioning that having a mature ecosystem usually attracts funds for startups and stimulates both local and international institutions to take part of it. Last year, Bahrain Development Bank launched a new \$100m venture capital fund of funds called Al Waha fund. This year, MSA Capital China, a Venture Capital Fund from China has chosen Bahrain to set-up their regional offices and will be leading their operations for the region from here.

All this helps attract quality startups from the region and from overseas. While this could be the subject of a separate study, a quick look at the startups currently enlisted with the aforementioned accelerators reveal that they are overwhelmingly foreign entities which chose Bahrain to set up their businesses, and that they are all about quality not quantity, which means that there is a rigorous selection process in place to choose which startups to accept in the acceleration programs. When it comes to market size, choosing Bahrain by these foreigners might seem to be a counter-intuitive choice, but a deeper look proves otherwise;

1.8 Launchpad to the Massive GCC Market

It is no secret that Bahrain is the smallest of all the GCC countries in terms of size and population, but because of its strategic location, robust infrastructure and connectivity, it is considered as the perfect launchpad for the GCC markets, thus giving startups massive potential to rapidly and cost-effectively scale up their operations into a regional market that is valued at \$1.5~ trillion. In fact, the Saudi Arabia market is within reach through one causeway, while UAE and Kuwait for instance are within 1 hour by plane. Logistically, Bahrain is also very advanced. In fact, has recently been ranked 2nd in Global Connectedness Index (DHL).

But connectedness is not only physical. Creating MOUs and agreements with key players in key sectors is also important and could prove empowering to the startups based in the kingdom. Bahrain has been very active in this regard. For instance, in April 2019, a Bahraini Business Delegation led by EDB visited "Le Swave" FinTech Incubator in France and signed joint cooperation agreement. In May 2019, Jersey and Bahrain signed a digital innovation agreement to assist entrepreneurs to create digital businesses, products and services – with a particular focus on those that will help the finance industry.

This is also an area where Bahrain beats UAE on the Global Innovation Index, where Bahrain is ranked 8th Globally and UAE is ranked 14th under the sub-indicator "Joint venture/strategic alliance deals".

1.9 Youthful, Modern and Educated Society

Bahrain is among the top five Arab countries when it comes to literacy rates with more than 95% according to the latest censuses. The population pyramid is very youthful with almost 70% under 40 years. Bahraini youth are tech-savvy and very open-minded. One key characteristic of the Bahraini society is the active participation of women in all sectors, including the startup scene. In fact, despite of the challenges that women entrepreneurs still face in Bahrain in the SME's field (Hasan and Almubarak, 2016), they have succeeded in overcoming these challenges, and they seem to be even more successful in the tech startups field. As a matter of fact, Bahrain has just topped Silicon Valley and London with the highest share of female founders according to the 2019 Global Startup Ecosystem Report (GSER) issued in May 2019 (Bahrain 18%, Silicon Valley 16%, London 15%). Being the country with the highest share of female founders is very telling in and of itself, but it should come as no surprise if we consider the fact that there are more female university graduates than their male counterparts. This also speaks of the quality of the educational system in the Kingdom, including a rapidly evolving higher education sector that is strategically leaning towards offering an international education with hosted academic programmes from the likes of London South Bank University (hosted at Applied Science University) and the all-new British University of Bahrain (BUB) and American University of Bahrain (AUB).

1.10 People Just Like It Here

Throughout history, Bahrain has been a crossroad for many civilizations. Perhaps that's why its people have always been genuinely hospitable and welcoming. Modern Bahrain is no different. According to HSBC Expat Explorer survey issued in 2019 (based on survey results of 2018), Bahrain is by far the best country in the region for expats (5th global), distantly beating UAE (10th), UK (22nd), USA (23rd) and KSA (26th) when considering all criteria (see Figure 4 below).

League Table (based on 2018 results)

Country or Territory	Your criteria	All criteria	
	Rank	2018	2017
Singapore	1	1	1
New Zealand	2	2	2
Germany	3	3	3
Canada	4	4	4
Bahrain	5	5	▲ 9
Australia	6	6	▼ 5
Sweden	7	7	▼ 6
Switzerland	8	8	8
Taiwan	9	9	▲ 12
United Arab Emirates	10	10	▼ 7
France	11	11	▲ 16
India	12	12	▼ 10
Indonesia	13	13	▲ 19
Spain	14	14	▼ 11
Malaysia	15	15	▲ 18

Figure 4: HSBC Expat Explorer survey, retrieved in June 2019 from www.expatorplorer.hsbc.com

This is of significant importance to keep attracting skillful workforce, talented entrepreneurs and promising startups to the Bahraini economy.

2. Discussion and Recommendations

Based on the ten aforementioned points, it is clear that Bahrain is steadily growing into one of the most exciting destinations for startup creation in the region. To accelerate this process, here are few recommendations that have been formulated based on the reviewed literature and the close observation of the author to the entrepreneurship scene in Bahrain:

2.1 The need to create techno parks and more clusters

"Clusters, technological parks, and innovational networks accelerate the rate of economic growth and increase its quality" (Sergi et al., 2019). Bahrain Fintech Bay is a very successful example of a cluster created around technologies applied to financial services with a high potential of massive growth in the upcoming year. In fact, in 2018, Team Bahrain, represented by the Central Bank of Bahrain (CBB), the Bahrain Economic Development Board (EDB) and Bahrain Fintech Bay, has won the MENA Fintech Hub of the Year Award conferred by Fintech Galaxy. Now steps are being taken to further explore the InsurTech (Insurance sector) and the PropTech (Real Estate Sector) as part of the FinTech Strategy. This is definitely a step in the right direction, and more clusters will be needed in the long run to diversify the attracted investments and the profile of the installed startups. Under the sub-indicator "State of cluster development", Bahrain is ranked 24th globally (Global Innovation Index, 2018) which is very encouraging, but it's still training UAE for instance which is ranked 2nd.

In addition, proper techno parks are yet to be created and they don't necessarily have to be in the IT sector. They could be in any industrial or agricultural sector (pharmaceuticals, biotechnology, food processing, energy, marine ecology, etc.) where collaboration with tech startups will be all the more possible, especially in the fields that are considered as priorities for the Kingdom of Bahrain.

2.2 The need to create more collaboration between universities and the industries

This is also an area where improvement can be made. Under the sub-indicator "University/industry research collaboration", Bahrain is ranked 44th globally (Global Innovation Index, 2018) which is encouraging, but it's still training UAE for instance which is ranked 24th. In general, universities have to play a bigger role in promoting entrepreneurship and consolidating the innovation ecosystem ("Giving an Edge to Entrepreneurship," 2019).

2.3 The need to launch spin-off programs/initiatives

In the same vein, higher education institutions should consider promoting spin-off projects out of student research and end-of-year projects in a systematic way. A good example for that is Univenture ©, a spin-off generator programme in Tunisia that helped create several companies and startups based on the academic research of students in different disciplines (biology, computer science, agri-food, media, etc.).

3. Conclusion

The economic and social growth of any given country is based on its ability to compete in a globalized market, its aptitude to attract foreign investments, its capability to innovate and create jobs and generate wealth in a balanced and sustainable way (Farinha et al., 2018).

Based on the above argumentation, it seems that Bahrain is ticking all the boxes and on a solid path to become a new regional hub in the region. The fact that big global companies such as Amazon and Huawei chose Bahrain as a launchpad for their regional operations is a testament of that. The same is true for financial institutions and venture capital funds such as MSA Capital China which will be leading their operations for the region from Bahrain.

In that sense, the successful hosting of Bahrain to the Global Entrepreneurship Congress in 2019 is not only a culminating success crowning all of its efforts but should be considered as the starting point for even bigger achievements and shall make the Kingdom even more ambitious.

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The Relationship between Creativity and Entrepreneurial Intention among Young People in Bahrain and Indonesia: Literature Review

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Abstract

The aspiration of governments as well as the higher educational institutions and universities continually seek to change the young people mindset from job seeker to job creator. Unemployment rate among graduates has steadily increased over the years, and some have decided to engage in entrepreneurship Intention. Therefore, the study look at the relationship between creativity and entrepreneurial intention among young people. However, the concept of entrepreneurship Intention is merged largely with concepts such as creativity. So in this article it is tried to see these key factors as development of communities together. In this paper, the relationship between creativity and entrepreneurship Intention is shown. Moreover, this study paid special attention to the understanding of the elements shaping EI among young people in Bahrain and Indonesia that can help organizations attract more young people to become entrepreneurs.

Keywords: Creativity, Entrepreneurial intention, Educational institutions, Students.

1. Introduction

In the last decades, entrepreneurship has become a legitimate field of research and managerial practice, and creativity and entrepreneurship have been critical discussions in the development of modern economics (Camacho-Miñano & del Campo 2017, Huang Wang, Zhang & Bin 2018). Given rising unemployment rates and the richer opportunities offered by globalization and rapid marketing, more and more students have opted to start their own businesses. Numerous empirical studies have attempted to establish the extent to which entrepreneurship contributes to economic growth by creating new jobs (Mahmood, Sarfraz, Ramzan, & Abdullah 2018). Since researchers have highlighted the importance of intentions as a past history of behaviour in recent years (Kusmintarti, Asdani & Riwayatanti 2017), investigating the factors that influence individual intent to continue entrepreneurship could accelerate the development of entrepreneurship.

Yet alarmingly, studies highlight the fact that entrepreneurial activity is lowest among young people under 25 (Aloulou 2016). In response, there has been an explosion of government initiatives seeking to unlock the entrepreneurial intention of young people in Bahrain (Al-Shammari, & Waleed 2018). Universities in Bahrain, for instance, are called to mobilize a more entrepreneurial workforce and help students overcome misconceptions about entrepreneurship (Zeidan & Bahrami 2011). Understanding the factors that drive entrepreneurial intention in young people is paramount in this effort.

The young Indonesian generation has a challenge and an opportunity to be an entrepreneur. Although the number of Indonesian enterprises reached 3.1% of the total population in 2016, which means that it exceeded the minimum rate of a country's entrepreneurial rate of 2% (Ministry of Cooperatives and SMEs, 2017), Indonesia is still left followed by other ASEAN countries, which in 2015 reached 7% for Singapore and 5% for Malaysia (Litbang Kompas, 2015). To meet this condition, the Indonesian government sets targets to increase the proportion of Indonesian entrepreneurs to at least 4% of the total population by 2017 (Ministry of Cooperatives and SMEs, 2017). This means that Indonesia still needs about 5.8 million young entrepreneurs to win the ASEAN Economic Community (AEC) (Soebandhi, Muzaki & Sukoco 2018).

2. Literature Review

This section presents the theoretical principles of the conceptual paper. Building on the literature on Planned Behavioral Theory (TPB), entrepreneurship as planned behavior, entrepreneurial intention (EI) and creativity, this study attempts to establish proposals for a new framework of relationships.

2.1 Theory of Planned Behavior (TPB)

Entrepreneurship studies have highlighted the significant role of intention to initiate a new business to investigate the behavioral trigger of entrepreneurship (Liñán and Chen, 2009). Ajzen's theoretical model of planned behavior (TPB) proposes three main antecedents to predict intentions. The first is "behavioral attitude" that pertains to the perception and evaluation of your own performance on the desired behavior, the second is the "subjective norm" referring to the influence perceived by the external parties (family, friends and colleagues) behavior, and the third is the "perceived behavioral control" that refers to personal perception of the feasibility assessment (easy or hard) to achieve the desired behavior (Ajzen & Fishbein 1980; Ajzen 1991). The TPB model is in fact an extension of the theory of action motivated by Ajzen and Fishbein, while TRA has postulated the determinants of intention that are "attitude towards behavior" and "subjective norm" in which the intention is mediated between the two previous real behavior dependent variable). The inclusion of "perceived behavioral control" leads to the formation of a planned behavioral theory, suggested as a better model for the planned behavior that applies to the entrepreneurial study (Krueger & Casrud, 1993).

2.2 Entrepreneurship as planned behavior

Entrepreneurship, as planned behavior, made it possible for scholars to begin to study the determinant of entrepreneurship based on the model of intent (Bird, 1988; Katz and Gartner, 1988). Intent studies have suggested that actual target behavior may be best predicted from intent as a good predictor in different contexts (Armitage & Cornner 2001). Its intent and antecedent are perceptions that are possible to be taught and expanded into variations depending on the situation and the individual (Kruger & Brazeal 1994). Research studies on entrepreneurial intentions have shown two dominant predominant models, namely Ajzen's Planned Behavioral Theory (TPB), which will be discussed briefly. Previous literature has shown an existing empirical study on the determinant of entrepreneurial intent focusing on TPB and EEM (Kruger 2009, Kruger 2017).

3. Entrepreneurial intention

The Entrepreneurial Idea According to Bulloughet, Renko and Myatt (2014), intention is a fundamental step in the entrepreneurial plan whenever the individual intent to start a new business. Several approaches such as the entrepreneurial events model (Shapero, 1982), the theory of planned behavior (Ajzen, 1991) and the potential entrepreneurial model (Krueger & Brazeal 1994) emphasized the importance of entrepreneurial intent in creating business. Entrepreneurial intention is defined as a state of mind and the desire to create a new business or start an activity (Wu & Wu, 2008). Thompson (2009, p. 676) defines entrepreneurial intentions as "recognized beliefs by individuals that they intend to set up new business and consciously intend to do so at some point in the future." Entrepreneurial intention remains a key factor in predicting effective business creation (Wu & Wu, 2008). In this sense, it seems worthy to investigate the predictors of entrepreneurial intent to build a more sophisticated knowledge of this concept (Wan, Lu, & Millington 2011).

4. Creativity

The concept of creativity has been considered by many authors and researchers, but everyone defines creativity in their own (Ford & Harris, 1992). However, most studies have looked at the concept of creativity that focuses on the formation and emergence of new products and ideas on the market that are useful to society, but it differs from other products and market ideas (Petrowski, 2000). Later, in the context of entrepreneurship, there must be a link between profitability and innovation in social and monetary terms. The major distinction between entrepreneurs and others is that they focus on internal capabilities and capabilities while searching for and analyzing solutions (Hunter, Bedell, & Mumford, 2007).

The more creative the individual is, the more he or she is involved in entrepreneurship, and this can influence his level and type of novelty in his business (Koellinger, 2008). The high level of creativity in the individual has a strong positive impact on entrepreneurial intent (Hamidi, Wennberg & Berglund, 2008). A study has shown that students with more ideas and higher quality of ideas have increased entrepreneurial intent (Molaei et al., 2014). The ability to generate ideas is consistent with divergent thinking that leads to an increase in the divergent thinking of the individual to positively predict entrepreneurial intent (Batchelor and Butch, 2012). People with creativity who offer useful ideas to solve the significant problems that people are willing to pay reflect the high value of the ideas that need to be captured through entrepreneurial activities (Kavanagh and Hisrich, 2010).

5. Creativity and entrepreneurial intention

Creativity has a significant and positive effect on entrepreneurial intentions. Entrepreneurial intention is a cognitive representation of actions to be implemented by a student with the intention of setting up new businesses. Creativity is one of the entrepreneurial characteristics that determines entrepreneurial intent. Creativity is the ability to develop something new about discovering and developing new ideas and new ways to look at issues and opportunities. Creativity is important for a person choosing to be an entrepreneur (Birdthistle, 2008). Kusmintarti, Thoyib, Ashar and Maskie (2014) argued that creativity is a dimension of the entrepreneurial characteristics that have contributed to the growth of entrepreneurial intentions.

Moreover, start-ups are not only important for universities, but the academic support of entrepreneurs is also significant, so many universities offer entrepreneurial courses in various degrees. The literature so far suggests that entrepreneurial intent is a key factor in stimulating future successful entrepreneurs (Souitaris, Zerbinati & Al-Laham 2007; Vij & Ball, 2010) because it could demystify the fear of failure, barriers or bootstrapping Politis, Winborg & Dhalstrand 2010). However, this link is not clear. For example, there is empirical evidence that there was a link between the role of creativity in entrepreneurial entrepreneurship support and entrepreneurship in Spain and the UK in the twentieth century (Tortella, Quiroga & Moral-Arce 2011), while Coduras, Urbano, Rojas and Martinez (2008) find evidence that there is no significant statistical relationship between the two variables at present. A positive effect between entrepreneurship education and training and entrepreneurial ability has been demonstrated, but as an indispensable factor through cultural and social norms (Díaz-Casero, Hernández-Mogollón & Roldán 2012); while a negative effect was observed between entrepreneurial programs and the intention to become an entrepreneur (Oosterbeek, Van Praag & Ijsselstein 2010). Therefore, the challenge is to identify the types of courses that universities should offer to stimulate, support and help young entrepreneurs to be successful, for example, with courses closer to real life, as some studies suggest (Taatila, 2010).

In this model, the two factors of creativity and entrepreneurship together to enhance educational and career success.

Creativity and entrepreneurship have always been associated, so necessary and interdependent. Fadaee & Alzahrh (2014) thinks that entrepreneurship can say without creativity does not bring any fruit. The results of studies have highlighted the fact that entrepreneurs are choosing new companies or companies and established institutions, not only for economic reasons, but also because there are jobs to be followed by creativity.

In recent years, schools, industries and decision-makers have highlighted the importance of campuses in developing national economies through the emergence of innovative ideas and technologies and increasing economic value and employment opportunities (Prodan & Drnovsek, 2010). The climate of on-campus innovation can enhance the entrepreneurial intentions of teachers and students through professional satisfaction and self-efficacy, which improve the relationship between professional satisfaction and entrepreneurial intentions (Lee, Wong, Foo, & Leung, 2011). In addition, students' imagination has a considerable influence on rural businesses and services (Chang, Yao, Chen, King, & Liang, 2016).

6. Discussion

The model of entrepreneurial intention mostly contributes to explaining entrepreneurial behavior within the planned behavioral theories. Shapero's EEM and Ajzen's TPB continue to be dominant in explaining entrepreneurial intention. Though, a current study suggested that numerous components of the determinants of entrepreneurial intent might require the inclusion of other distal constructions to better explain entrepreneurial intention (Schlaegel and Koenig, 2014).



Figure 1: Conceptual framework

Although the construction of personality factors such as creativity seems to have less attention from researchers on entrepreneurial intention, a previous research has shown a positive relationship with entrepreneurial intention (Linan & Fayolle, 2015). Individual creativity is capable of influencing the entrepreneurial intention of students and mediating institutional factors (family and university support for creativity) with entrepreneurial intent (Zampetakis et al., 2011). Besides, the idea of creativity that results in new ideas would require the initiative to extend the idea into implementation or to be adopted as innovation.

Thus, these lead to the following suggestion:

Proposition 1: Creativity has a positive effect on Entrepreneurial Intention

7. Conclusion

Entrepreneurship as an economic engine is an essential component for the continued growth and continuity of the nation's ecosystem. Future research could be undertaken to empirically test the proposed framework to complement Shapero's existing TPB or EEM entrepreneurship model. Individual level research would be beneficial for empirical testing and analytical purposes. It could explore the outcome in the context of individuals such as students or business learners and entrepreneurship courses or programs. Students of business studies, MBA programs, or business accelerator and incubator learners may be the best samples to apply the proposed framework.

Entrepreneurship as a challenging career requires a high commitment to resources for the high expectations expected in the future, while it also inherently has a high level of uncertainty and financial risk for its pursuers as well as for those who invest in them. Thus, the possibility of having access to the individual potential of entrepreneurial traits and entrepreneurial behavior could be an advantage in reducing unnecessary wrong investments and the allocation of economic resources. In addition, it is possible to optimize the allocation of economic resources to more successful business candidates and entrepreneurs.

Extending this concept can contribute to the theory of planned behavior in the entrepreneurial intention to become a more comprehensive model. It can clearly contribute to explaining how individual creativity affects the individual's intention to start a new business from a new perspective, including IEO. The expected benefits of understanding this proposed relationship can also identify potential mechanisms for existing firms in selecting potential individuals that are suited to conducting new risk projects with better evaluation criteria. The same case may apply to venture capital and accelerator programs. Another possible outcome is to help people who believe and show interest in pursuing their entrepreneurship. Meanwhile, understanding certain criteria in personal traits and behaviors related to entrepreneurial activity may be helpful to help make better decisions for career, work, or projects that positively support. This also helps them to express their creativity and to exercise their own innovative behavior, besides contributing to their entrepreneurial journey before starting their own company.

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The Role of Higher Education Institutions in Promoting Entrepreneurship in the Kingdom of Bahrain

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Abstract

The strategic choice of the Kingdom of Bahrain to diversify its economy and the growing number of University graduates versus the decrease in the number of jobs offered by the public sector dictated a new paradigm shift for the higher education institutions (HEIs): they are no longer expected to graduate good job seekers, but rather innovative job creators, who can create new opportunities for themselves and for others. The Higher Education Council (HEC) has put "Entrepreneurship" as one of the six guiding themes of the "National Higher Education Strategy 2014-2024". This is also in line with the "Economic Vision 2030", launched in October 2008 by His Majesty King Hamad bin Isa Al Khalifa, which recognizes the importance of entrepreneurship and innovation in enhancing the competitiveness of any given economy as evidenced by the Global Competitiveness Reports issued by the World Economic Forum every year.

This paper explores the role of HEIs in promoting entrepreneurship amongst their students and the challenges they face to achieve that, using as a case study the experience of a leading private university in the Kingdom of Bahrain.

Despite the ongoing debate whether entrepreneurs are made or born, the paper finds that learning entrepreneurship at HEIs is undeniably paramount in increasing the students' intentions to become entrepreneurs, yet some educational methods are more effective than others, and a blend of various pedagogical approaches is more likely to achieve best results. The article concludes by proposing a 3-stage model for Entrepreneurial Education (EE) at HEIs to create the entrepreneurial student and extends some further recommendations to enhance entrepreneurship promotion in Bahrain.

Keywords: Kingdom of Bahrain, Higher Education Institutions, Promoting Entrepreneurship, Entrepreneurial Education (EE) Model, Challenges, Recommendations.

1. Introduction

The impact of entrepreneurship in driving economic growth is well documented as nations constantly need entrepreneurs to create new businesses and explore new opportunities (European Union, 2003). For both developed and emerging countries, entrepreneurship is perceived as a key tool for economic development (Stel *et al*, 2005) and an important contributor to job creation, namely with the introduction of the "serial entrepreneurs" notion, referring to those who, once they succeed with their first venture, go on to start several other businesses, thus creating many more jobs in the process (Linan *et al*, 2005).

The available literature also strongly suggests that teaching entrepreneurship is conducive to job creation and poverty reduction (Timmons and Spinelli, 2004). It is believed that formal education of entrepreneurship can affect the attitudes of students towards entrepreneurship as a viable career path and prepare them to become successful business owners. As a matter of fact, results from previous research show that entrepreneurs with higher academic degrees are more innovative and use newer technology and modern business models to drive successful ventures (Pajarinen *et al*, 2006). Galloway and Brown (2002) argue that entrepreneurship education at universities is a true driver in the creation of high growth firms.

Therefore, it is no surprise that most countries have been increasingly encouraging universities to include teaching entrepreneurship in their curricula and play their expected part in promoting it amongst students. The Kingdom of Bahrain is no exception. This is evidenced by the "National Higher Education Strategy 2014-2024" where "Entrepreneurship" is one of its six guiding themes, as well as the "Economic Vision 2030", launched in October 2008 by His Majesty King Hamad bin Isa Al Khalifa, which recognizes the importance of entrepreneurship and innovation in enhancing the competitiveness of the national economy.

This paper aims to explore the ways HEIs are promoting entrepreneurship in Bahrain and the challenges they face while doing so, and tries to provide recommendation to help improve entrepreneurial education and promotion in the Kingdom.

2. Method/ Approach

This article is more of a conceptual paper that is heavily based on literature review, secondary data, previous experiences of the author and a the case study of the University in which the author operates.

3. Definition of entrepreneurship and entrepreneurs

There are several definitions of entrepreneurship in literature, but they all revolve around the capacity to seize opportunities to create innovative businesses under uncertain conditions, in other words, the ability to take risks for greater rewards. This notion of "*willingness to take calculated risks*" is present in Kuratko's definition of entrepreneurship (2003) and with Rwigema and Venter (2004) who define entrepreneurship as a "*process of conceptualising, organizing, launching and, through innovation, nurturing a business opportunity into a potentially high growth venture in a complex, unstable environment*". A more recent definition focuses more on the value creation in the pursuit of personal satisfaction and financial independence (Hisrich *et al*, 2009).

Consequently, entrepreneurs have been defined as the founders of new business ventures (Onuoha, 2008). To achieve that, entrepreneurs share common traits that are, according to McClelland (1961) "desire for responsibility; preference for moderate risk; confidence in their ability to succeed; desire for immediate feedback; high level of energy; future orientation; skill at organizing, and value of achievement over money".

When it comes to depicting the skills that define entrepreneurs, the literature is indeed extensive. From Schumpeter (1926) to Wickham (2006), recurring attributes are creativity and innovation, risk-taking and drive to maximize profits. High level of self-confidence (Denslow and Giunipero, 2003), good networking skills (Peters, 2005; Platt, 2004), the ability to take decisions based on incomplete information -gut feeling- (Zimmerer and Scarborough, 2002), and being knowledgeable in different areas -jack of all trades- (Lazear, 2005) are all recurring themes.

4. Are entrepreneurs born or made?

While this paper is clearly all about teaching entrepreneurship, it is worth mentioning that the scientific community has debated for a while whether entrepreneurs can be made. In line with the previous paragraph depicting the attributes of successful entrepreneurs, it has been argued that many of those attributes are more of personal traits that people acquire at a very young age rather than skills that can be taught. These traits can even be attributed to genetic factors, such as the level of testosterone. Testosterone levels correlate positively with risk-taking behaviour (Fannin and Dabbs, 2003), dominance and status seeking (Mazur and Booth, 1998), which are all useful for entrepreneurial behavior (White *et al*, 2006).

However, the literature is vastly more supportive of the opinion that entrepreneurship can be taught (Timmons and Spinelli, 2004) and is to be considered as an academic discipline and academic disciplines can be learned (Drucker, 1985). Evidently, there are many extensive studies and literature that showcase successful experiences in teaching entrepreneurial skills when adopting the rights methods for entrepreneurship education (Henry *et al*, 2003, 2005a, b).

In Bahrain, a recent study revealed high Entrepreneurial Intentions (EIs) amongst the students of three private universities (Al-Shammari and Waleed, 2018) with the focus on "*personal attraction towards becoming entrepreneur, perceived behavioral control, and subjective norms and social valuation of entrepreneurship*".

5. History and typology of entrepreneurship education

Anietie (2014) states that "*entrepreneurship education as a course in business schools started in the early 1970s. The University of Southern California started the first Master of Business Administration (MBA) concentrating on entrepreneurship in 1977. This was followed by the first undergraduate course concentrating on entrepreneurship 1972.*" However, the real emergence of taught entrepreneurship was

in the early 1980s as more than 300 higher education institutions were delivering entrepreneurship courses (Kuratko, 2005). Nowadays, teaching entrepreneurship has become all the rage and universities in many countries have been competing to deliver the best entrepreneurial programmes to attract students with entrepreneurial minds.

As for the types of methods used in entrepreneurship education, Taatila (2010) reprises the depiction by Jamieson (1984) has divided entrepreneurial education into three classes:

- Education about enterprise: this is learning about entrepreneurship which is reflected in the typical theoretical courses.
- Education for enterprise: This involves practical aspects that prepare the students for the actual business creation in the foreseeable future.
- Education in enterprise: This is about offering training and education for established entrepreneurs and small business owners (Henry et al., 2003, pp. 92-3).

In the next paragraph, we will present a case study of a leading private University and see to which extent these methods have been implemented.

6. Higher education in Bahrain and the promotion of entrepreneurship: case of Applied Science University

6.1 Higher Education in Bahrain

This year, Bahrain celebrates 100 years of formal education which started back in 1919. However, the first institution of higher education in Bahrain goes back to 1968 with the establishment of the Gulf Polytechnic. In 1986, the University of Bahrain was established by the Amiri Decree No. 12 /1986 as a merger of two public colleges; the Gulf Polytechnic and the University College of Arts, Science and Education which was established in 1979 (Peck, 2007). As per the annual report 2017 of the Higher Education Council, the number of universities in Bahrain (both private and public) has reached 14, with new licenses for other universities being considered. As Dr. Majid bin Ali Al-Nuaimi, Minister of Education and Chairman of the HEC puts it in his forward to the National Higher Education Strategy, "*The higher education sector is central to the future development of the economy, public services and nation. The sector must perform a critical role in terms of the skills needs of the workforce of tomorrow and developing our knowledge economy through improving overall quality, skills, **entrepreneurship** and technology*".

To stress the importance of promoting entrepreneurship by HEIs, the HEC Institutional Accreditation Framework developed jointly with the British Accreditation Council dedicates an entire area, area 5, to "Economy and Society Impact" (out of 8 areas). The very first standard in this area stipulates that "*the institution's strategy must recognize the importance of promoting entrepreneurship and provide appropriate academic, physical and financial resources to support this*" (Ministry of Education, 2016). The second key indicator (out of four) explicitly mentions that the "*institution must have or be developing policies and mechanisms which will facilitate funding for graduate and staff enterprise and provide appropriate facilities such as incubator support*".

6.2 Applied Science University (ASU): towards an entrepreneurial university

6.2.1 History and achievements

ASU was established as a private university in the Kingdom of Bahrain and granted its licence by the Ministry of Education according to the decree issued by the Minister's Council No. WD 140/2004 dated 5 July 2004. ASU aspires to become one of the leading universities in the Kingdom of Bahrain and in the wider Gulf region.

The University's first Chairman was Mr. Abdulla Nass and its first President was Professor Waheeb Al Khaja. At its formation in 2004, ASU was located in Juffair and organised into three colleges (Administrative Sciences, Arts and Science, Law), with an initial intake of 236 students supported by 23 academic and 16 administrative staff. The University has grown and developed since then, passing new milestones each year:

- In 2007, ASU's first cohort of 105 students graduated
- In 2013, ASU moved to its current campus at East Ekir, having grown and diversified its programme offering to meet increasing demand
- In 2014, ASU's second President, Professor Ghassan Aouad, was appointed
- In 2015, Professor Waheeb Al Khaja was appointed as Chairman of the Board of Trustees and ASU was included in the top-tier universities ranking in the Higher Education Council (HEC) Annual Report
- In 2016 ASU successfully achieved Institutional Listing on the National Qualifications Framework (NQF) Register and has since successfully applied for the Programme Placement of several of its undergraduate programmes
- In 2017, the first students were admitted to four new degree programmes established under ASU's UK partnerships
- In 2018, ASU held its eleventh graduation ceremony (bringing the alumni total to 4484) and ASU's ASUrise scheme to support staff towards achieving HEA Fellowship recognition was accredited by Advance HE UK
- In 2019, several endorsements and recognitions were received:
 - ✓ Institutional Accreditation by the Higher Education Council (HEC)
 - ✓ QS Arab Region University Rankings 2019: #45 (highest of Bahrain's private universities)
 - ✓ THE University Impact Rankings 2019: in the 301+ category (highest of Bahrain's private universities)
 - ✓ UI GreenMetric World University Ranking 2018: #25 in Arab region and in the 601+ category (highest of Bahrain's private universities)
 - ✓ BQA confidence status for all programmes following reviews/follow-up reports
 - ✓ HEA Fellowships have now been awarded to 46 of our staff in recognition of professional standards in supporting student learning

6.2.2 Promoting entrepreneurship

Because of its applied nature, ASU has always been keen to promote practical learning including entrepreneurship. The University's efforts in this regard include:

- Including the promotion of entrepreneurship in its strategic plan 2015-2020
- Making the course "Introduction to Entrepreneurship" compulsory in all programmes of the University since 2017.
- Organizing workshops about entrepreneurship to raise awareness amongst students about its importance and the governmental support offered to them, namely by TAMKEEN.
- Inviting guest speakers and successful entrepreneurs to motivate students and increase their EIs (Entrepreneurial Intentions).
- As part of its Community Engagement (CE) activities, reaching out to local communities to offer knowledge-sharing and learning opportunities.
- In 2016, ASU signed a memorandum of cooperation with Bahrain Businesswomen's Society which is a leading NGO in Bahrain promoting entrepreneurship amongst women, and with Bahrain SMES Society, the go-to organization to support small and medium enterprises and encourage young men and women to create their own businesses.
- In 2017, ASU signed a memorandum of Cooperation with Flat 6 Labs Bahrain, part of FLAT 6 LABS which is a network of startup accelerators promoting entrepreneurship in the Arab region.
- Promoting research on entrepreneurship by supervising master thesis and publishing scientific papers on the subject.
- Including in the advisory boards of academic programs members from bodies that work on entrepreneurship.
- Encouraging and supporting students to participate at the various national and regional competitions about entrepreneurship.
- More recently, in 2019, the University officially inaugurated its "Business Incubation Center" that will contribute to providing students with the support they need to establish their business before even graduating from the University.
- In the academic year 2019/2020, ASU will inaugurate its "Legal Clinic" which, among other things, will work in tandem with the University's "Business Incubation Center" to support

students with the legal matters related to their ventures (writing statutes, contracts, legal advisory, etc.).

Most recently, all these efforts paid off by the crowning achievement of winning the premier national entrepreneurship competition organized between universities by "INJAZ Bahrain". The students who won the award developed a mobile application dedicated to the car service industry and qualified to the regional competition which will be held in Oman. At the time of writing this article, the students initiated the process of incorporating their business and could benefit from the services of the University's "Business Incubation Center" which would be a good success story to inspire the other students. This presents a significant progress for ASU, although it is worth mentioning that it is still trailing UOB (University of Bahrain) which has already signed several contracts with a number of its student entrepreneurs to profit from UOB's Business Incubation Center.

7. Creating the entrepreneurial student: a 3-stage entrepreneurial education model

Based on all the above and building on the entrepreneurial education classification by Jamieson (1984), a model of 3 stages is proposed here as a framework to help universities create the entrepreneurial student it desperately desires in a methodic and systematic way (see figure 1. Below).

- **Stage 1: entrepreneurial education (EE) for the *potential entrepreneur***
The assumption here is for HEIs to consider each and every student as a potential entrepreneur. Thus, it would only be fair to equitably provide students with the theoretical background and knowledge they need in case they decide to become entrepreneurs. Provision should be based on the basis of equal opportunity with no preferential treatment to some students over others.
Educational activities at this stage would mostly consist of making a basic entrepreneurship course compulsory to all disciplines. Additionally, in preparation for the next stage, activities must include here awareness and motivational sessions to entice students to consider entrepreneurship as a career path. This may include getting guest speakers such as successful entrepreneurs, site visits to successful company, etc. So, the objective here is to ensure a shared and common understanding of entrepreneurship amongst all students on the one hand and try to increase their EIs on the other.
- **Stage 2: entrepreneurial education (EE) for the *aspiring entrepreneur***
Unlike the previous stage, this one should be a selective process. The HEI must have a mechanism to identify and select the high-potential students who are truly eager to venture on their own. Such mechanism may include personality tests, calling for volunteering to entrepreneurial initiatives, calling for application for entrepreneurial programs, etc. The HEI must focus its resources on the identified students as these are the more likely to succeed and make it to the next stage. Educational activities for the aspiring entrepreneur must focus on developing real skills that would bring the student closer to creating his/her business, such as organizing bootcamps for idea generation and business planning, developing leadership, problem solving, negotiating, sales and marketing skills, increasing knowledge about the legal procedures to open up a business, training on fundraising skills and increasing awareness of the available funding opportunities, etc.
It is very important here to allow students to identify and pursue opportunities of their own choosing to ensure their sustained interest and motivation. A good example of this is the entrepreneurial program initiated by Haaga-Helia University of Applied Sciences to help students turn their hobbies into businesses. The study it led to assess the program (Romer-Paakkanen and Pekkala, 2008) revealed that students "*must have a high level of personal interest in the subject of their business in order to create a successful new venture*".
- **Stage 3: entrepreneurial education (EE) for the *established entrepreneur***
This is where HEIs reap the rewards of their efforts in the two previous stages and get to create their own stars. The student actually crosses to the other side, establishes his/her business and becomes an entrepreneur. The role of the university should not stop here. It must cater to the needs of its new ambassador to ensure his/her continuous success so that he/she can be a role model to the other students. Typical activities at this stage include

business incubation, legal advice, capacity building on certain topics depending on the sector of the new venture, mentoring services, easing access to funding, etc.

Here, it is very important to change the community's negative perception of start-ups failures -the culture of shaming failing entrepreneurs. Throughout history, many celebrated entrepreneurs experienced crushing defeats before making it back to the top, such as Steve Jobs, the co-founder of Apple Inc. Indeed, literature reveal that failure is an integral and important part in learning entrepreneurship (Huovinen and Tihula, 2008) and that is how student entrepreneurs should be able to perceive it.

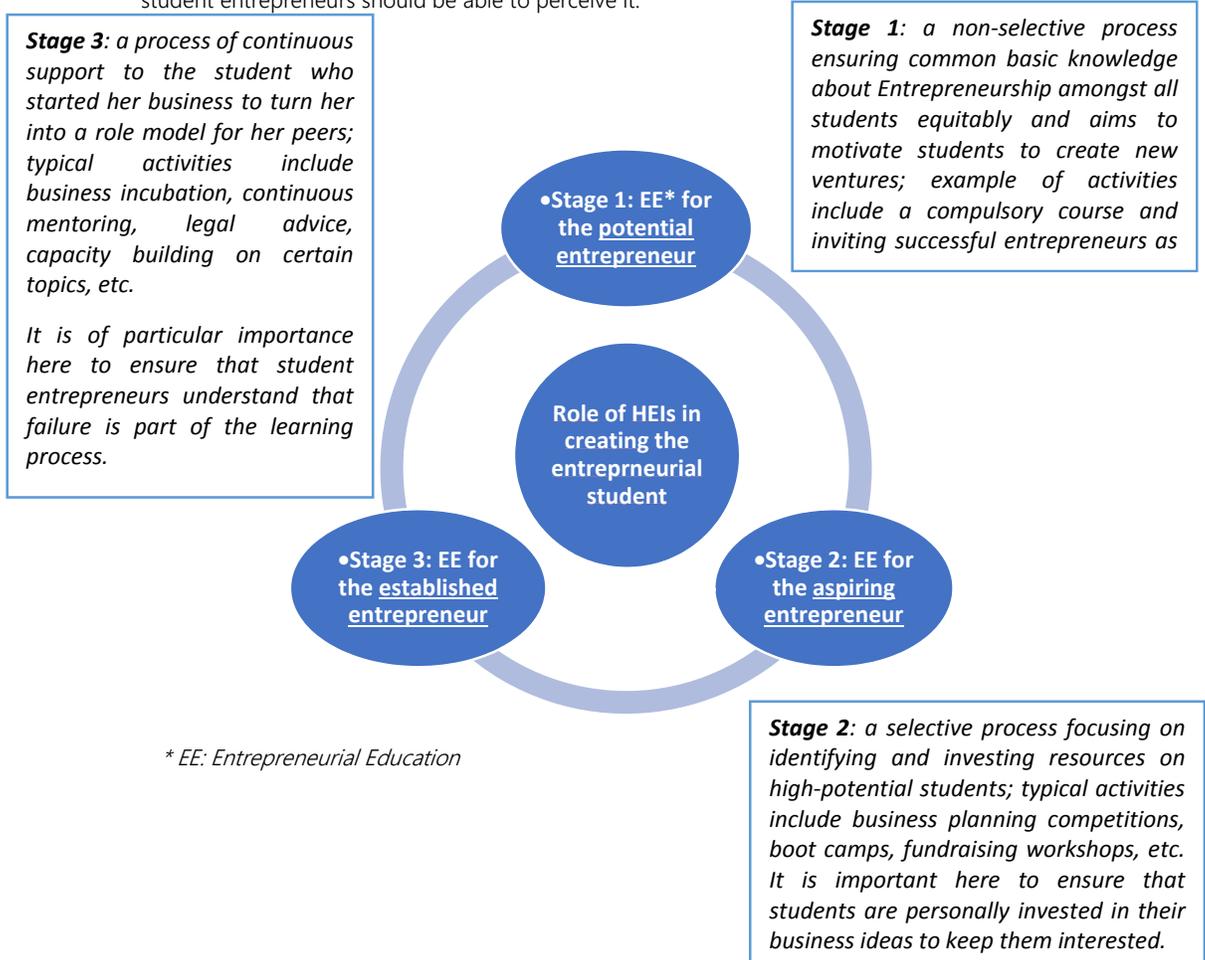


Figure 1: Entrepreneurial Education at HEIs for creating the entrepreneurial student: A 3-stage model

8. Challenges of entrepreneurship education

As mentioned earlier, promoting entrepreneurship is clearly at the top of the national agenda in Bahrain and a quintessential part of its higher education strategy, but that objective comes with an array of challenges:

- The need for an academics with the necessary qualifications and the entrepreneurial abilities to be able to deeply impact students. Katz (2003) suggests that, generally, the most limiting factor of EE development is the shortage of faculty and PhD programmes.
- The need to conduct more research on entrepreneurship in general and to assess the effectiveness of the various entrepreneurship programmes and initiatives in particular.
- The need to develop more links between academia and the industries to foster joint entrepreneurial projects and initiatives.
- The need to create techno parks to boost applied research aimed at innovation and value creation.

9. Recommendations to enhance entrepreneurship education in Bahrain

After careful examination of the role of higher education institutions in promoting entrepreneurship in Bahrain, the following recommendations have been put forth:

- It is important to start entrepreneurship education at secondary and even primary levels of education to help shape the views of students towards entrepreneurship at a younger age.
- Higher education institutions are invited to consider the 3-stage model proposed earlier and ask themselves: what are we providing our students with at each of the three stages? This will enable them to identify the gaps in their approach to EE in a systematic and methodical way.
- Higher education institutions should consider promoting spin-off projects out of student research and end-of-year projects in a systematic way. A good example for that is Univenture ©, a spin-off generator programme in Tunisia that helped create several companies and startups based on the academic research of students in different disciplines (biology, computer science, agri-food, media, etc.).
- Higher education institutions should consider collaborating with international entrepreneurship centers at universities known for their entrepreneurialism. A good example of that is the Babson Global Center for Entrepreneurial Leadership (BGCEL) at Prince Mohammad Bin Salman College (MBSC) of Business & Entrepreneurship at King Abdullah Economic City (KAEC).
- Unlike dictated budget allocations for research (3%) and academic staff development (2%) by HEC for private universities, allocating resources to promote entrepreneurship is left for the goodwill of HEIs. Thus, this paper suggests a 1% budget allocation to fund student ventures and help them create their planned businesses, albeit through a rigorous and monitored evaluation and selection process to avoid any favoritism in funding projects.

10. Conclusion

Entrepreneurship is undoubtedly a key factor in driving economic growth, creating jobs and improving the quality of life of citizens. The Higher Education Council strongly encourages entrepreneurship through its strategies and through the HEC Institutional Accreditation Framework. Consequently, the higher education institutions feel pressured more than ever to play their role and contribute to the promotion of entrepreneurship amongst their students and graduates. This can only be achieved by a holistic educational approach that combines providing student with the necessary theoretical knowledge with real-life skills and abilities, in addition to investing in promising student entrepreneurs to become success stories and role models for their peers.

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Section 4
Sustainability

Evaluations for Sustainable Policies in Latin-American Countries: A Sustainability Measurement Framework for Cali, Colombia

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Abstract

The rapid process of urbanization occurring in the world is generating several harmful impacts, especially in Latin America, where cities have a high growth rate. According to the UN, an 81% of the population lives in cities, and is expected to increase within the next 15 years. Therefore, the deterioration of the natural environment, inequality of income and access to basic needs and decline of the population's quality of life are the main consequences. Therefore, it is necessary to take action to converting the cities into resilient and sustainable environments.

This study aims to design a framework to measure sustainability in the city of Cali, Colombia. Proposing the first step for the development of an assessment system of the progress of sustainability achieved in the city and the suggestion of an application of the framework in the current planning tools and projects for the city.

The methodology to develop the framework consists of : (i) Comparing the indicators of two internationally recognized assessment tools (BREEAM Communities and LEED for Neighbourhood Development); (ii) filtering the resultant indicators, using as a criteria the Sustainable Development Goal 11 for the purpose of focusing the resulting framework to specific targets; (iii) contextualize of the framework supported by the iberoamerican bank protocole, ICES - Iniciativa para Ciudades Emergentes y Sostenibles.

The result is a framework consisting of 23 indicators to measure sustainability taking into account the Sustainable Development Goal # 11 indicators. The scope of the analysis is limited to the urban scale assessment, which allows the implementation of an evaluation framework and the modification of urbanistic regulations and policies.

Keywords: Indicators; Sustainable development Goal (SDG); Assessment tools; Case study.

1. Introduction

Urbanization constitutes one of the most important change processes in landscapes. In most countries, especially in Latin America, the majority of the inhabitants live in urban settlements, conditions that are increasing each year. According to data provided by the UN, currently 55% of the world's population lives in cities and is estimated to reach 68% by 2050; In Latin America, the situation is more drastic, in 2018, the 81% of the population lives in urban settlements (UN, 2018). Therefore, what sociologists call "urban society" (Lefebvre, 2014), constitute a major concern for planning professionals and institutions, because the concentration of people that a city implies and to a large extent, because is where political decisions are taken and directly influences the rural environment. The rapid and effective development of an evaluation framework and measurement of the efficiency of the realization of strategic projects in the government's plan is crucial. Considering the growth rate of the cities, the impact that a project can generate in its environment should be a priority in the next government development plan analysis. Also, the need to generate a support instrument to the land-use plan.

Particularly, Terraza et al., (2016) identify some main problems in an urban scale such as disorganized urban sprawl, lack of definition between urban and rural soil, low density and presence of urban voids and a high percentage of unused soil, unchain at the same time a number of urban problematics. Such as the deficit of public transport and inequitable distribution of public space and green areas; strong socio-spatial segregation; the proliferation of informal settlements in vulnerable unoccupied areas of the city; and present a high risk of being affected by natural disasters caused by climate change.

According to Terraza et al., (2016) a "sustainable city" is: compact (i.e. has clear limits between urban and rural occupation); socially cohesive, (i.e. offer spaces for social interaction, presents a good index of public spaces and green areas); and resilient towards natural disasters (i.e. encourages social activities and allows the community to develop). The arguments leading to the conclusion that most Latin-American cities

present the same problems thus will share possible causes and solutions was the analysis made by the IDB (International Development Bank BID, in Spanish); in which data was compared side to side and situated cities considering similarities. Three scenarios are exposed as a result of the analysis, the optimum, the trend, and halfway. The basic criteria are oriented to improve the quality of life of the inhabitants, in which every intervention is thought to increase the values of the indicators towards sustainable values. However, these territories are also considered as new cores of investment and opportunities, what makes them prone and ideal to develop new models of expansion and control of the urban print, taking advantage of their privileged localization and resources, guiding social processes towards sustainability as the concept is new to the governments.

Ameen & Mourshed (2019), mention that considering the local context for sustainability assessment is fundamental in order to identify the needs and priorities of the place. In their work, they develop the final part of a sustainability assessment framework in Iraq, using already relevant indicators and determining the appropriate weighting and hierarchy using the analytic hierarchy process. Moreover, Yan et al.,(2018), emphasize that sustainability should not only consider natural resources and the environment but also in human wellbeing and resident happiness. Thus, the result is a sustainable assessment index, a methodology to determine sustainable development efficiency based on the natural resources limitations, and human welfare needs.

As most of the Latin-American cities present similar characteristics and dynamics, they can be analyzed under the same criteria and a general strategy to guide urban planning and the formulation of plans in prof of sustainability can be formulated similarly.

For public planning entities is already evident that generating changes in the government and development strategies and the policies that regulate and sustain them is necessary, considering sustainable development as well as achieving equality of conditions and opportunities, as the rates of inequality in Latin-America are significantly high. In Colombia, the first steps are already done, integrating the UN's development goals with the national and local development plans in urban planning and national environmental policies. The problem statement is that there is still a lack in articulating the goals in different scales since every scale contributes to one another and defining the studies that support the relevance of the sustainable goals, prioritize strategies and monitoring the same.

The biggest challenge is to start opening effective urban planning spaces that allow the proposal and execution of not only short-term projects but also the correct execution and evaluation of long-term projects, the articulation between scales of intervention and the continuity of the s despite the change of government.

In order to respond with a cohesive development of research that can help Cali, the case study, to consider implementing sustainable strategies into the new urban developments and policies; moreover, include a system to measure sustainability in order to do changes in short-term policies if a development is generating negative impacts to the city.

The main objectives of the present study are:

- Initiate the process of articulation between development plans and Land-use Plans (POT) over time, establishing standard indicators for the future assessment of progress.
- Propose a framework to complement the current evaluation system of the Land Use Plan that is focused on sustainability assessment.

This paper is organized as following: **Section 177** introduces the importance of considering the assessment and adjustment of globalization strategies towards sustainability. Also gives an insight into the current assessment methodologies to evaluate sustainability from different points of view. The methodological approach is demonstrated in **Section 2**, describing the process of generating a list of sustainability assessment indicators starting from the description and analysis of existing measurement frameworks and taking the elements that are considered pertinent in the context of the case study. **Section 4** illustrate the results of the application of the methodology on case study. The paper lasts with the conclusive remark and some future developments (**Section 4**).

2. Methodology

The methodology followed to generate a measurement index of sustainability consists of an analysis of sustainability frameworks developed in three steps.

Figure 1 shows the methodological scheme.



Figure 1: Summarizing scheme of the methodological development.

- **Step 1:** Analyze the current indicators of two sustainability assessment methodology (LEED for Neighborhood Development and BREEAM Communities) to establish the relationship between them and generate a singular list of indicators.
- **Step 2:** Filter the selected indicators from step one according to the targets defined in the SDG 11 and complete the list with the indicators from Goal 11.
- **Step 3:** Make a comparison between the lists of indicators resulted from step 2 establishing the relevance of the indicators in a Latin-American context, using as reference the ICES methodology.

The solution to the need of generating a framework of measurement of sustainability had to be accurate and simple to develop. Accordingly, a review of different approaches to sustainability measurement in multiple scales is made in order to understand how the influence of the factors in the context and the scale of evaluation, orientate the selection of a certain methodology or indicators in a framework.

Further on, the existent frameworks selected to develop the methodology in creating a new one, are explained in more detail in order to have a deeper understanding of the reasoning behind the proposed framework.

The steps of the methodology consist of an analysis of LEED and BREEAM, which leads to a list of indicators classified in categories and described in detail that are common to both methodologies; that constitute mandatory criteria to one or another methodology. To filter the selection of indicators the criteria used, is that the indicators must be related to the United Nations' sustainable development goal # 11: Sustainable cities and communities; then, the indicators are contextualized in Latin-America, based on a methodology for sustainability measurement and prioritizing of projects called ICES that make emphasis in common Latin problematics and measurements for sustainable progress. The result is a list of indicators that are related only to goal #11 and to the context, to compare to the current indicators from the revision and evaluation of the POT (Land Use Plan - Plan de Ordenamiento Territorial).

BREEAM, was established in the UK and was the first commercially available environmental assessment tool is focused on mitigating the overall impact of development projects within the built environment and for the assessment of larger scales, they created a methodology called BREEAM Communities. In this methodology, the categories of infrastructure and transport are the most emphasized; consists of 51 criteria in which all are weighted equally. BREEAM Communities considers the issues and opportunities that affect sustainability in the earliest stages of the design process where the site selection is not done yet (BREEAM Communities, 2012).

The performance of a development is determined by a combination of different elements that are the mandatory standards, the assessment issues, and credits, awarded credits for innovation, the issues weighting, the BREEAM rating level benchmarks. The benchmarks start from passing with a 30% score until an outstanding performance with a score of 85% or above. (BREEAM Communities Technical Manual SD202, 2017)

LEED (Leadership in energy & environmental design), is a rating system developed by the United States Green building council and base their assessment mainly in site selection, design and construction elements, bringing those elements with infrastructure together are the criteria emphasized in LEED for Neighbourhood development; they evaluate with a rating system that weights each category differently that could reach a total of 100 points.

The scoring system of LEED works with a basic required criterion that have to be met in order to certify a project, and the rest of the credits can give additional points to the total score to rate the certification. Unlike BREEAM that gives a weight to each category in connection with the other credits, LEED defines a series of criteria that is mandatory in order to classify the project as certified and also some more criteria that the project can or cannot fulfill. The definition of the points in each criterion is made according to the relevance and positive effect that generates in the project and its environment. (Getting to know LEED: Neighborhood Development, 2014)

The United Nation's Sustainable Development Goals are an update of the expired Development Millennium Goals, which were a compromise by several nations to act against extreme poverty, hunger and illiteracy up until 2015. In 2016, there was a new agreement, the launch of the 2030 agenda, called the sustainable development goals. The agenda calls countries to achieve 17 sustainable development goals for the next 15 years. The goals promote the ending of poverty and inequality in the world, simultaneously building economic growth and fighting climate change. The SDG's are presented as a guide for countries to develop policies in order to collaborate with the global commitments but is finally left to each government the development of plans, policies, and programmes.

Depending on why a place establishes necessary to measure and assess its sustainability, is mandatory to select a methodology capable of evaluating relevant criteria for the context; which is why a framework that has been developed in Latin-America effectively is chosen.

In this specific case, the methodology analysed to contextualize the framework is called ICES (Iniciativa Ciudades Emergentes y Sostenibles) because is an evaluation executed in multiple Latin-American cities to establish general critical criteria that have to be prioritized to improve living conditions in the city and develop strategies towards sustainable development.

The Methodologic guide ICES is a fast application methodology and diagnosis to help emergent cities the realization and application of an action plan that structure interventions to achieve their sustainability goals in the short, medium and long-term period developed by the Ibero-American Development Bank (BID). (Guía Metodológica Iniciativa Ciudades emergentes y sostenibles, 2016).

The proposed methodology to provide a new framework consists of three analytical phases followed with consulting the opinion of experts about the final proposed index in order to validate the investigation and analysis. The result will be an index of indicators classified in categories and criteria that works as a complement of the municipal expedient¹ which is the evaluation instrument of the POT. The main idea is to take as reference existing sustainability measurement frameworks to create one that can be adapted to the context of Cali, the city of study, considering the fact that no progress has been made regarding the orientation of urban projects towards sustainability outside its environmental dimension.

The comparison is made at a building level and a district/urban level, as the interest is to assess the progress of a city towards sustainability, therefore only the indicators at a district level will be taken into consideration. The indicators are divided into three categories that correspond to the three pillars of sustainability: environmental, economic and social.

2.1 Step 1

Development of step one, selection of the preliminary index consists of following phases:

- List categories of each methodology (BREEAM and LEED), weight distribution/ points;
- Define categories that relate to both methodologies;
- Classify indicators in the selected categories;
- Find links and similarities between indicators;
- Condense indicators by relations and criteria;
- Select mandatory and high weighted indicators.

The methodology development begins listing and analyzing every indicator in both methodologies (Is important to mention that each methodology has a different categorization and the indicators do not respond to the same definition, therefore not only what the methodologies name as indicators are considered, but also the criteria that the measurement has to fulfill.). In the selection of the categories was considered the ICES methodology, which is used in step 3 of the development of the framework to allow a more efficient organization from the beginning in correspondence with the last filter. The categories chosen from ICES are Environmental sustainability and climate change, Urban Sustainability and Fiscal sustainability and governability.

The 51 criteria from LEED-ND and the 53 from BREEAM are divided into five categories that respond to different topics, therefore the first thing to do in step 1 is to find the links between the indicators between both methodologies, as some of the indicators from one methodology could replace several from the other. One of the limitations of the investigation is the scale for which the indicators were designed, being

¹ Expedient Municipal of Cali. Is a system of urban information that comprehends documents, maps, data and georeferenced information that is used as an evaluation tool of the Land Use Plan (POT). (Alcaldia de Santiago de Cali- Expediente municipal, n.d.)

for both cases neighbourhood/urban small developments; since the resulted framework is to be applied in a city scale.

Multiple indicators relate to different categories from ICES as shown in **Error! Reference source not found.** (See Appendix). But what is considered for the final classification as a priority is the indicator that contains multiple from the other category. For example: the BREEAM indicator Safe and appealing streets relates to security but is contained in the mobility and transport category from LEED, for the classification is going into mobility and the same criteria applies for the rest of the indicators.

The output of step 1 is a single list of indicators classified in categories. The resulting categories from this step are apart from water and energy; waste, risk vulnerability, land-use, mobility and business, and employment.

2.2 Step 2

Development of step two; target definition in phases consists of following points:

- List categories and indicators;
- Define categories that relate to Goal 11;
- Find links and similarities between indicators and sub-indicators.

The target of the evaluation is to establish an effective measurement of sustainability in a city scale; due to this reason, the UN sustainable goals are used as a reference and specifically the Goal number 11: Sustainable cities and communities. This goal establishes the importance of accommodating the growing population in affordable and quality housing, public spaces green areas and efficient public transport encouraging sustainable urban planning and management. Consequently, the filter to the indicators from step 1 the targets and indicators from the UN's development goals are used.

The objective of giving a category to each target is to select only the categories from step 1 that contribute with goal 11 (

Figure 2). In addition, it is important to consider that the indicators proposed by the United Nations are more specific than the ones presented by BREEAM and LEED, thus are used as a complement description and definition of the sub-indicators.



Figure 2: Summarizing scheme of the methodological development.

There is an ongoing discussion about the efficacy and reach of the SDG's, (Spangenberg, 2016) argues that we should analyse further into the targets of the SDG since they are missing in addressing the causes of unsustainability and are focusing on changing unsustainable states and impacts. The strategies for the achievement of the targets are left unclear by the UN as is left to each government to implement legally binding standards to ensure the compliance of national policies that can favour sustainability. Also, create an economic environment that promotes rewards for institutions that contribute to sustainable development.

Hajer et al., (2015) states as well that SDG cannot be achieved in charge of intergovernmental organizations, but be mobilized by new agents such as business, cities and civil society. Concluding that SGD can be a tool to guide governments into a vision that promotes sustainable development and be applied to introduce effective policies that represent an advantage to work towards sustainable development.

The result of this step shows a table of indicators that measure sustainability in a neighborhood or city scale and is related only to the UN's goal 11, but still lacks relation with the context of the case study, as mentioned before is important to increase the accuracy of the assessment.

2.3 Step 3

Development of step three, contextualization of the indicators in Latin-American cities consists of following phases:

- Explain and understand the definitions of the ICES methodology's indicators;
- Define fundamental issues for Latin-American cities according to the methodology;
- List indicators from ICES that are related to the categories selected in step 2;
- Complete indicators assessment criteria.

Contextualization of the indicators in the city, based on the assessment framework ICES, completing the table of indicators resultant from step 2.

As the ICES methodology's indicators are aimed to evaluate and rate the progress of a city and prioritise the projects that should be executed are specific and focus on the fulfillment of people's basic needs to ensure the quality of life that the city and local government should provide. Thus, the indicators work to define the focus of the measurements of the criteria from the steps before.

The result of the last step is a table that still lacks definition in the categories that contain multiple criteria and the indicators are not included in the ICES methodology, therefore is completed with the indicators and criteria from each methodology from step 1.

To achieve a more feasible index of indicators the developed one was complemented with extra information to clarify the availability of data or how to collect it when is not available. The extra criteria were: Assessment method, Parameter for assessment and Type of calculation (Qualitative or Quantitative).

2.4 Case study

The methodology is applied in Cali, Colombia considering that there has been from little to no progress regarding the compromises that were taken by the nation regarding sustainable development in 2016 and the articulation of existent policies with an updated framework that can be implemented with the current urban development policies. Cali is a middle-sized city and the third most populated of the country with 2'400.000 inh. Located in the southeast of Colombia. Officially named Special District and main city in a metropolitan area of more than 3million inhabitants.

Sustainability being a concept so hard to define and specify is left to interpretation, and when is combined with development it's focus changes progressively to economic development rather than overall sustainability (Verma & Raghubanshi, 2018). For this motive, the definition presented in Colombian law should be consequent with every policy related to sustainability. Sustainable development in Colombia revolves around the idea of economic growth since the concept was introduced globally in the '80s, as it became evident that industrialization started damaging significantly natural resources and environments. Sustainable development was defined by the Law of 1993 art.3 as the leader to economic growth, elevation of quality of life, social wellbeing, without the exhaustion of renewable resources in which is grounded, nor the deterioration of the environment or as the right of future generations to use them to satisfy their own needs (Sánchez Pérez, 2002). Even though the concept of sustainability was introduced in planning instruments and normativity since 1993, it was not until the 2000's that policies were officially introduced by CONPES (The superior organ in charge of the planning the development of the country).

A problematic with the correct functioning of this institutions is that following the procedures specified the articulation between the legislation in a national scale and those on a territorial scale are not clarified or verified. As the law is based mainly on the natural areas declared important to the conservation of the environment nationally, lacking criteria and guidance when establishing planning policies in the city scale, which is the most important for actual quality of life improvement and application of sustainable strategies.

It is mandatory to consider that the instrument strictly related to land-use policies is the territorial ordinance plan (POT), which is renovated every 12 years (Period that is still discussed if is pertinent, given that is where projects at medium and long-term are stipulated and could take an execution time of more than 15 years) **Error! Reference source not found.**, consequently, is just being developed in smaller scaled cities, with a lower amount of inhabitants. There is an instrument designated to assess the fulfillment and progress of the projects presented in the POT, called the "Expedient Municipal" (Municipal record), in this respect, the indicators designated to assess the progress and development of the city are registered there.

The indicators published by the municipal records aim to show in a measurable form the complex dynamics in the occupation of the territory, display them in a way that is easy to comprehend and be useful to provide information about the tendencies of municipal development. The indicators are centralized in the site of the System of Social Indicators (SIS).



Figure 3: Scheme of the duration of the validity of planning tools in Colombia.

3. Results and Discussion

As shown in Table 1, the result of the methodology contains 23 indicators to measure sustainability regarding the Sustainable Development Goal #11.

Table 1 Indicators to measure sustainability in Cali.

TOPIC	CATEGORY	INDICATORS	DEFINITION	UNIT	QUANTITATIVE OR QUALITATIVE	
WASTE	Solid Waste Management	Meet waste disposal demand	Proportion of urban solid waste regularly collected and with adequate final discharge out of total urban solid waste generated, in the city.	Percentage	Quantitative	
		Solid waste treatment	Solid waste in the city that are composed Solid waste in the city sorted out and classified for recycling	Percentage Percentage	Quantitative Quantitative	
		Reduce waste production from construction		N.*	Quantitative	
RISK VULNERABILITY	Management of risks	Risk management and assessment	Number of deaths, missing persons and persons affected by disaster per 100,000 people. Direct disaster economic loss in relation to global GDP, including disaster damage to critical infrastructure and disruption of basic services. Percentage of homes in risk because of inadequate construction or located in a non mitigable risk area Fundamental infrastructure in risk situation because of inadequate construction or located in a non mitigable risk area	Deaths/100.inh Economic loss/Global GDP Percentage Percentage	Quantitative Quantitative Quantitative Quantitative	
		Housing provision	Meet housing demand	Proportion of urban population living in slums, informal settlements or inadequate housing Quantitative housing deficit	Percentage Percentage	Quantitative Quantitative
			Housing affordability	Proportion of new rental and/or for sale dwelling units for households with less than the median income	Percentage	Quantitative
			Demographic needs and priorities	Access to green suitable green spaces	Green areas for every 100.000 inhabitants	ha/ 100.000 inh
Access to suitable public spaces	Average share of the built-up area of cities that is open space for public use for all, by sex, age and persons with disabilities. Public spaces for every 100.000 inhabitants	Percentage ha/ 100.000 inh		Quantitative Quantitative		
Jobs availability	Unemployment rate Ratio of jobs by home	Percentage Ratio		Quantitative Quantitative		
Delivery of services and facilities	Mixed-use neighborhoods Essential facilities are provided and located within walking distance distributed in the city			Qualitative Quantitative		
Ensure urban safety	Percentage of citizens that feel safe Amount of thefts for every 100.000 inhabitants	Percentage Thefts/100.00 inh		Qualitative Quantitative		
Inclusive design	Number of sectors that have participation in which exists citizens participation in the formulation of public policies			Quantitative		
Land-use strategy	Compact development	Ratio of land consumption rate to population growth rate.		Ratio	Quantitative	
		Annual rate of the urban print growth	Percentage	Quantitative		
Utilities	Meet public services demand	Percentage of houses with connection to the municipal water network	Percentage	Quantitative		
		Percentage of houses with connection to the municipal sewage system	Percentage	Quantitative		
		Percentage of houses with connection to municipal electric power	Percentage	Quantitative		
Enhancement of ecological value	Protect existing natural habitats	Ensure the protection of natural existing habitats and mitigate negative impacts		Qualitative		
MOBILITY	Transport assessment	Meet transport demand	Planning and management transport system		Qualitative	
		Access to public transport	Proportion of population that has convenient access to public transport, by sex, age and persons with disabilities.	Percentage	Quantitative	
			Affordability index	Percentage	Quantitative	
		Public transport facilities	System of transport planning and management		Qualitative	
		Cycling network	Connected, efficient and safe cycling network		Qualitative	
	Kilometers of cycling roads for every 100.000 inhabitants		km	Quantitative		
	Access to quality transit	Transit facilities	Adequate provision of cyclist facilities (Storage, permits, maintenance)		Qualitative	
Reduce vehicle distance traveled				Quantitative		
Walkable streets	Safe and appealing streets	Kilometers of pavements and pedestrian paths for every 100.000 inhabitants	km	Quantitative		
ENVIRONMENTAL	Air Quality	Concentration of air pollutants	Air quality Index	N.*	Quantitative	
			Concentration of PM10	µg/m3 media in 24h	Quantitative	

From Step 2
From ICES

TOPIC	CATEGORY	PARAMETER	NOTES	DATA AVAILABILITY
WASTE	Solid Waste Management	Ratio of solid waste collected in the city by the amount correctly disposed	Discharged in landfill with an adequate treatment of leachate and gases	Easy
		Ratio of solid waste discharged by SW composted		Hard
		Ratio of solid waste discharged by SW recycled		Hard
		Difference of amount of waste produced from construction		Hard
RISK VULNERABILITY	Management of risks	Number of deaths and missing people by every 100.000 inhabitants		Medium
		Ratio of economic loss by the global GDP		Hard
		Ratio of homes in risk by the total homes	Homes in risk because of insecure roofs, floor or walls or located in a risk area	Hard
		Percentage of vulnerable public fundamental infrastructure to natural disasters		Medium
LAND-USE	Housing provision	Percentage of houses in inferior conditions to the habitability standards lower than the ones established (Number of homes-Number of houses)/Number of homes		Exists/Medium
		Percentage of new rental or for sale houses priced for households earning more than the AMI (Area medium income)		Easy
		Hectares of green permanent space for every 100.00 inhabitants		Easy
	Demographic needs and priorities	Average proportion of the built area dedicated to open public spaces disaggregated by sex, age and people with disabilities		Medium
		Hectares of opened public space for every 100.000 inhabitants		Easy
		Total of unemployed people by the total of the workforce	Annual rate. The rate represents the percentage of people looking for a job	Medium
		Number of jobs opportunities	Data of employment (sectors, buissiness, income, unempoyment)	Medium
		Ensure mixed-uses in the implementation of planning policies	The aim is to reduce vehicle distance traveled and automobile dependance	Hard
		Ensure the existance of basic need facilities within walking distance in every neighborhood		Hard
		Percentage of inhabitants that feel safe or very safe		Hard
		Amount of thefts for every 100.000 inhabitants	Disregarded in violent and non violent	Medium
	Existence of a policy framework that supports and ensures public participation in urban planning and execution/evaluation of projects			Medium
	Land-use strategy	Ratio of the rate of land consumption and the rate of population growth		Medium
		Ratio of the annual rate of the growth of the urban print within the legal limits of the city		Medium
	Utilities	Ratio of houses conneted to the municipal water network/Number of houses		Easy
Ratio of houses conneted to the municipal sewage system/Number of houses			Easy	
Ratio of houses conneted to the municipal electric power/Number of houses			Easy	
Enhancement of ecological value	Creation, protection and enchancement of wildlife corridors linking existent wildlife habitats		Easy	
MOBILITY	Transport assessment	Existence of a planning and management of a public transport system	*Note 1	Easy
				Medium
		(Amount of trips in the month by person x Average cost of the trip)/ Income of the lowest income quintile		Easy
		Availability of facilities for the development of the management of public transport		Easy
		Total of linear kms of byclicle paths inside the city expresed as kms by every 100.000 inh		Medium
	Promote cycling by the provision of cycling facilities	Parking and storage spaces	Easy	
	Access to quality transit			Medium
		Encourage multimodal transportation developments and a well connected network		Hard
Walkable streets	Total of linear kms of pedestrian paths inside the city expresed as kms by every 100.000 inh		Medium	
ENVIRONMENTAL	Air Quality	$I = \frac{I_{high} - I_{low}}{C_{high} - C_{low}} (C - C_{low}) + I_{low}$		Exists/easy
		Concentration of particles in suspension with a diameter inferior to 10µm in an average of 24h		Exists/easy

The generated framework was thought to measure in a city scale. Even though the aim of the assessment is to create an interaction between the scales of application of strategies of sustainable development, the city scale is the focal point for the creation of policies, development of projects, effective generation and distribution of economic resources and more efficient monitoring. For instance, the regional scale not very relevant considering that the governing authorities have minimal influence on urban policies. The articulation of scales in this case is proposed as a modification of the model of territory that is proposed in the different instruments of urban development. Focusing on the sustainable development goals as the guiding thread of the revision of the current regulations, proposal of new regulation documents and the center of discussion when the topic is which is the future of the city.

After the comparison of sustainability assessment frameworks, filtering of indicators and contextualization of the resulting framework in this case in Cali, Colombia the final table is divided into 5 topics: Waste, Risk vulnerability, Land-use, Mobility and Environment, where the topic that contains the most indicators is land-use meaning that the major influence in the framework is the design and management of the urban environment.

In step 3, when the filter of indicators was made, simultaneously the indicators from the municipal record were also filtered with the criteria of the indicators of SDG 11. The result of this filter was that only three indicators from the municipal record can measure sustainability supported on goal 11; those indicators were: Demand of public transport, settlements located in risk areas, volume of solid waste produced in the day, houses with access to the waste collection system, air quality index, concentration of PM10 and effective public space. This filter at this stage shows how important the contextualization of the framework because otherwise means that the municipal record has little to no relation to the sustainable development goals and does not have either enough information for an effective assessment of sustainability.

One of the most important aspects of the proposal of the framework was to incorporate it into the existent policies and assessment methodologies, to make it easier to implement and avoid creating the necessity of creating new entities.

After the analysis of the case study and the revision of the results of the methodology, there is a lack of coherence and clarity between the models of development that is proposed by the multiple planning and management instruments as well as a clear manifestation of the importance of the consideration of sustainable strategies to adjust current projects and to edit the factor for future developments.

The first step to develop a sustainability strategy is to establish a common goal between municipal Land-use plans, regional and municipal development plans and communication with the national plan. Consequently, the proposal aims to establish a strategy based of sustainable development since Colombia has already set up sustainable goals to be fulfilled by 2030, however the legal tool to route the projects that are proposed in the POT is the revision and adjustment that is made in the short term.

4. Conclusions

The methodology consists in the development of three steps that result in a final framework of assessment of sustainability based in SDG 11. The steps are the review of existing sustainability assessment tools like LEED-ND, BREEAM for Communities and the ICES methodology in order to obtain as a result a list of indicators that are contextualized in concordance with the case study.

The case study is Cali, Colombia, which is a middle-sized Latin-American city with almost 3 million inhabitants; characterized for its favorable geographic and natural conditions give it a major advantage for it economic and industrial development, which still needs a boost that favors equally investors, owners, clients and inhabitants. Considering sustainable development proposals and policies the best alternative to develop the city and enhancing the natural values that possesses. The tools that can support and encourage the proposal and implementation of ideas for sustainable development are the POT which is the local land-use plan and the municipal record, where indicators are used to measure the effectiveness and accuracy of the projects presented in the POT.

For further developments, the proposal is to encourage local authorities and entities to invest in proposals for urban planning that is focused on sustainable development. The first step to route policy-making towards sustainable proposals needs to be done and consider sustainability as a concern that affects all the dimensions in a city and not only the new construction of an individual building or residential compounds.

Also, the application of the framework in multiple case studies can help determine the factors and indicators that can be standardised, and which need to be analysed within a context, like the articulation of the indicators in a current policies regulation plan or to generate alternatives to introduce the measurement of sustainability in the urban development of the cities.

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Appendix

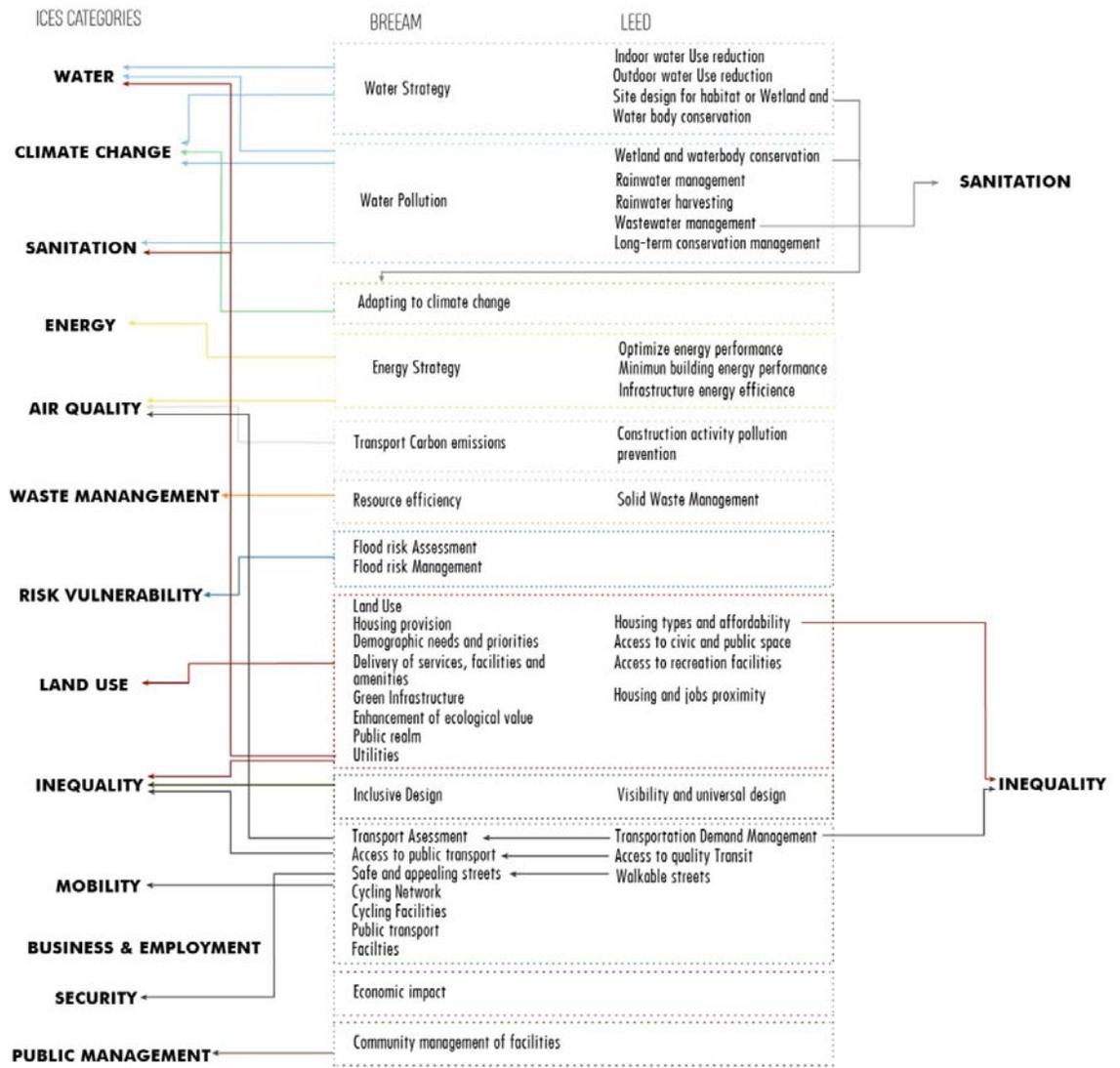


Figure 3: Scheme of links between categories and indicators from LEED and BREEAM.

Smart and Green Infrastructure for Future Cities

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Abstract

The Smart City agenda aims to use technology and large data systems to assist in making decisions and create networks, sensors and instant data that can modify processes through the city. For the environment, this means providing potential solutions to inefficiencies in using energy, water and other resources. Smart technology in cities can contribute to smart pricing (water, energy, parking etc.) and drainage systems, smart energy grid systems, transport and communication efficiencies. Coupled with Green Infrastructure ecosystems that enhance the resilience, long-term sustainability and the well-being of city dwellers, the solutions will have the potential to face up to many challenges of the future cities. Currently the Smart and Green Infrastructure agendas run parallel and a slight disconnect between the two exists as they operate independently. The need for more research in integrating smart and green has been identified to reduce risk, uncertainties and make it mainstream. This paper presents the case for integrating smart green infrastructure components into existing urban infrastructure assets to improve their resilience in withstanding extreme weather effects. A broad-ranging literature review of stakeholder reports, case studies and action plans provide the foundation and an understanding of the wider context and the debate. The paper also identifies current practice, drivers of challenges and opportunities. The findings will benefit many stakeholders who are responsible for implementation of smart green infrastructure strategies, as the challenge of the Future City is to combine green infrastructure into the high-tech world of the smart city agenda.

Keywords: Smart and Green Infrastructure, Future Cities, Green Infrastructure, Smart Infrastructure, Urban City Resilience, Infrastructure Components

1. Introduction

The introduction and use of new technology and large data systems allow the potential to use Smart and Green solutions to manage storm-water, flooding, pollution and rising temperatures, as well as to improve the look and feel of future cities. Smart Green Infrastructure (SGI) can be perceived as integrated infrastructure solutions where smart technology and IT systems are combined with green and blue (water) nature based features to solve complex urban and environmental challenges. 'Smart City' agendas use technology and big data systems to assist in decision-making and creating networks for monitoring and modifying processes throughout the city. Smart technology in cities can contribute to smart pricing of many public services, drainage and smart energy systems, mobility and transport services and communication efficiencies. Combined with nature-based ecosystems that enhance the resilience, long-term sustainability and the well being of city dwellers, these solutions have the potential to address future urban city challenges.

Currently, smart and green infrastructure agendas run in parallel, mainly independently. The capability of smart networks to collect and monitor data on a large scale could prove crucial in identifying issues and improvements linked to the performance of GI components, bridging this gap and forming an essential tool for future smart green city planning. The real time data generated will help inform energy efficiency and savings, water efficiency and storage, minimise pollution and improve biodiversity. Additionally, feedback on functions and performances of green buildings will help planners, facility managers, estate managers and the construction industry to come together to improve SGI development for future cities. Implementing nature-based solutions are becoming a key approach in dealing with urban problems and challenges, such as those associated with storm water, flooding, air pollution and bio-diversity in cities across the world (Hodgins, 2017).

Green city and smart city are two themes that contain distinctive but often overlapping attributes (Chan et al 2018). Cities either focused on nature based solutions or innovate to incorporate smart solutions. This paper explores how combined smart and green infrastructure solutions that exploit nature and technology can help transform cities, providing significant environmental and socio-economic

benefits whilst making cities more resilient, healthier places to live. It examines how integrating SGI components into existing and new urban infrastructure assets can improve their resilience in withstanding extreme weather effects due to climate change. The aim is to identify the infrastructure systems and elements that can benefit from the incorporation of smart and green GI components in improving urban resilience. It will examine how infrastructure providers can collaborate with both individuals and related agencies to boost the capabilities of infrastructure systems, greatly influencing social, economic and community resilience. A broad-ranging literature review including research papers, government and other stakeholder reports, case studies and action plans inform the paper's wider context. The methodology is based on both primary and secondary data sources and information captured from different case studies carried out in the UK and abroad. This study synthesizes the information and these findings to identify how combined smart and green can mitigate the damages caused by extreme weather events. It provides an insight into how mitigation strategies adopted through an integrated nature and smart based solutions combining green infrastructure with the high-tech world can help future-proof infrastructure systems, and protect the urban populations and biodiversity of a locality as a whole.

2. The Concept of Smart and Green City

A 'smart' city is defined as an innovative city that uses information and communication technologies to improve quality of life, the efficiency of its urban operations and services, and competitiveness, while ensuring that the needs of present and future generations will be met with respect to economic, social and environmental aspects (ITU-T, Report, 2014). It is necessary that cities become "smarter" to respond to the numerous challenges in the 21st century, which include environmental degradation, limited resources, urban migration and climate change (Crnčević et al, 2017). In the context of climate change, green infrastructure (GI) has an important role in reducing the need for energy, providing ambient cooling effects, reducing floods at the local level, restoring local groundwater reserves, and allowing the soil to absorb acidity. 'Smart environments' (GD IP Directorate, 2014) description includes smart energy including renewables; ICT enabled energy grids, metering, pollution control and monitoring, the renovation of buildings and amenities, green buildings and green urban planning, as well as the efficient use and reuse of resources and resource substitution to serve the above goals. Therefore, green infrastructure planning, greening of the environment and the use of related IT contribute towards achieving climate-smart cities by means of adaptation measures and limited but still important mitigation measures (Cvejić et al., 2011).

Green Infrastructure typically refers to the interconnected network of multifunctional green spaces strategically planned and managed to provide a range of ecological, social, and economic benefits (Tzoulas et al., 2007; Wright, 2011). Examples of green infrastructure include green roofs, walls, permeable vegetated surfaces, green alleys and streets, urban forests, public parks, community gardens and urban wetlands (Foster et al, 2011). Scholars recognise that GI offer improvements to the health and wellbeing of urban inhabitants as well as better methods for sourcing food, reducing wind speeds, storm-water run-off, modulating ambient temperatures, efficient energy use and carbon sequestration, amongst other ecosystem service benefits (Mell, 2013; Roy et al, 2012). GI also holds potential in mitigating many of the anticipated impacts of climate change (Brown et al, 2015), providing a better conceptual framework for balancing manmade infrastructures with natural ecosystems (Wang et al, 2018).

In next generation 'smart' city, monitoring of everything from traffic flow to household waste will be networked and responsive (Carter, 2013). Many large technology companies are adding robust information technology infrastructures to power emerging feedback systems. These smart-grid networks will become increasingly responsive in allocating electricity in response to demand or public transport systems that respond to congestion by allocating buses where people are congregating or changing lights automatically based on traffic patterns (Carter, 2013). Hi-tech operations centres are also needed, where public safety responses to infrastructure failures such as building collapses or flooding can be quickly identified, analysed and disseminated to both technical specialists and the general public.

3. Climate Change and Infrastructure Resilience

The literature highlighted substantial amounts of research into the impact of a wide range of natural hazards, including snow, ice, rain, fog, wind and heat, on infrastructure (Kaluarachchi, 2017). These studies span events of different spatial scale and magnitude and include results from a number of different countries. The increased frequency of flooding is the most significant climate change risk to UK

infrastructure including transport, energy, communications and services, resulting in lengthy and expensive repairs averaging an estimated £1 billion per year in the UK (DEFRA, 2012). 'A large number of assets (17% of railway tracks and 16% of railway stations, 9% of A-roads and motorways) are in locations which are prone to river or coastal, ground or surface flooding and it is projected that this risk will increase. Future Climate Change predications involving 4°C of global warming by the 2080s imply large increases in possible flood damage in UK. This scenario would lead the 2,400km of the UK rail network vulnerable to flooding rising by 120% by the 2080s' (CCC, 2017a).

Rainfall intensity has repeatedly been shown to be a factor in transport disruption, reducing driver visibility, and reduced speeds. More intense rainfall will also increase sewer-flooding events. Rising sea levels of 0.5–1m by the end of the century will increase the proportion of assets vulnerable to coastal flooding. The need to realign coastal defenses in some areas in response to rising sea levels will have implications for infrastructure assets in the coastal zone, increasing their annual cost of maintenance (Kaluvarachchi, 2017). In order to address these major issues the government has created a long-term statutory framework for assessing and managing the risks to the UK from the changing climate. The Act requires the Government to assess the risks and opportunities relevant to the UK every five years and present a report to Parliament. As a result of these assessments priorities for further action and research have been identified (CCC, 2017b). Promoting and incorporating SGI components in urban development can contribute significantly in this process climate proofing future cities.

4. *Advantages of Smart and Green*

Current urban infrastructure systems are expected to be robust, resilient and adaptable to changing patterns and capable of being optimised in terms of efficiency, cost, low carbon footprint and service quality. In order to face major challenges such as climate change or biodiversity loss, there must be a development of synergies between the three sustainability dimensions; socio, economic and environmental to achieve smart and green cities (Kaluvarachchi, 2019). Cities can benefit enormously from being 'smart', which involves the innovative use of emerging technologies in sensor and data management (Mair, 2015). In order to be truly sustainable, future infrastructure systems will need to be able to anticipate and be proactive to respond correctly, not only to short-term local conditions, but long-term, global phenomena such as extreme weather impacts. Much like an ecosystem, these will contain many small-scale, networked elements that serve a multitude of uses, rather than one single guiding purpose for their existence (Carter, 2013).

Green infrastructure (GI) has clear links to natural capital that refers to valuable elements of the natural environment and when managed well, can reap the wide-ranging economic benefits that natural assets provide. GI is often cost effective, resilient and capable of delivering multiple benefits and meeting objectives across social, environmental and economic themes. Incorporating well designed, managed and maintained GI into strategic infrastructure assets can improve resilience, increase its efficiency and performance and deliver improved return on investment (Kaluvarachchi, 2019). In relation to GI, Within the process of creating climate-smart cities, the domains of ICT applications and improvements include: public space and utility services management, informing citizens and involving them in decision-making processes, the ability to perform various online activities (overlapping with economic needs) and similar. One of the applications of ICT is in the Geographic Information System (GIS), which can integrate data from various sources and therefore can be very helpful while "converting a city into a smart or green city" (Rehmat, 2016). The GIS is a computer-aided system for collecting, editing, storing, modeling and analyzing data, used for its alphanumeric and graphical presentation (Crncevic et al, 2017). Other novel technologies that promote smart and green infrastructure in cities include fibre optics, wireless sensor networks, low power sensors based on micro electro mechanical systems (MEMS), computer vision and energy harvesting (Mair, 2015).

Being in the midst of a digital revolution, big data has a hugely important part to play in the design, development and management of future smart cities. New sensor technologies are capable of producing vast amounts of new and important data to provide new understanding, streamlining and health monitoring of a nation's city infrastructure. However, this data needs to be managed in an integrated way, and new Smart City Standards must be developed. These standards will help to develop the market for smart city products and services and how these can be used to enable cities to become smarter by continuous improvement. Transparency, privacy and data protection are other wider criteria that will have to be managed to achieve a smart city governance standard.

Besides GIS analysis making the density of the grey infrastructure visible, mapping green roofs at a small scale, surveying residents to assess and access different patterns of built-up sites or new

technologies could be applied through the smart-compact-green city frameworks (Crnčević et al, 2017). Smart Planning systems will be able to share knowledge and data to strategically manage growth and innovation by interconnecting with other urban development departments, local authorities, residents and businesses. ICT, big data analytics offer the possibility to be more transparent, accountable, using resources more effectively and empowering and educating citizens through interactive platforms and applications used to engage all stakeholders in the decision making process in relation to their environment (Crnčević et al 2017, Albino et al., 2015).

These technologies have the capability to face the global challenges leading to considerably enhanced efficiencies, economies, resilience and adaptability benefiting not just the construction industry but also the wider society served by its infrastructure. Emerging technologies can also be applied to advanced health monitoring of existing critical infrastructure assets in cities to quantify and define the extent of ageing and the consequent remaining design life of infrastructure, thereby ensuring resilience and reducing the risk of failure. The latest sensor technologies can also transform the industry through a whole-life approach to achieving sustainability in construction and infrastructure in an integrated way (Mair 2015).

5. Use of Innovative Smart Green Systems

5.1 Storm Water Management

Climate change impact has caused extreme weather resulting in unexpected torrential rain and one of the challenges is storm water management where buildings, roads, hard surfaces drain excessive water loads to sewer systems. The sewer systems are not able to handle large increases in the rainfall and it either ends up as an overflow into the rivers, which causes pollution, raised water levels and related flooding or backs up into basements in buildings causing severe floods (Kaluarachchi, 2017). Green spaces, being covered in vegetation and soil systems, act like sponges to soak up rainwater, reduce the volume and rate of run-off and play a key role in sustainable urban water drainage. It is stated, 'the rate of run-off for surfaces with trees and grass is estimated to be 10 to 20%, compared with 60 to 70% for 'hard' urban areas' (Natural England, 2015). Incorporation of green ways, landscapes and wetlands that can absorb flood water, improve biodiversity and provide additional recreational areas for the local population and promote and develop healthy and multi-functional spaces can contribute to environmental, economic and social well being of communities. Sensors and electronic gauges that can monitor the sewer systems and alternate pipe systems can contribute to controlling storm water management. For example, urban community garden plots provide food for urban dwellers and serve as components of storm water management systems, allowing water and waste to be recycled at the smallest scale with real-time sensors telling the centralised system how much less will have to be processed downstream (Carter, 2013). Smart and intelligent processes could also include instrumentation, ultrasonic flow and level measurement, and smart data loggers for monitoring water levels.

5.2 Flood water Management Systems

Flooding is the most significant climate change risk to UK infrastructure and assets and according to UK Climate Change Risk Assessment (2017); the number of assets exposed could double under expected changes in climate by the 2080s. The most common sources of flooding include: river flooding, coastal flooding, surface water flooding and groundwater flooding (CCC, 2017b). Rain runoffs quickly undermine structures such as dams, railroad beds, bridges, and buildings. In the future, tunnels may become more vulnerable, both because the risk of their entrances and vents flooding will be greater, and because the hydraulic pressure on the tunnel walls increases as water tables rise (Titus, 2002). Built up urban areas need to be drained to remove surface water quickly, but the impermeability of many built surfaces raises the probability of flash floods. Green roofs, green drainage options, sustainable vegetation management, water channels to improve green drainage and flood management, woodland corridors, green and open spaces incorporated in urban landscapes combined with smart sensors and valves for automated solutions, soft opening and closing vent systems that are controlled by smart technologies are applications that can be utilised in flood management systems (Kaluarachchi, 2019). It has now become significant to shift from individual monitoring and prediction frameworks to smart flood prediction systems with the help of recent technological advancements. Internet of Things (IoT) is a technology that is a combination of embedded system hardware and wireless communication network which further

transfers sensor data to computing device for analysis in real-time (Bande et al, 2017)

5.3 Costal Infrastructure Management Systems

Storm surges and rising sea levels pose a major threat to coastal infrastructure as well as cause sea erosion. Solutions will need to focus on future sea level rise driven by climate change and the infrastructure necessary to protect these cities from future flooding. Conventional infrastructure repairs have used a robust engineering approach, elevating hard floodwalls to predicted future sea levels, and strengthening levees to protect against more frequent and intense storm surges. Progressive coastal infrastructure proposals include designs relying heavily on natural wetland and "green" solutions. These can buffer and adapt to the disturbances through time, letting ecological processes respond, shift, and adjust to each intervention rather than creating stiffer, man-made armour. Building Information Modelling and other modelling and simulation techniques provide a greater understanding of how the new structures would interact with the existing environment. Robots and drones used for surveys provide data for modelling the foreshore and seabed and how they will behave in costal storm surges.

5.4 Waste Management

Smart green management concepts can be applied to urban waste, where rather than moving water and solid waste away from human settlements they could be treated as resource flows, treated and reconnected to other essential city services. This is already implemented in some cities where wastewater has been converted into drinking water (Southern California), and is known to be potentially cleaner than snowmelt (Carter, 2013). The implementation of smart urban waste management will allow a more efficient waste collection and optimising the way in which it is performed encouraging people to produce less waste and move more towards recycling. The Internet of Things (IoT) empowers comprehensive data collection of information on a complex and more precision way than ever before. In the "Smart Urban Waste Management" application scenario garbage collection can be optimized e.g. in terms of route optimization based on fill levels. Empty bins are bypassed, full bins are emptied, and broken bins can be repaired quickly (Anwar, 2018).

5.5 Smart energy Networks

With the desire to increase the use of renewable energy sources and reduce electricity consumption, smart grids and meters are implemented in UK and worldwide. In UK, Smart grids are 'expected to enhance energy security and integration of low-carbon technologies and green technologies, and take a step further towards an affordable, low carbon energy system to reduce the overall costs for consumers' (DfBEIS, 2014). Key ICTs elements will include sensing and monitoring technologies for power flows; digital communications infrastructure to transmit data across the grid; smart meters with in-home display to inform energy usage; coordination, control and automation systems to aggregate and process various data, and to create a highly interactive, responsive electricity grid that can maintain a demand-supply balance on a second-by-second basis. To achieve significant advantages over traditional communication technologies, smart grid also involves collaboration with Wireless Sensor Networks (WSNs). WSNs can enhance various aspects of today's electric power systems that include generation, delivery, and utilization (Goel, 2015). Wireless options are easy to implement and enjoy wide support but present security concerns that could be compromised to disable and damage the infrastructure of the system.

5.6 Transportation and mobility

The rise of e-commerce, e-business and various on-line services have changed the way people move in a city from urban mobility to smart mobility. The rapid development of ICT and subsequent ICT-enabled transport services has huge potential to turn new urban mobility concepts into realities at an amazing speed and scale and they can help avoid or reduce the volume of motorized traffic. New business models associated with smart urban transportation systems will have to face new governance challenges in the successful transition from old urban transportation systems to more innovative, smart, urban mobility systems that are sustainable. These will also include integrated ticketing, ride sharing and peer-to-peer services, integrated scheduling, driverless vehicles, smart parking systems etc. Examples include: Zipcar, an ICT-enabled car sharing service provider in USA; the Walkable City concept

(implemented in New York and other cities); smart bike sharing systems; Leap in San Francisco (an ICT-enabled on-demand transit service) and Uber (an ICT-enabled ride-sharing service) that have enabled many people to enjoy an urban lifestyle without owning a private vehicle (Fang, 2015). The long-term sustainable city concept must be to promote walking, cycling and use of public transport to create liveable healthy cities with minimum pollution and congestion.

5.7 Recreational Spaces.

Park-like wetlands created for hurricane and flood mitigation can be incorporated as blue (water based) and green to existing infrastructure (grey) to benefit well-being of communities. Many of the drainage and storm water controlling practices, like rain gardens or green roofs, have aesthetic values which can be used for multi functional urban recreational spaces and combining these elements with smart mobility networks and functions create more accessible connections in future cities. Smart recreational areas can use technology (environmental, digital and materials) to reflect and fit within their cultural and environmental surroundings. Smart irrigation controllers for water use and maintenance, interactive play structures and areas that use multi cultural customisable software to meet community needs accessible to disabled children, energy-generating exercise equipment, automatic lawn mowers and other maintenance equipment and intelligent lighting systems that improve security (Jessup, 2018) are some of these smart and green infrastructure components that can be applied.

5.8 Asset Management

Monitoring and feedback data systems are essential for cities aspiring to be smart and green to accurately measure conditions and respond to future scenarios. Sensors and technological controls embedded within existing retrofitted and new infrastructure components could monitor conditions and provide real-time feedback in case modifications are needed. Companies are adding robust information technology infrastructure to power these emerging feedback systems. With many achievable benefits, a convincing case is made for using sensing and data analysis to enable smarter, proactive asset management decision-making for city infrastructure. A system of sensors, platforms and applications that automatically collects, analyses and reports on data is radically changing the way stakeholders manage infrastructure assets. Being proactive, not reactive, enables maintenance, inspection and refurbishment programmes for city infrastructure assets to be developed, focusing on condition and preventive maintenance. It is essential to capture and analyse the right data at the right time for city asset management decisions to be effective (Mair, 2015).

6. Conclusions

It is a challenge to achieve smart and green cities in contemporary urban design and planning practices due to the two agendas working independently. The applications and benefits can be vital in achieving the balance between nature-based solutions and reliance on technology that is required for many challenges in future cities. There is also renewed interest in promoting citizen's health, well-being and quality of life and integrated smart, green and nature based urban environments could well be the solution. In the past, infrastructure designs solved one particular problem for an isolated part of a larger system. The study found that this concept has now shifted from single-function to multifunctional infrastructure systems. It is a fundamental rethink and the networked nature of future smart green cities will allow infrastructure to cross sectors. There is also an urgent need to repair and restore out-dated infrastructure in many cities, which could be used as an opportunity to incorporate smart green technology and components

In order to achieve the required transformational impact, individual and collective smart and green infrastructure systems must be incorporated to development standards and regulations at strategic government policy level to achieve resilient urban futures. Widely used, user friendly, flexible modern technological systems could support more informed decision making around urban resilience setting requirements for new building developments and in designing new facilities. Joint up thinking, policies and strategies, the pooling of resources, investment in stable and robust smart green infrastructure via new design standards and codes and collaborative working appear essential to moving forward with the sustainable future city agenda. The smart networks are becoming increasingly responsive to stakeholder requirements and more research and development in areas such as the economics of climate change

adaptation, metrics, systems; networks modeling, sensor technology and simulations, spatial decision tools and funding sources are needed.

The study found that many cities are implementing green drainage systems to reduce local flooding and incorporate sensor systems to monitor water levels in storm water management. In modern flood management systems response time is reduced and actions are greatly enhanced by implementing IoT technology in real-time. BIM, Simulation and Virtual reality technology illustrate how systems can work or fail in a given extreme weather scenario providing valuable information in adapting to such events. Smart waste management systems have increased recycling and re-use independently and collectively. Smart grid networks enhance energy security and integration of low-carbon technologies and green technologies and more innovative, smart, urban mobility systems that include integrated ticketing, scheduling, smart parking systems are common to see. Monitoring and feedback data systems are essential to accurately measure conditions and respond to future scenarios and companies are adding robust information technology infrastructure to power these systems. The real measure of its success will be bringing all stakeholders at different level into the process with a changed mindset; and the major challenge, maintaining a united approach that balances the needs of all sectors and integrates different systemic requirements to promote effective collaboration.

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Supporting the Growth and Development of SMEs in Kingdom of Bahrain

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Abstract

In light of OECD statistics, private SMEs represent over 95% of all organizations outside the essential agriculture sector, establish a noteworthy wellspring of business and create critical residential and send out income in transition and developing countries. Clearly, improving the competitiveness of SME could add to monetary and social advancement and neediness decrease in those countries. The Kingdom of Bahrain is considered to be a regional hub for the development of small and medium-sized enterprises, which contributed to improving its ranking in many international indices. It ranked third in the Arab world and twenty-ninth globally in the index issued by the American Institute for Entrepreneurship and Entrepreneurship Development 2016. However, small and medium-sized problems at the current stage encounter three main challenges: First, the challenge of economic stagnation and weak demand for national products and services due to low income and lack of liquidity flow. The second challenge is the rise and diversity of government fees on licenses and services provided by government institutions to small and medium-sized enterprises. The third challenge is the financial challenge. The legal classification of small and medium enterprises is mostly individual, making it difficult for them to increase their capital by offering shares in the stock markets or issuing bonds with the reluctant commercial banks to grant them medium or long-term credit facilities unless they provide guarantees, especially real estate ones. The aim of this research is look at how to enhance SME competitiveness in Bahrain through methods of supporting their growth and development.

Keywords: SMEs- Bahrain- Growth- Development- Challenges and Barriers.

1. Introduction

Starting with the 1990s, Bahrain has grown an ecosystem system of state establishments whose reason for existing is to empower the development of SMEs. Support provided in Manama run from enterprising help and start-up assistance to brooding and increasing speed offices, warning administrations and concentrated coaching. The Bahrain Development Bank (BDB) has offered financing to SMEs since 1992 and has created incubators with particular orders –, for example, ICT-explicit or ladies centered – just as a universally useful incubators at Al Hidd that takes into account in excess of 150 startup organizations, called the “Bahrain Business Incubator Center (BBIC)”. The Ministry of Industry, Commerce & Tourism “MICT” is one of the various state or semi state agencies offering a SME start-up toolkit, and it runs the BBIC in a joint effort with the UN Industrial Development Organization. In 2013 the Bahraini Chamber of Commerce and Industry (BCCI) propelled its SME Development and Support Center, which gives administrative counsel, send out tasks, business forms, access to subsidizing, and setting up associations with local and international SMEs.

In April 12, 2017, both of the Bahraini Commerce and Industry Chamber and Tamkeen (a public authority established in August 2006, tasked with supporting Bahrain's private sector and positioning it as the key driver of economic growth and development) launched a financial portfolio of 300,000 BD to allow financial grants to SMEs in the light of the support provided by both agencies for the private sector and levelling up its contribution to the national economy, and based on their belief that the financial distress of SMEs would negatively affect the national economy and result in flight of national capital invested in them, in addition to the confusion in the national investment market. Hence challenges and obstacles encountered by SMEs should be precisely studied and analyzed in a way that serves the national economy as a whole.

Small enterprises play a significant and developing role in the Bahraini economy. As indicated by the Labor Market Regulatory Authority “LMRA”, over 90% of authorized organizations had under 10 workers in 2016 and around 98% of them utilized under 50 individuals each. The action of this noticeable piece of the economy has turned out to be simpler to follow in the most recent decade: the Ministry of Industry,

Commerce and Tourism (MICT) built up a working definition of SMEs in 2006, getting to be one of the principal state agencies in the area to do as such.

Bahrain has a vibrant culture of SMEs but the ecosystem is incomplete, Bahrain Economic Development Board's Jarmo Kotilaine. "The fact that we have [a growing number of] SMEs does not mean we are getting the full impact from it.

2. Importance of the study

Despite the significant role that SMEs play in the growth of the economy, very limited scholarly work has been conducted in Bahrain on their contribution and challenges they face.

Efforts made to stimulate entrepreneurship in Bahrain have paid off – SMEs made up 99 percent of Bahrain-registered companies in 2015, according to government statistics. But this teeming mass of small businesses is failing to bring about a proportionate economic impact, as it still accounts for less than a quarter of Bahrain's GDP.

We have to know the challenges and opportunities available in the market place to support business owners achieved their growth objectives at any stage of their business life-cycle."

His Royal Highness Prince Salman bin Hamad Al Khalifa, Crown Prince and Chairman of the Economic Development Board approved the SME Development Board strategy and the Sector Development Indicators in February 2018.

- Access to Finance
- Streamline Business Environment
- Foster Start-ups & Skill Development
- Access to Markets
- Foster Innovation

3. Objectives of the Study

- Discuss challenges and barriers encountered by SMEs in Bahrain.
- Increase SMEs Contribution to GDP, Increase SMEs Contribution to exports and Increase Number of Bahrainis employed in SMEs.
- Profitability enhancement through operations and supply chain excellence for SMEs'
- Increase the SMEs support schemes from Bahrain Development Bank and Tamkeen.

4. Theoretical Background

4.1 Bahrain 2030 Vision, The Economic Part

2030 Economic Vision, propelled by His Majesty King Hamad Bin Isa Al Khalifa in October 2008 epitomizes a far reaching vision for the Kingdom of Bahrain that goes for making an unmistakable way to deal with build up the kingdom's economy while concentrating on the primary goal, which tries to improve the expectations for everyday comforts of every single Bahraini Citizen.

The 2030 Economic Vision centers around solidifying a coordinated financial government vision and spotlights on three fundamental standards which are competitiveness, integrity and sustainability.

4.2 Bahrain economic review

As the public budget deficit continues and the Government resort to increasing public debt to meet its obligations in the areas of security, defense and human development while undertaking fiscal reforms aimed at reducing non-productive spending and channeling support to the most needy; 5 billion dinars by the end of the first half of 2018, accounting for about 87% of GDP, according to Central Bank data, up 12% from the same as last year.

Bahrain has grown successfully over the past 10 years, due its liberal economic policies, and the clear roadmap that aim to achieve prosperity for the society. The country's annual real GDP growth ranged between 2.1% and 8.3% over the period.

Table 1 The Economic Indexes for the Kingdom of Bahrain

The Index	The Value
The gross domestic product in current prices	31.1 Billion US Dollars (2015)
The gross domestic product in fixed prices	30.8 Billion US Dollars (2015)
The growth in the gross domestic product the percentage growth for one year after the other	2.9% (2015)
The inflation in the consumer price index (100= 2006) annual change	3.3% (June 2013)
Population	1,423,726 (2016)
Employment rate (the workforce as a percentage of the population between 20 and 64 years of age)	79.0% (2010)
Bahrainis	58.4% (2010)
Non-Bahrainis	89.7% (2010)
Unemployment rate	4.3% (2016)
Public sector debt (% of the gross domestic product)	37.6% (2015)
Current account	8.9% (2015)

Source: The Economic Development Board and the Information & e-Government Authority

The worldwide Standard & Poors (S&P), credit rating agency, certified a credit rating of (BB-) for Bahrain with a steady standpoint, bolstered by the positive advancements that have been accomplished in the course of recent years.

4.3 SMEs In Bahrain

With the government's focus on strengthening the role of micro, small and medium enterprises in the national economy within the joint program of the Ministry of Trade, Industry and Tourism with the Economic Development Board and the Tamkeen Labor Fund, It aims at creating new laws, facilitating financing channels, encouraging exports of these institutions, and providing a full business environment capable of achieving success. These institutions represent about 30% of the Bahraini economy and have the ability to diversify products and create jobs. The number of micro-enterprises in the Kingdom is about 85,000, small, 5485, and medium 950, compared with 176 large enterprises.

The number of active commercial records registered with the Commercial Registration Database from the beginning of its establishment until 20/11/2016 reached 86,277. It is also clear that the local and foreign direct capital accumulation of companies operating until 2016/11/20 amounted to 223.20 billion dinars.

Previous state

In 2012, the Ministry of Industry and Trade worked on the project of developing sub-contracting capabilities in small and medium industrial enterprises. The project aims at facilitating the access to information related to industrial works, helping the businessmen to identify foreign and local suppliers as well as identifying contractors or entrepreneurs. The links between the business owners and the two. Where the completion rate of the project about 95% for six phases of the total project, where the project is divided into seven stages, as follows:

Stage 1:

Development of project requirements, in which a master plan for the project was developed, identification of the work team, presentation of the project, its objectives and expected benefits to the relevant authorities. In addition, large national companies were contacted to confirm their commitment to the project and their agreement to the partnership in its implementation.

Stage 2:

Analysis of the current situation by measuring the level of demand for industrial products / services by large local companies, namely Bahrain Aluminum Company, Bahrain Petroleum Company, Gulf Petrochemical Industries Company, Bahrain National Gas Company, and then classified industrial products / services into ten categories. The level of international procurement is analyzed by large local firms to identify investment opportunities to be replaced by local purchases. The underlying causes of international procurement were also identified and the challenges to local procurement highlighted.

Stage 3:

An evaluation of the products and services that have been identified and classified according to their local manufacturing potential has been carried out. Procurement information for these products has been obtained from the countries and companies from which they are imported or exported, and their quantity and value are determined.

Where the expected benefits were determined by large local companies and imported products identified with locally manufactured products were replaced.

Stage 4:

At this stage, small and medium enterprises were selected and a detailed list of information on possible SMEs was recommended by major local companies. Major local companies have also evaluated the recommended SMEs for pre-qualification. On May 24, 2011, a conference was held between large local companies and small and medium enterprises to measure the willingness of small and medium enterprises to manufacture the selected products, followed by a review and evaluation of proposals submitted by SMEs.

Stage 5:

At this stage, gaps were analyzed for small and medium enterprises, a framework for cooperation and a working group structure was established to identify the mechanism for linking the Ministry of Industry and Commerce, major local companies, SMEs and the project advisory firm. A gap analysis system was used to identify the current gaps in SMEs to meet the requirements of large local companies to produce a particular product / service. The process of "collecting the seller with the buyer" has been applied in terms of the procedures followed and the way of communication between large local companies and small and medium enterprises. At this stage, guidance and advice was provided to SMEs in providing information and access to financial support. The Ministry of Industry and Trade will continue to support small and medium enterprises and obtain the approval of major local companies on the quality of the products and their conformity with the approved specifications as well as pricing them properly.

Stage 6:

The vendor and the buyer were monitored and the performance of the SME included in the "vendor-to-buyer" phase was monitored. Visits were undertaken to evaluate SMEs and provide a comprehensive assessment of the performance of each identified SME. In order to provide local companies with selected products for laboratory testing.

Stage 7:

A workshop is under way for the major local companies in the project and the general SME to explain the project's steps, present the results of the initial study, and introduce the investment gaps to implement the project, highlight the success stories and develop a road map to move forward with recommendations to achieve more. Success of the project.

The Status Quo

The framework separates between the SMEs based on their number of workers, capital speculation and yearly turnover, with small scale firms having less than 10 workers and medium-sized organizations beginning at 51 individuals. Together, SMEs represent practically 30% of GDP and provide employment of about 75% of private division workers. These spots of business are in this manner integral to the administration's endeavors to saddle private venture to drive monetary development and give more openings for work to residents.

Sides of Support Structure- Tamkeen

Founded in 2006, "Tamkeen" is one of the government's most significant SME advancement instruments. The semi-governmental agency seeks after a double command of empowering the making of undertakings and giving the help important to expand the efficiency of existing organizations. Perhaps Tamkeen's most significant work was the financing system it created in a joint effort with the Bahraini banks, by which SMEs are conceded access to sharia-consistent offices at great rates. Since its origin, Tamkeen's account program has extended from giving advances just to fixed-resource guarantee to incorporate credit for working capital and exchange financing. By 2015, Tamkeen had spent around BD 22m (\$58.3m) in benefit and certification installments to give more than BD 350m (\$928.1m) in financing through accomplice banks. In doing as such, the program has developed numerous young organizations.

While the financial program remains a focal movement, Tamkeen recently has put expanded accentuation on abilities improvement and handy help. A venture bolster program, for instance, offers experience working through universal positions for workers and a wide scope of help for new businesses. The expert confirmation program, then, enables Bahrainis to get accreditation from worldwide organizations, such as the Association of Chartered Accountants. Before the end of 2015, Tamkeen had trained almost 95,000 people and framed associations with more than 50 professional establishments, as per Tamkeen's latest yearly report.

The SME bolster condition keeps on developing. State bodies have a solid reputation of coordinating with one another, non-benefit associations and private segment elements to deliver new projects for handling explicit issues in the segment. A standout amongst these has been the inauguration of a \$100m support that will put straight forwardly in SME improvement. The activity, revealed in May 2017, is the after effect of a joint exertion between Tamkeen, Bahrain's Idbar Bank and Saudi Arabia's Islamic Corporation for the Development of the Private Sector. The reserve will focus on the customer products, modern, ICT, education and social insurance segments, and depends on a sharia-agreeable, mezzanine model. Such initiative will supplement the BDB's SME Fund, another sharia-consistent instrument that targets the small projects prospects in the health services, education, foundation, sustainable power source, tourism industry and industrial fields.

Bahrain has a powerful admin structure in contrast with the remainder of the area, and ongoing changes embraced by the CBB demonstrate its versatility, effective connection between the regulator and the market players is a significant piece of this, and of keeping pace with improvements in the segment.

Maybe the most intriguing advancement of 2017, be that as it may, is the new administrative structure for SME crowdfunding discharged by the Central Bank of Bahrain (CBB). The regulator has for quite some time known about the challenges independent ventures involvement in verifying bank advances, and it accordingly trusts that crowdfunding stages will give a feasible elective wellspring of assets. The CBB's system utilizes a person to-business financing model with regular and sharia-consistent choices, and permits crowdfunding person to build up with BD 50,000 (\$133,000) minimum capital. Remote and residential SMEs with paid-up capital not surpassing BD 250,000 (\$663,000) are qualified to exhibit themselves to potential investors. In the event that the SME can't raise at any rate 80% of its offer size, the endeavor is viewed as ineffective and the monies raised come back to investors – an administrative obstacle that helps thin down the field of possibility to those that the venture network considers generally encouraging. Successful applicants can raise a limit of BD 100, 000 (\$265,000) in a single year, with the financing tenor topped at five years.

The CBB has incorporated various investor protects in its crowdfunding structure, most essentially a restriction on retail investors partaking all the while. Just certified investors will be permitted to give financing through the new stages, and these will be constrained to coordinating a limit of 10% of their net advantages for a single borrower. Regardless of the confinements, the capacity of Bahraini organizations to raise reserves legitimately from the venture network may demonstrate helpful over the coming years. In business sectors where crowdfunding is now settled, its development has been great. Worldwide crowdfunding stages created an expected \$2.1bn in venture for young organizations in 2015, as per Forbes, and the World Bank predicts that such investments will hit \$96bn every year in developing countries alone by 2025.

4.5 SMEs Challenges in Bahrain

Bahrain is considered to be a regional center in regards to developing small and medium sized projects. This helped in enhancing its rankings in several international indicators. It came 3rd among Arab nations and 29th internationally for pioneering and developing small and medium sized enterprises in the indicator issued by American International Institutions for 2016. We have to admit that small and medium sized projects encounter several main challenges.

Qualified Human Resources

The capacity to contract qualified HR was one of the greatest hindrances to development referenced by owner-managers. Owner-managers communicated elevated amounts of worry on their capacity to contract expatriates after the usage of the Labor Market Regulatory Authority (LMRA) principles and guidelines. The LMRA makes expatriates progressively costly and hard to contract, with the point of expanding the work of Bahrainis (called the Bahrainization process). Owner-managers mentioned that it isn't that they were reluctant to employ Bahraini nationals; Bahraini nationals were not set up to apply and work for occupations they saw to be second rate. Further, when a Bahraini is used, it is hard to fire him/her and get a substitution since a legitimization must be given to the Ministry of Labor. Additionally, an organization could be "black-listed" for terminating Bahrainis'. Neither expatriates nor nationals are effectively employable inside Bahraini SMEs, along these lines demonstrating a quandary for Bahraini SMEs. In any case, owner-managers mentioned that they had no serious issues with their present employees as far as abilities, inspiration, retention, and wage satisfaction.

Financial Challenges

The other principle development challenge for Bahraini SMEs was finance. As indicated by the owner-managers, banks in Bahrain did not comprehend their monetary necessities; there are not very many money related items for the SMEs. Despite the fact that numerous banks gave loans at start-up stage, they were not giving the financial support required at the development stage prompting troubles in putting resources into new types of gear, innovation, framework, stretching out credit offices to clients and fulfilling different business needs. Respondents likewise called attention to that financing costs on credits charged by banks were exceptionally high and did not relate with the pay created by business. There was likewise the issue of the restricted accessibility of funding account in Bahrain. It is amazing to realize that none of the 200 owner-managers have heard or utilized the services of one venture capital bank situated in Bahrain.

Fierce Competition and Lack of adequate Marketing Support

Bahrain is the smallest nation in the Arab world with a populace of a little more than a million living on a land zone of about 1,000 square kilometers, which all alone has put a restriction upon the development of SMEs and interest for its output. Almost all (99%) of the owner-managers grumbled about the absence of legitimate insurance from unfair competitiveness. The proprietor of a little contracting organization referenced that he couldn't contend with the illegal contractors who ask for low costs from clients, because of low cost and illegitimate workers. This was relevant to numerous owner-managers who grumbled that they paid considerable expenses for work, while firms utilizing workers "without classified visa" work (illegitimate) in Bahrain appreciate the advantages of lower working expenses. There were additionally sure astonishing discoveries like 8% of sampled businesses conceded that they didn't have the foggiest idea how to market their services or products; 11% did not improve their services or products design on a regular basis; and 28% didn't have a clear strategy for the growth and development of their business. There were around 72,000 SMEs enlisted financially in 2012 as per LMRA sources. There was a discussion on the genuine number of dynamic SMEs as it is generally had confidence in Bahrain that there were numerous SMEs enrolled, however they were latent for various reasons. Arabian Journal of Business and Management Review (OMAN Chapter) Vol. 4, No.3; October. 2014 states that there were requests by owner-managers for enactment ring-fencing a level of open acquirement from Bahraini SMEs, so as to decrease the impact of competition from foreign organizations and to make SMEs endure the savage challenge.

Instability

Related literature has a lot to tell about the effect that instability has on the business investment development and growth. Investment, including Foreign Direct Investment (FDI), is a forward-looking action dependent on financial specialists' assumptions about future returns and the certainty that they can put on these profits.

Therefore, the FDI choice requires some evaluation of the political eventual outcomes of the host country. There are two chief risks that the financial specialist appearances emerging from political unsteadiness in the host nation. The first is that residential unsteadiness will diminish the benefit of working in the host nation because of the impairment of domestic sales or exports, or disruption of production, or damage that could be sustained by the facility. The second is the outcomes of political shakiness on the host nation's finance, along these lines lessening the estimation of the benefits put resources into the host nation, just as of things to come benefits created by the venture. The impacts of this kind of political stability on the economic performance have been argued broadly from the theoretical and the empirical points of view. An expansion in the political instability diminishes investments and influences the growth and development of the economy.

Procedures and Fees

There is worry about charges that SMEs need to pay each year. Bahrain has no charges on workers or business organizations, however there are expenses forced on each foreign specialist in the organization, which incorporates a month to month expense of £ 17 (BD 10) and a one-time expense of £340 (BD 200) to be paid by owner-managers of any organization to the Labor Market Regulatory Authority (LMRA). Workers insurance is additionally to be paid each month to the General Organization for Social Insurance (GOSI).

Training expenses were another classification, which place a burden on medium-sized companies. Albeit some medium-sized companies did not use the training levy framework for some reasons, they needed to pay all the training charges each year. Health care expenses are likewise forced on medium companies for expats. Given the slowdown of the economy and political situation, the government reacted emphatically and postponed LMRA charges for a time of a half year yet different costs stood.

Bahrainization Percentage

Bahrainization has been upheld in SMEs through a government guideline that has the target of settling on Bahrainis the employees of choice. From one side, the government was convincing SMEs to utilize Bahraini nationals to diminish unemployment in the nation, on the opposite side the SMEs felt it was hard for them to utilize nationals who couldn't work in an occupations offered by SMEs. As per the owner-managers in our example, it was hard to assimilate Bahrainis for some reasons, for example, high pay scale, absence of work involvement, low retention, less advantages contrasted with the work in the public sector, demand for continuous training and career development. SMEs regularly had a long working day in contrast with eight working hours in the public sector. The idea of SMEs' work is not quite the same as the public sector, and SMEs were worried about keeping the expense of employees as low as conceivable to boost benefits, which makes it hard for owner-managers to give a pay increment to staff or to attract them with different advantages, for example, health insurance.

No one was uncertain that Bahrainis ought to be upheld at every possible opportunity, yet the confinements that SMEs confronted made it hard to pull in and hold Bahraini workers over the long range. SMEs will be punished on the off chance that they don't accomplish a specific Bahrainization rate and every one of their transactions would be obstructed in the LMRA agency. The opposite side of the issue is the inclination of owner-managers to utilize expats for some reasons, for example, the lower compensation requirements, the capacity to work a more noteworthy number of hours than a neighborhood Bahraini, having more involvement and obeying guidelines without negotiation or discussion. To wrap it up, the Bahrainization rate remained an issue for owner-managers and they mentioned that it kept them from selecting more ostracizes to become their SMEs.

Bahrain strategy to Increase SMEs Contribution to GDP, to exports and Increase Number of Bahrainis employed in SMEs

Table 2 Increase SMEs Contribution to GDP, to exports and Increase Number of Bahrainis employed in SMEs

Increase SMEs Contribution	2017	2022
Increase SMEs Contribution to GDP	30%	40%
Increase SMEs Contribution to exports	8%	20%
Increase Number of Bahrainis employed in SMEs	36%	43%

Source: Annual Report of the Ministry Industry, Trade and Tourism of 2018

The previous table shows the ambition of the Bahraini government to Increase SMEs Contribution to GDP, Increase SMEs Contribution to exports and Increase Number of Bahrainis employed in SMEs.

5. Results and Conclusion

The study findings demonstrated that the primary obstacles to development for Bahraini SMEs were the shortage of qualified HR that can fit the requirements of SMEs, an absence of satisfactory finance, and wild competition. To a lesser degree, different obstacles were charges, procedures, and the burden of the Bahrainization rate.

The Government, through Tamkeen, MOIC, LMRA, BCCI and the parliament, is attempting to overcome the issue with support plans. It was additionally seen that there is a dire requirement for Bahraini SMEs to be increasingly creative and versatile in their methodology towards managing their businesses; they have to seek after a functioning internationalization strategic system.

One of the main challenges for businesses in Bahrain is marketing, given the size of the domestic market. "If you don't have a good marketing strategy or you don't know how to market your product in your country or outside, you are facing a real challenge". The fierce competition between businesses could lead to some of them being getting out of the market completely.

Another finding of the challenges encountered by the SMEs is the absence of regional/ international focus. There was an understanding that the small size of the local market made it hard for some organizations to develop.

Other implicit challenges. Some of the other implicit development difficulties include: Employee retention: Growing SMEs confronted the test of keeping qualified workers since they couldn't give better pay bundles. Education: the played role of owner-manager in the methods business was run; low level of training was noticed in the related literature on the issue regarding business sector and business prerequisites. Support of big organizations: the absence of provided support from big organization, particularly in zones like coaching and mentoring. Technology: in addition to what is said, the employment of inefficient equipment and lack of ability to use the new technology given its extravagant acquisition costs. Absence of planning: in spite of the fact that there was a typical vision for Bahrain called "Vision 2030", there were no short term plans to apply this vision to SMEs.

6. Recommendations

1. Bahraini SME's should seriously explore going beyond domestic and regional markets. Instances of successful regional and international expansion of certain Bahraini SMEs were provided.
2. Bahrain Development Bank should engage in dealing with the challenges encountered by SMEs through allowing extra loans and rescheduling the old ones for long range (15-20 years) with suitable installments and grace periods of 1-2 years guaranteed by the projects themselves, in addition to the chamber of commerce and industry and Tamkeen.
3. Both Tamkeen and Bahrain Development Bank should supervise the admin, accounting, and marketing situations of SMEs and provide the necessary support at least for 2 years.
4. The necessity of directing a part of the governmental procurement to the products and services provided by SMEs, which would contribute in its operations and regaining their life cycles.
5. The necessity of LMRA, SIA, and EWA to find solutions that would relieve the financial burdens of SMEs.

6. As for the macro economy as a whole, Ministry of Industry, Commerce, and Tourism should deeply study the reasons leading to the distress of several SMEs in different sectors, which could be turned into a dangerous phenomenon if not dealt with drastically, especially when it comes to unfair competitions in some sectors and the huge increase in granting commercial registrations in some sectors considering the limited capacity of such sectors.
7. Bahrain Central Bank should contribute in solving the financial problems sustained by most of SMEs though allowing traditional and Islamic financial institutions to grant easy loans for SMEs guaranteed by the projects themselves, especially that the financial sectors owns high levels of liquidity that is not sufficiently invested because of the restrictions imposed after the international financial crisis.

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Smart City Business Models from a Waste Management perspective: A Systematic Literature Review

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Abstract

Smart city is the new buzzword for economies in the world. As a challenge to urban sustainability, smart cities are gaining the attention and momentum positively. A major urbanisation problem is the generation and management of waste. Huge amount of resources and costs are associated with keeping cities clean, cities around the globe are working towards this mission. Business strategies are developed to reduce costs and resources with the inclusion of value proposition. This paper reviews literature on different sustainable business models for smart waste management solutions. Smart applications from different cities and technologies around the world are compared to define systematic steps to develop a smart business model providing solution to waste management. Advanced technology and innovative features provide an efficient operational smart waste management system. New technologies help in the evolution of business models that could be applied to different public services in smart cities. A developed framework has been used in the paper which discusses about three elements of collection, novel business model and infrastructure. The paper focuses on the element of novel business models: associated and involved citizens to share products and services.

Keywords: Business model, waste management, smart cities, smart solutions

1. Introduction

The earth population is responsible for the increasing global climatic changes. With the ever-increasing portion of the world's population living in cities the resources used by the urban residents are the key drivers of global environmental change. It is projected that the gradual shift in residence of the human population from rural to urban areas in combination of the overall world's population would add 25 billion people to urban areas by 2050 (UN 2018). Asia and Africa are projected to contribute 90% for this increase. With urbanisation comes the urban sprawl which results in maximum of sustainability and environmental problems and impacts the social lives. People and resources used increases exponentially. As a result, the dumping of waste on earth increases unprecedented. It is estimated that currently 1.3 billion tonnes of waste is generated per year worldwide which would increase to 3.40 billion tonnes by 2050 per year (World Bank 2019). Cities are the targets of these overhauling waste problems. Government, policymakers and citizens are responsible for providing viable solutions for this. Cities unable to manage their waste would lack the basic facilities such as electricity, health, education or transportation (Moya 2017). Different technologies are used around the world to collect, segregate, transport and manage waste. The different types of waste managed in different countries are diverse. Developing countries and developed countries have an equation for managing their waste as per their methodological study.

This paper provides an overview of different case studies of waste management solutions used in different smart cities. Furthermore, a systematic review of literature was conducted to review different smart waste management applications and technologies adopted by different cities and the role of smart city business models implemented by smart cities. The paper confers on different waste management challenges faced around the world and the solutions adopted. The paper addresses the research question: on the formation of business models for an effective and efficient waste management solution?

2. Waste Management – A Glance at the World

Every year an estimate of 2.12 billion tons of waste is generated around the world. The World Bank estimates this to increase by 3.40 billion tonnes by 2050. Countries like America, Canada and the European Union produce 34% of the world's waste. Waste generated in low-income countries is mismanaged. An estimate of 93% of waste is not managed properly and only urban areas have a proper collection process.

It is reported that a between one-third and 40% of waste generated worldwide is not managed properly and instead dumped or openly burned (World Bank 2018).

The composition of waste is diverse worldwide. It is influenced by factors such as culture, economic development, climate and energy sources. Waste is measured in many ways. One of the most common categories is municipal solid waste: household and some commercial waste also known as organic and inorganic (World Bank 2019). Other categories include electronic waste, hazardous waste, recyclable waste and endless other distinctions. In England the composition of waste from households has changed very little over time, with residual waste making up over half; dry recycling around a quarter; and other organics and separately collected food waste making up the rest (DEFRA 2018). Table 1 shows the different types of waste and the source of generation. Waste has to be handled and treated based on the type generated in different countries. This develops the need for different business models and the need for technology advancements.

Table 1 Forms and sources of waste generated (Adu-Boahen, 2014)

Source	Waste Generators	Example
Residential	Single and multifamily Dwellings	Food wastes, paper, cardboard, plastics, textiles, leather, yard wastes, wood, glass, metals, ashes, special wastes (e.g. bulky items, consumer electronics, white goods, batteries, oil, tires), and household hazardous wastes
Commercial	Stores, hotels, restaurants, markets, office building	Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous wastes
Construction and demolition	New construction sites, road repair, renovation sites, demolition of buildings	Wood waste, steel waste, concrete waste, dirt waste
Industrial	Light and heavy manufacturing, fabrication, construction sites, power and chemical plants	Packaging, food wastes, construction and demolition materials, hazardous wastes, ashes, special wastes, scrap metals
Institutional	Schools, government center, hospitals, Prisons	Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous wastes
Agriculture	Crops, orchards, vineyards, dairies, feedlots, farms	Spoilt food wastes, agricultural wastes, hazardous wastes (e.g. pesticides).
Process(manufacturing, etc)	Heavy and light Manufacturing, refineries, chemical plants, power plants, mineral extraction and processing	Industrial process wastes, scrap materials, off specification products, slay, tailings

3. Waste Management Challenges

Waste Management is still a global challenge in the 21st century. Collection, transport and disposal of waste are the three pillars to solve any waste management delinquent. Each pillar holding the same amount of importance as the other. The increasing waste generation, lack of municipal budgets due to the high costs for waste management, diverse factors, functioning and understanding conditions are the challenges the faced by developing countries (Guerrero 2013). Authorities in developing countries face these challenges due to the lack of a system to link the functioning of a proper waste management. Understanding of the stakeholders involved – authorities and citizens, and the responsibilities involved with a proper structure to establish an effective and efficient system (Guerrero 2013). Cities unable to manage waste effectively tend to lack basic facilities for its citizens such as electricity, health, education, or transportation (Moya 2017). Improper bin collection systems affect the collection, transfer, transport practice, poor route planning, unplanned schedules, and poor infrastructure (Guerrero 2013).

Waste management requires facing a number of challenging issues, for instance, balancing objectives between promoting recycling and protecting consumers against harmful chemical substances in recycled materials; insufficient data collection; quality aspects related to recycling; energy recovery of waste; and

waste prevention. The opportunities relate mainly to a shift towards a more circular economy, with benefits for the environment and human health, as well as the economy (Bourguignon 2015).

Literature shows that the most important challenges faced are obtaining adequate funding for local waste management resources, retaining professional highly motivated staff in the waste management industry, addressing the climate impact, health and safety standards for handling waste and the non-availability of smart waste management systems (Waster 2018). It has been reported that the common constraints faced by environmental agencies include lack of institutional arrangement, insufficient financial resources, absence of bylaws and standards, inflexible work schedules, insufficient information on quantity and composition of waste, and inappropriate technology (Ogwueleka 2009). The involvement and contribution of citizens plays a vital role in the management of waste which is not given the required attention (Vidanaarachchi et al., 2006).

Research gives an overview of the challenges faced in the management of waste, being the following: inefficient collection methods, insufficient coverage of the collection system and improper disposal. Interconnecting proper infrastructure for collection of product life cycle, new business models and new intelligent sensor-based infrastructure would help in highlighting better waste management practices in cities. Technological improvements and formation of business models in the context of smart cities could provide solutions to the issues faced in waste management.

4. *Smart Cities*

Cities are the engines of growth and play a very important role to achieve faster growth, which will inevitably imply a structural transformation and a rising share of industry and services sectors. Planning for urbanization and better management of cities is therefore not only important for the quality of life for those living in our cities and towns, but also because it contributes to a better investment climate. Smart city is an understandable concept based on the ideologies for citizens and industries. Cities need to be efficient, sustainable, equitable and liveable (Kehoe 2011). Smart cities are characterised with technological innovations, policy innovations and the management innovation (Pattaro 2013). IoT is the emerging technology in the context of smart cities and is being set up for different projects. Use of IoT as a technology to connect between the physical and virtual world in the field of waste management could help in significant and fundamental ways (Diaz-Diaz 2017). As a challenge to urban sustainability, smart cities are gaining the attention and momentum positively.

5. *Business Models*

Business strategies are developed to reduce costs and resources with the inclusion of value proposition. Likewise, they have always been at the origin of social innovation. Business models have routed its way through smart cities. Business model can be defined by three core components of creating, delivering and capturing value in the economic, social and cultural forms of value (Anthopoulos 2015). The importance of business models in smart cities has developed tremendously due to the number of stakeholders involved in the process. Every service involved in the context of smart cities is connected with a value proposal following contemporary or innovative business models (Anthopoulos 2015). Business models provide an architectural design for smart cities and provide the government with strategies to meet customer expectations.

6. *Research Methodology*

Scientific writing is based on the availability of literature resources (Evelin, 2017). Review of literature provides an in-depth knowledge of the subject. A systematic analysis based on Jesson et al. (2011) approach has been followed in this paper for writing the literature review. The systematic review has been done to provide an answer to the research question: what are the key challenges faced by developing countries and developed countries in their journey to develop a waste management solution? A systematic review was conducted using the string words "waste management", "smart cities", "business model". As the study is based on the sustainable business models on smart waste management solutions. The systematic review searched for peer reviewed articles in the database Scopus. Scopus is the largest abstract and citation database of peer-reviewed literature: scientific journals, books and conference proceedings. Delivering a comprehensive overview of the world's research output in the fields of science, technology, medicine,

social sciences, and arts and humanities, Scopus features smart tools to track, analyse and visualise research.

The initial search for a string of keywords “waste management” and “business model” and “smart cities” was done in May 2019 which resulted in 5 documents. Further the search was broadened with two string words “waste management” and “business model” resulted in 375 documents and “business model” and “smart cities” and “waste management” and “smart cities” which resulted in.

“waste management” and “business model” - 96

“business model” and “smart cities” - 154

“waste management” and “smart cities” – 225

This resulted in 475 documents.

The inclusion and exclusion criteria for studies were applied to find the relevant papers in the field of study. A review of the inclusion and exclusion criteria was conducted with academics experienced in the field of study. Criteria like date, location, language and subject were considered to filter the papers further. Below, the inclusion criteria for the study have been shown: papers between the year 2010 and 2018 were used for the study. Papers published in English were opted for the review.

“waste management” and “business model” - 25

“business model” and “smart cities” - 84

“waste management” and “smart cities” – 151

Based on the inclusion criteria above the result was narrowed to 260 sources totally. After the removal of duplicates the results narrowed down to 155 documents. Further the papers were checked for duplication, required keywords and relevance to the study and the search was narrowed down to available full papers total of 35. The papers were read and reviewed and 11 papers relevant to the subject were selected for the literature review analysis.

7. Smart Waste Management – Business Model Perspective

Waste management solutions help to tackle and address more than half of the high-level sustainable development goals. Further helping in significant reductions in greenhouse gas emissions throughout the economy (UNEP 2015). Smart cities along with being technologically applied, importance should be given to monitoring, analysing, planning and process within. An intelligent city is defined by the sense of the ability to learn, understand and reason using ICT technologies (Picon 2015). Smart cities empower data-driven decision-making processes, which in-turn can improve efficiency, equity and quality of life for the smart city’s citizens, in real time. Mobile devices and sensors help to collect and analyse the data gathered to help with smart city intelligence (Schaffers 2011).

A business model for smart cities is meant to guide a City Council in expressing and articulating how it will accomplish the objectives of its smart and sustainable city strategy. Smart cities require innovative business models. Business models which depend on different characteristics and factors. Literature shows that various researchers have developed different theoretical frameworks to analyse business models (Diaz-Diaz 2017).

As described by (Esmailian 2018) an integrative framework for waste management in smart cities has been developed with a concept on whole product-life-cycle. For smart and connected communities, the following elements are of importance: a) Collection of product lifecycle data, full visibility through product lifecycle b) novel business models based on product lifecycle data c) City infrastructure, intelligent and connected data. The design aims at increasing efficiency by adopting the concept of circular economy and economy of sharing. Literature discusses about the importance of considering new business models for the proposed and efficient development of smart cities (Belissent 2010).

This study uses different smart waste management applications and technological innovations from different countries to understand the role of business models for better waste management solutions in the development of smart cities. Smart waste management initiatives have moved from compliance to value creation. From waste bins equipped with fill-sensors, to data-based management and logistics platforms, the industry is shifting into a cleaner, more efficient part of modern life.

Case study 1: City of Seoul – Installed Clean Cubes

Source: Seoul Metropolitan Government, 2016

Seoul is the second largest metropolitan city by population and is the capital city of South Korea. The city faced huge problems with waste overflow and waste collection. Insufficient bins and poor collection strategies resulted in waste piling up in the streets. The city followed the Ecube Labs smart waste management solution. Seoul municipality decided to install 85 Clean Cubes: bins which are provided with

a tracking system to collect waste efficiently, real time monitoring and route optimization. The process has in-turn helped to reduce bin overflowing by 66%, reduced waste collection costs by 83% and increased recycling.

Case study 2: Installation of Big Belly Solar Compactor

Source: www.BigBellySolar.com, 2011

The Iowa State facilities, Planning and Management department installed Big Belly intelligent waste collection system at the Iowa State University. The system has solar compactors, with wireless monitoring. Reduced the tipping frequency, bins are cleared only when full which has increased productivity, 90% cut out in collection costs.

Case study 3: Makkah –SWMS, City: Makkah and holy sites [Mona, Arafat, and Muzdalifah]

Source: Elhassan, 2019

The proposed system raises the efficiency by providing smart trashcans with the concept of recycling and sensor networks. The technology uses sensor technique inside the container, and segregates the waste. Actuators are used to inform and collect the waste in time. The system provides low cost solution, saves money and provides high performance with improved quality of life.

The business model canvas provides an understanding of the complex deliverables from the innovation of fundamentals of the business model. A case of Santander City council is described by (Diaz-Diaz 2017) with innovative technologies compared with those managed conventionally. The author describes the business model canvas for conventional waste management versus the canvas for waste management with IoT. The services such as collection of waste are improved with better frequency and improved fuel efficiency, incident communication, user efficiency to dispose waste are some of the advantages with mobile technologies for waste management systems. The author (Diaz-Diaz 2017) mentions about the significant differences being economic social and environmental costs for both the models, with the IoT model being cheaper and less polluting compares to the conventional model.

Zucchella (2017) articulates the importance of a circular business model for smart cities and moving from waste management to resource management within a circular economy. The circular business model is an ecosystemic one which links business models with industrial ecology. The author describes the collaboration between actors and innovators that are the key factors which need to be explored for a successful business model in the circular economy.

The need to understand the adoption of circular business models in waste management solutions and the application of business model canvas features in the system is of requirement for future smart cities. Sustainable innovative business models provide the solution for a better waste management system in the developing smart cities. The need for business models has been seen in literature as the requirement of resource for future cities.

8. Conclusion

As the World's population shift towards urban areas, cities have been facing complex problems in resource management, health, pollution, traffic and waste management. Waste management is a critical factor for sustainable, healthy and inclusive cities and communities. Cities are moving from waste management to resource management. Due to population difference in countries, different economies need to design strategies and implement the process of waste management system. The paper talks about the use of technologies and contribution to business models which is managed and analysed in the same platform. The business model canvas identifies the important aspects like social and environmental issues which are not present in other theoretical models. The circular business model talks about the circular economy and the development of the same in the waste management systems. For future research the author would like to delve in to the development of theoretical frameworks for business models in smart cities. Smart city initiatives would grow and make business model analysis necessary.

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A Review of Occupant's Energy Behavior Data Collection Methods and Techniques

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Abstract

Energy efficiency in buildings has been a main concern for governments over the past decade and has induced intensive research into honing building energy performance prediction. There is a large gap between actual and predicted building energy performance and this gap is attributed partially to the impact of occupant's behavior on energy use. Approaches to identifying and analyzing occupants' behaviors are highly sought as they support reducing the performance gap.

In general, a broad range of methods to evaluate the energy performance of buildings exists, some of these methods are data-driven in which data would be quantified and transformed into insights, serving as a basis for predicting energy performance under different settings.

Research evidence signifies the value of energy-related data collection, monitoring and mining when aiming at a better knowledge of buildings' energy behavior. Yet, albeit methods and technologies for imparting energy data are abound, having a complete breakdown of these data is challenging due to the complexity in tracing occupants' behaviors and their subsequent impact on energy use. Up till now, scarcity of occupant's behavioral data recognition has been a barrier for insightful extrapolation and reliable prediction of building energy performance.

Occupant's behavioral data collection is challenging, which is attracting a lot of research attention. Suitable data collection enables evidential recognition of behavioral patterns and better analysis of occupant's behaviors leading to more reliable interpretation of their impact on energy performance.

This paper is devoted to investigating technologies and methods used to gather occupant's behavioral data and study their state of the art. The paper presents a review of various technologies and methods employed for data collection in the pursuit of identifying and quantifying occupants' behaviors impact on energy performance. A short description of key enabling technologies and methods (monitoring, recording, sensor technologies, observations, questionnaires, surveys...) that facilitates behavioral data collection are presented, followed by a description of areas of application of these technologies and methods in relation to occupant's energy consumption behavior will be presented. Based on the review, challenges from existing literature are discussed, and directions for future research opportunities are provided.

Keywords: Energy efficiency, data collection methods, sustainability.

1. Background

The gap present between the predicted and actual building energy performance is evident as per research findings over the past 20 years (Fedoruk, Cole, Robinson, & Cayuela, 2015). There is an increasing effort to provide accurate energy performance prediction to promote achieving global and local energy targets (Di Foggia, 2018). As per De Wilde (2014), the modelling and simulation stage is involved in the contribution to the mismatch between the prediction and actual measurements, as this stage is a central component of prediction. Insufficient data inputs, inadequate tools or methods leads to inaccurate prediction, and accordingly add up to the performance gap (CarbonTrust, 2011; Menezes, Cripps, Bouchlaghem, & Buswell, 2012).

It is important to note that building energy prediction is a complex process accompanied by uncertainties resulting from the various factors that involves the energy consumption. In order to effectively utilize the energy consumption and promote better energy performance in building, more accurate energy simulation and more sustainable modelling techniques are needed (Petri et al., 2017). It is imperative to predict the energy usage in building to achieve energy efficiency through exploring different scenarios that can support the decision making in selecting the most effective building use (Huang, Lu, Ding, & Gu, 2014).

Having that established, building energy modelling has a significant role in predicting building energy performance. Simulation and modelling tools provide the opportunity to study the energy usage patterns and predict the energy consumption in buildings (Huang et al., 2014). However, in order to obtain reliable and accurate predictions, a high level of accuracy is needed, as well as inclusion of the various parameters that affects building energy performance (Buratti, Belloni, & Palladino, 2014).

Research findings disclosed that building energy consumption is a result of nonlinear dependency on exogenous variables (Huang et al., 2014). One of these variables that promoted a challenge to research is occupants behavior which must be considered and explored in a more detailed manner (D'Oca, Corgnati, & Hong, 2015).

In this paper, the most common occupant energy consumption behavior data collection methods, techniques and technologies are reviewed in terms of their capability in providing reliable input contributing to better prediction for the building energy performance. Exploring occupant's behavior data collection methods brings us a step closer towards analyzing occupant's behavior and their input into building energy prediction. Appropriate data collection facilitates identification of behavioral patterns and consequently better analysis of occupant's behaviors leading to more reliable analysis and prediction of their impact on energy performance. The review will shed the light on the challenges associated with the behavioral data collection methods and technologies and opportunities to overcome the challenges.

2. The impact of occupant behavior on energy performance

As research disclosed occupants behavior is becoming an important topic as occupant's presence, actions, and interactions with the building make occupants' behavior one of the leading influence on energy consumption in buildings (Delzende, Wu, Lee, & Zhou, 2017b). The complexity in occupant's behavior lies within its stochastic nature, and the drivers and needs that affect it (T. Hong, S. D'Oca, W.

J. Turner, & S. C. Taylor-Lange, 2015a). Occupant's behavior is driven by needs as per the use of appliances affecting plug loads, use of hot water, they can be driven by comfort level in which occupants control window/door opening, air conditioning, thermostats and closing/opening blinds. Also occupant's behavior can be random behaviors related to occupant's psychology (Yan et al., 2017). Occupant's related parameters whether defined as passive (production of metabolic heat) or active (occupant's interaction with building systems) affects the indoor environmental quality and the energy consumption in buildings. Figure 1 describes occupant's behavior activities that influence the building energy performance prediction.

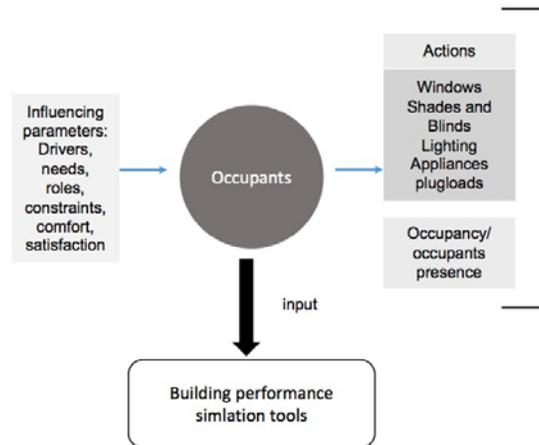


Figure 1: Occupant's Behavior affecting energy performance prediction

Researchers have realised the value of studying the impact of occupant's behavior on building energy performance, with an increased focus over the past decade (Figure 2), which elevated the need of providing accurate and sufficient occupant behavior related input in models, in which occupancy and occupant behavior are not oversimplified and are comprehensive, hence providing a real presentation of human interactions with buildings and their systems.

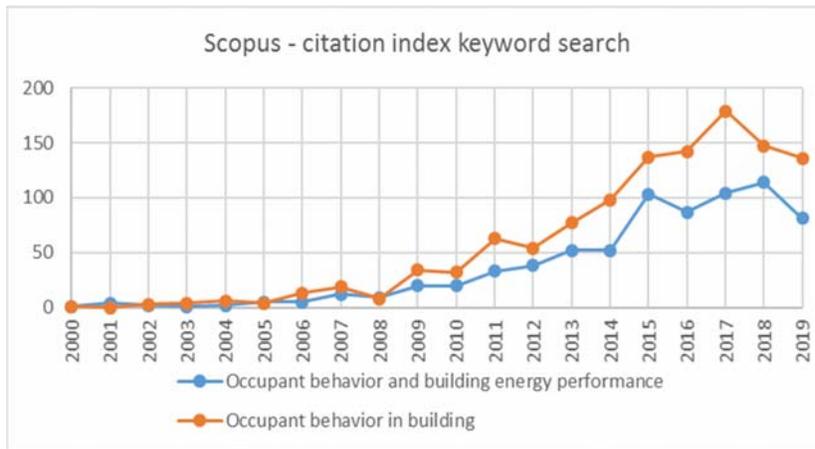


Figure 2: Screening of Scopus database for keywords

Providing more accurate occupants' behavior inputs will help defy the challenge of analyzing their behavior, which is complex and stochastic in nature (Dong et al., 2018). In addition to that, it will promote better inclusion of occupant behavior inputs into simulation tools providing support for decision making during the design phase and leading to more accurate and inclusive building energy prediction; as the oversimplification of occupant's actions and interactions with building systems has led to the underestimating of their impact on the energy performance.

In order to provide better insights on occupant's behavior impact on energy performance, more reliable and comprehensive data must be collected and analyzed studying different aspects of the occupant's behavior which can aid in the modelling and predicting process as well as providing feedback.

Currently there is an abundance in advanced technologies and techniques that provides more prospect in terms of occupant energy behavior monitoring and feedback. These technologies facilitate real-time occupant related monitoring, data acquisition, and feedback, which are specific, timely and targeted inputs that allows better understanding and inclusion of occupants' energy behavior and therefore better predictions (Paone & Bacher, 2018).

3. *Occupant's behavioral data and Energy prediction*

Overcoming the energy performance gap has been studied extensively in literature. Researchers devised numerous approaches to include and quantify the impact of occupant behavior on energy performance. Unlike static approaches that relies on prefixed schedules and occupant's profiles, and assumptions; stochastic modelling approaches have become popular. The existing studies on the impacts of occupants' behaviors on energy consumption in buildings, have adopted agent based or/and stochastic approaches to improve the deterministic energy models used in the existing energy simulation tools (Ahn & Park, 2016). Stochastic methods consider parameters and probabilities derived from the collected data of a certain case and have been implemented by various scholars (Jang & Kang, 2016; Page, Robinson, & Scartezini, 2007). Agent based approaches focus on occupants' intentions and perceptions (Ahn & Park, 2016). There has been also a third approach using a combination of both agent based and stochastic methods, such as: Multiple Modules (MuMo) model proposed by Liao and Barooah (2010) to simulate multiple occupants' movements between multiple zones. In another classification, Jing Zhao, Xin, and Tong (2012) mentioned "model simulation method" and "statistical analysis" as the two methods used to determine the energy efficiency in buildings: model simulation methods use the integration of actual observed data and the mathematical calculation of building energy consumption, and statistical analysis methods use great number of data and generate information regarding energy consumption by analyzing them.

The existing studies on this research area, applied various data collection methods and techniques including: quantitative, qualitative and both.

Around 70% of the existing studies in this research area used case study as their research strategy with different data collection techniques: survey, monitoring and observation, field measurements, interviews and questionnaire (Delzende, Wu, Lee, & Zhou, 2017a). In addition to case studies, experiments, reviews, various models and simulations were applied in building energy consumption studies.

4. Occupant's behavioral data collection techniques

Occupant's behavioral data collection is challenging; quantification of occupants' impact consists of several phases; starting from collecting raw data on their behavior, defining behavior markers, structuring and preparing the data, determining the analysis method and choosing suitable inference techniques, and concluding the impact of all behavior markers. Suitable data collection enables evidential recognition of behavioral patterns and better analysis of occupant's behaviors leading to more reliable interpretation of their impact on energy performance. Reeves et al (2015) mentioned

that "Inaccurate input related to occupant behavior and building operation is a common and substantial source of error in building performance simulations under realistic conditions". The need for more truthfulness in input related to occupant's behavior created a growing interest in utilization of technologies for detecting human actions and occupancy patterns.

In this section, we review existing work in the literature, which investigates methods used in identifying occupant's behavior and gathering their data with an aim to translate the potentially raw data into meaningful behavioral insights. A short description of key enabling technologies and methods (monitoring, recording, sensor technologies, empirical studies, observations, questionnaires, surveys...) that facilitates behavioral data collection followed by a detailed description of areas of application of these technologies and methods in relation to occupant's energy consumption behavior will be presented. This section summarizes existing occupancy and occupant behavior sensing and data acquisition technologies, and provides an overview and discussion of different current state-of-the-art occupant's behavioral data collection methods and technologies.

4.1 Observations

It is widely accepted that observing behavior is a reliable and direct method of collecting data from this dynamic phenomena (Zeisel, 2006). Also, Saunders, Lewis, and Thornhill (2016) stated that observation is clearly one of the best ways to study any research related to occupant behavior.

To collect primary data through observation and real monitoring of occupants has been used as a method of data collection in various studies on occupant behavior and energy consumption (Andrews, Chandra Putra, & Brennan, 2013; Simona D'Oca, Valentina Fabi, Stefano P. Corgnati, & Rune Korsholm Andersen, 2014b; T. Hong, S. D'Oca, W. J. N. Turner, & S. C. Taylor-Lange, 2015b; Li, Li, Fan, & Jia, 2015; Schakib-Ekbatan, Çakici, Schweiker, & Wagner, 2015).

There are several classifications of observation types based on the nature of the observant, the position of observer in relation to the observant. Saunders et al. (2016) categorized forms of observation in two parts: participant observation and structured observation. In structured observation, the observed phenomena and the procedure of the observation are clearly defined by the researcher in advance, while, in participant or unstructured observation, every aspect related to the phenomena is observed (table 1).

Table 1 Forms of observation (Saunders et al., 2016)

Participant Observation	Structured Observation
Qualitative	Quantitative
Concerned with meanings and drivers of actions	Concerned with frequency of actions
Roots in Sociology or Anthropology	Roots in Computer technology

4.2 Questionnaires, surveys, and self-reporting

Allowing occupants to provide behavioral related data through questionnaires, interviews and reporting is mainly applied to identify behavioral patterns and occupant's preferences for actions such as use of equipment, shades, windows. Questionnaires can be well-established, clear, concise and easy to fill in and can result in high response rates and provide more details about occupants and their characteristics.

4.3 Monitoring and Sensors

The application of IoT and sensors are considered the most widespread techniques for monitoring occupant behaviors, and providing continuous and organized data. The monitoring techniques varies depending on the measurement required or methods used as explained in figure 3 and table 2.

Figure 3 presents the various data collection methods and technologies reviewed from literature, while table 2 discusses their related parameters and sheds the light on advantages and disadvantages.

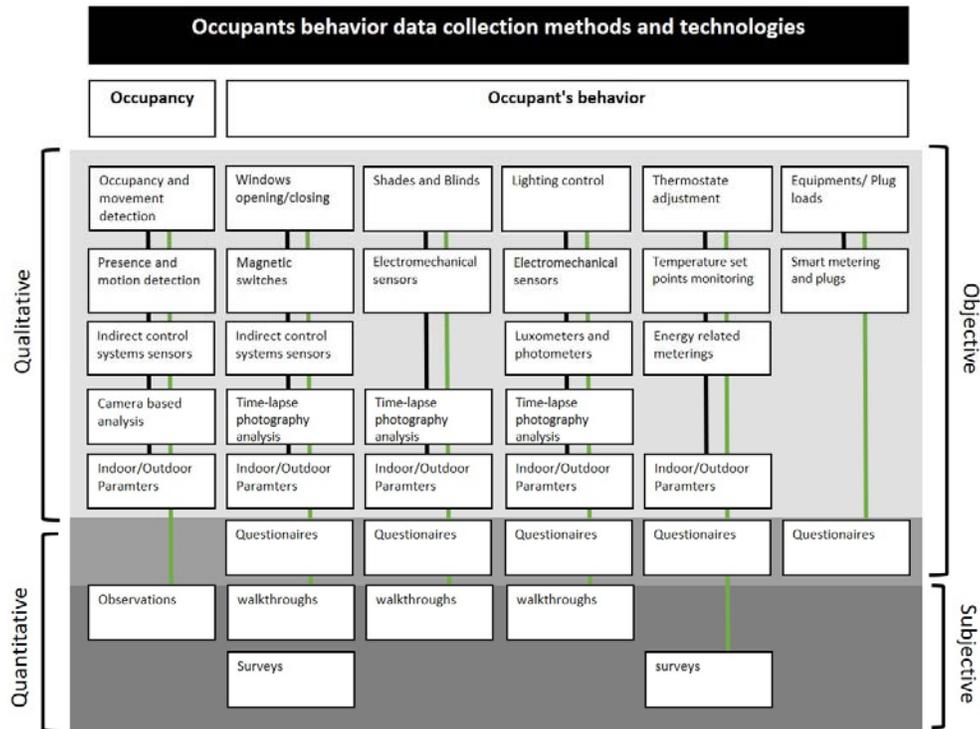


Figure 3: Occupants behavior data collection methods

Table 2 Review Analysis

Data collection methods and techniques	Occupants related parameters	Data collection methods and techniques	References	Advantages	Disadvantages
Direct control systems	Occupancy, windows opening and closing, shading control, equipment use, lighting control, Thermostat adjustment	Motion detectors, electromechanical sensors, set point monitoring, magnetic switches.	(Dodier, Henze, Tiller, & Guo, 2006; Emery & Kippenhan, 2006; Fabi, Andersen, Corgnati, & Olesen, 2013; Karjalainen, 2009; Sutter, Dumortier, & Fontoynt, 2006; Jie Zhao, Lasternas, Lam, Yun, & Loftness, 2014)	Ease in planning, Detects behavioral and occupancy patterns, continuous results	Entails analysis of large amounts of data Errors in data can occur Sensors might not work sometimes
Indirect control systems	Occupancy, windows opening and closing, lighting control, Thermostat adjustment	Co2 concentration levels, luxometers, photometers, Energy metering, light switch sensors, computer IP and switch	(Andersen, Toftum, Andersen, & Olesen, 2009; Branco, Lachal, Gallinelli, & Weber, 2004; Tarzia, Dinda, Dick, & Memik, 2010)	Detects behavioral and occupancy patterns Practical and reliable	Can be time consuming Needs analysis of large amounts of data
Photographic analysis	Occupancy, windows opening and closing, shading control, lighting control	Camera based methods and time-lapsed photography	(Mahdavi, Mohammadi, Kabir, & Lambeva, 2008; Sutter et al., 2006; Tarzia et al., 2010)	Can spot problematic issues in the buildings	Difficulty in generalization
Indoor/outdoor parameters	Occupancy, windows opening and closing, shading control, lighting control, thermostat adjustment	Measurement of variables between indoor and outdoor (longitudinal and spot measurements)	(Simona D'Oca, Valentina Fabi, Stefano P Corgnati, & Rune Korsholm Andersen, 2014a; Dong & Lam, 2014; Reinhart, 2004)	Controlled and undertaken by the researcher over selected time	Needs validation and can be disruptive for the studied space

Data collection methods and techniques	Occupants related parameters	Data collection methods and techniques	References	Advantages	Disadvantages
Questionnaires and surveys	windows opening and closing, shading control, equipment use, lighting control, Thermostat adjustment	Thermal comfort questionnaires, real time questionnaires, IAQ surveys,	(Andersen et al., 2009; Brager, Paliaga, & De Dear, 2004)	Ease in application and high response rate Can provide insights for statistical analysis on large samples well-established, clear, concise and easy to fill in	Occupants are prone to error and might not recall accurately It can be complicated depending on number of occupants Time consuming and doesn't accurately reflect the actual patterns
Walkthroughs, Observations and physical monitoring	Occupancy, windows opening and closing, shading control, lighting control	Longitudinal and spot measurements	(Andrews et al., 2013; D'Oca et al., 2014b; Hong et al., 2015b; Li et al., 2015; Schakib-Ekbatan et al., 2015)	Can diagnose problematic issues in the buildings	Qualitative, cannot be coupled with quantified data Difficulty in generalization

5. Challenges and Future directions

The review identified the following challenges in terms of occupant's behavior data collection;

- Since occupant's nature is complex, diverse, and stochastic, the selection of the sample size of occupants can be challenging. The researchers must use their own judgment in most cases to provide an adequate sample representative for various occupants biological, physical, and social characteristics (age, race, gender, employment...)(Andersen et al., 2009).
- Different occupant's actions require different frequencies for monitoring. For example, adjusting the shades or window opening requires a shorter sample range than equipment use. This also applies in terms of duration; occupant's energy behavioral data are often collected over a specific period of time varying from days to years (O'Brien, Gunay, Tahmasebi, & Mahdavi, 2017) in which the research relies on generalization. However continuous monitoring to study seasonal differences in behavior is essential.
- Ethical and privacy issues make data collection difficult, as well as organizational, legal and, practical limits on the extent to which this can be achieved (Yan et al., 2017)
- Sensors used for occupancy behavioral data collection can be complex and costly.
- The challenge with questionnaires and surveys lies within the probability of occupants to misrepresent or recall their behavior accurately.

6. Conclusion and Future Direction

Knowing that quantifying the impact of occupant's behavior on energy performance relies heavily on occupant's behavioral data gathered through sensors and surveys, developing models in virtual reality immersive environment is a novel research direction. This immersive environment couples modelling with sensing and translate the building environment into a virtual system which can mimic and simulate occupant's behaviors in the building (Gilani & O'Brien, 2017; Heydarian et al., 2014).

As a conclusion, this paper reviewed occupant behavior data collection methods and techniques summarizing their application, advantages and disadvantages, and pointing out their challenges and future opportunities.

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Sustainability of the UK Construction Industry Workforce: A Critical Review

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Abstract

The construction industry value chains are fragmented, poorly skilled and unproductive in the UK. Performance of the industry is stymied by poor talent acquisition and lack of investment in value chain development. Construction organisations respond to unstable economic conditions by buying and selling their workforces as capital and actively seek to avoid direct ownership of human assets that can become burdensome when economic conditions deteriorate. The scarcity of skills in the construction workforce has been developing over a long period and the impending retirement of a previous generation of workers could potentially increase the skills gap beyond the industry's ability to operate effectively. As this skills availability crisis has developed the digital revolution has been taking place and the skills required for the future are changing significantly to align to new digital economies. UK Construction is struggling to adapt to changes associated with the technological advancements of industrial revolution 3.0 as other industries are on the verge of tipping in to industrial revolution 4.0.

This paper details an investigation of the barriers to a sustainable construction workforce in the UK and skills that it lacks for the needs of today and those of the future. The findings of the literature review were combined to produce a list of concepts for inclusion in a value chain development framework. The developed concepts were then tested against an industry sample to understand attitude towards ideas that industry would need to support for effective change management.

Keywords: construction industry skills, sustainable workforce, value chain management.

1. Introduction

Human society is rapidly changing to adapt to new digitalised landscapes. This is a global revolution and no industry or country is immune to the changes that are being driven by the digitalisation of economies. The World Economic Forum (2017) cites a global job loss figure of between 2 million and 2 billion by 2030 due to the adoption of technologies in favour of human labour. The large difference in the figure is indicative of uncertainty surrounding the outcomes of this revolution.

Digitalisation has been the cause of the third industrial revolution and technological advancements are now driving industries towards a fourth. In the fourth revolution; industry 4.0, the lines between the digital, physical and biological realms will blur and a complex and inconceivably vast transformation of humankind could take place. The potential of this coming revolution is very promising and it could provide the most positive developments in human history. There is also potential for this to be one of the most perilous times in human history as the disruption associated with the short and medium-term changes could be great. Schwab (2015) states that it is the way in which the changes are met that could be the difference between human societies thriving and merely surviving.

The World Economic Forum describes the coming revolution as the Machine Age and categorises jobs in relation to their relevance to a digitalised world:

- Jobs that will disappear
- Jobs that will collaborate with machines
- Jobs that are completely new or roles that remain untouched by machines

(World Economic Forum, 2017)

Digital literacy will be fundamental to survival in the digital world. Construction in the UK currently suffers from deeply entrenched traditional practices that resist modernisation. It must embrace the modern world of digitalisation and learn to understand how it can adapt its workforce to digital based operations. Shifting to digital environments is a complex, long term challenge that the industry must rise to if it is to address ongoing productivity issues and provide the skills required to address present and future sustainability challenges (HM Government, 2013), (BIS, 2009).

Digital technologies like Building Information Modelling (BIM) have begun developing within industry 3.0 and these new digital processes have introduced the requirement for new modern skills. Sensory and robotic technologies that are associated with industry 4.0 will be incorporated in to processes that are being developed as part of industry 3.0 (Vaha, Heikkila, Kilpeläinen, Järviluoma and Gambaio, 2013).

But construction in the UK still requires its traditional workforce and it has been failing to address a skills scarcity that can be traced back to the early 1990's. The failure to address long standing issues in construction employment could result in paralysis of the industry as retirements deplete the skills pool further. Some forecasts have predicted a reduction of the UK construction workforce of up to 25% over the next ten years because of retirements (Farmer, 2016).

Recruitment of talent in to the industry is harmed by poor industry image and the consequences are: low productivity, low profits and poor adoption of modern technologies. The workforce is further harmed by the uncertainty of economic cycles and the need for organisations to remain detached from their workforces so that they can be easily disbanded when required. This cocktail of negatives is providing an unsustainable industry that is seemingly impotent to address its own failings (Farmer, 2016).

UK Construction is historically very slow to implement change and this has been highlighted by the CITB (2007) as one of the long-term trends in the industry. The industry also consistently underachieves in areas of efficiency, profitability and investment in capital. These issues have been well documented and evidenced in numerous renowned reports, including: The Latham Report, Constructing the Team (1994), Egan Report, Rethinking Construction (1998), and the Farmer Report, Modernise or Die (2016).

This paper details an investigation in to the UK construction industry workforce that explored its current level of sustainability and the prominent causal relationships. It defines likely and desirable future skills needs. Further work on this research will be to collect primary data that tests the industries own attitudes towards concepts that could be used for future proofing the workforce. The ultimate output of the research is a conceptual value chain management tool designed specifically for the needs of the UK construction industry.

2. Research Methodology

A literature review was carried out using physical resources available at the library of the University of Wolverhampton city campus and online resources made available through the University's access to extensive digital databases. Due to the nature of the subject matter, substantial use was also made of official publications made available by industry sponsors such as the UK government and leading industry bodies.

Through the literature review the current barriers to a sustainable UK construction workforce were identified and the parameters of a sustainable construction workforce ascertained. The literature review also identified current and future skills needs of the industry. These findings were combined to produce a list of concepts for inclusion in a value chain development framework. The developed concepts will then be tested against an industry sample to understand attitude towards ideas that industry would need to find acceptable.

A pragmatic mixed method approach will be used to test the concepts against a non-probability industry sample. Attitudes will be measured using Likert scales and results subjected to univariate descriptive analysis.

3. Barriers to a sustainable workforce

Six distinct barriers were revealed after a comprehensive review of literature. They are:

1. Workforce satisfaction and retention.
2. Industry image and attraction.
3. Homogeneous and engendered workforce.
4. Aging and migrant reliant workforce.
5. Economic conditions: job security and skill investment.
6. Workforce productivity and modernisation.

3.1 Workforce satisfaction and retention

Dainty and Loosemore (2012) described human resource management (HRM) in the construction industry as poorly understood and said there is a reluctance to having critical discussions. They say that the industry is reliant on 'best practice' panaceas, which is a reference to the industry's steadfast use of tried and tested traditional practices. They say that discussion of construction HRM has focused on producing cost efficient performance outcomes. This is supported by the findings of Farmer (2016) that show the industry is low profit, financially fragile and reliant on adversarial pricing models. Managing human resources narrowly within the scope of financial risk may therefore be seen as a necessity and in within the terms of human capital the human element is likely lost.

Modern changes in social conditions have complicated labour markets by bringing human rights into play. It is no longer acceptable to treat workforces as simple human capital, they must be cared for. Labour is also free to come and go from any given industry so the more difficult or stressful the work in a sector the harder it is to resource. Despite the industry's size and importance to the UK economy it may fail to recognise the necessity of effective human resource management in the modern world (Dainty and Green and Bagilhole, 2007).

Oluwatayo (2014) supported this view, and like Dainty and Loosemore (2012) he highlighted the lack of studies that have been undertaken into human resource management within the sectors of the construction industry. Oluwatayo (2014) suggests some major factors for job satisfaction; work interest, autonomous working, acceptable pay and transparent work environments. Lim and Ling (2012) agree and add reasonable workloads and recognition of work to the list of factors for job satisfaction. They go on to link job satisfaction with employee retention and support the view that workforce satisfaction needs to be managed if an organisation intends to retain its employees. Hussey (1996) supported a link between satisfaction and retention and states that there are "few solutions" in human resource management that can be treated as lone issues. Hussey (1996) examples the complexity of satisfaction by listing various entangled issues such as: business culture, career prospects, communications, training, salaries etc.

Satisfying a modern workforce is a necessity if organisations are to retain the best talent. In the modern world it is relatively simple to move organisations or industries in search of job satisfaction. Expectations from modern workers are far higher than in previous generations and if the expectations are not met then the labour simply moves on.

An unsatisfied workforce is also a poor ambassador for prospective talent. Farmer (2016) described the industry as lacking belief and conviction and those from within do not promote to those outside in a way that they perhaps should do.

3.2 Industry image and attraction

Globalisation has complicated talent acquisition by increasing mobility and diversifying workforces (Lawler, 2008). An industry needs to have a modern, diverse image if it to meet the expectations of young talent. There is also higher demand for talent in modern economies and this increased scarcity further emphasises the importance of the industry image.

The complexity of modern talent acquisition may be compounded within construction because it suffers from distinctly poor attraction which Farmer (2016) cites as an influencer when informing the career decisions of quality human resources. He says that this is a holistic issue that is the result of the industries other issues combined to create an unattractive image for the industry.

Image may also be affected by the poor promotion of the industry from those within it. As discussed earlier, the industry suffers from poor worker satisfaction and unsatisfied workers are unlikely to promote the industry to those outside of it. Farmer (2016) describes this as a lack of frontline ambassadors that should be promoting the industry to their social networks. Poor promotion is also evident in popular industry publications. Professional Builder (2017) recently ran an article that cited a figure of only 17% of UK people who would consider a career in construction and 67% stating that they would *never* even consider it. The article suggested that the industry is seen as strenuous and dirty and one of the least industries requiring higher education.

The Department for Business, Innovation and Skills (2013) agrees with these suggestions and describe the industry as generally perceived to be a dirty industry for those who are incapable of doing better by going to college or university. Agapiou, Price and McCaffer (1995) sum up the issue by stating that employers are limited to the left over pool of young talent because of the industry's image problem.

The industry image may also suffer from a lack of diversity within the industry as those looking in from the outside may perceive a majority aging white, male stereotype.

3.3 Homogeneous and engendered workforce

Wilkinson, Johnstone and Townsend (2012) provide the idea that the industry's image problem may be exacerbated by the male or 'gendered' nature of construction. They suggest that the gendered nature has caused hostility towards effective management of human resources in the industry and the workforce is neglected as a result. From a human resources management perspective the industry is archaic and it may be as a result of a traditionally masculine environment. It may be that women currently foster more ethical and healthy attitudes that promote effective human resource management in other industries. Harvey, Heidrich and Cairns (2014) highlight research that demonstrates this and put it down to psychological factors and motivation that differs between the sexes.

According to the CITB (2015) women make up around 2% of manual labour positions in UK construction and between 15% and 18% of architectural and engineering positions. This is disproportionate to the wider UK population divide of approximately 50/50 and is indicative of an industry out of sync with the world around it.

Kumra and Manfredi (2012) discussed general diversity in the workplace and highlighted the benefits of an integrated and diverse workforce. Acquiring new resources in to an already diverse environment is easier because the environment looks more attractive to prospective talent. Diversity may also introduce enhanced creativity from novel perspectives and help to challenge traditional view points and drive organisational change. Problem-solving can potentially be enhanced by a wider range of perspectives that can contribute to the analysis. They conclude that the core argument for diversity is the flexibility and dynamism it introduces and the greater potential for challenging accepted norms. The UK construction workforce historically struggles with change and the traditionally masculine environment of the industry may be a strong contributing factor to this. A modern, sustainable workforce could be representative of the wider population and take advantage of the potential value of diversity.

3.4 Aging and migrant reliant workforce

In the UK the construction workforce is aging and Farmer (2016) cites a figure of 20-25% of the workforce retiring over the next decade and states that this is a reality that the industry hasn't faced before. The CIOB (2016) supports Farmers concerns and have conducted various studies on the issue and found that 65% of construction professionals perceive that construction has an ageing workforce. 65% also noted a reduction in the recruitment of those aged 16-30. They cited 76% of responders as being aware of the aging workforce issue but only 24% gave it any consideration as part of their projects.

The CITB (2007) also highlighted this issue some 9 years before Farmer and stated that special measures will be required to maintain future skills requirements. This may support Farmers (2016) view that the CITB is not fit for purpose; having highlighted the issue in 2007 yet achieved little to address it.

The UK has a history of utilising migrant labour rather than addressing issues with the resident UK construction workforce. Farmer (2016) states that half of the London construction industry is now migrant labour; the CITB (2017) quote the same figure from their own research and add that 1 in 8 of the workforce is non-UK outside of London.

Migrant labour is also younger in the construction industry than the native workforce Over 70% of migrant labour are aged 44 or below and over 40% are aged 34 or below (ONS, 2018)

The CITB (2017) more recently found that the proportion of migrant labour in the age range of 25-34 is significantly higher than the UK demographic and is masking the aging workforce issue somewhat

3.5 Economic conditions: job security and skill investment

Dainty and Loosemore (2012) described the construction industry as 'highly vulnerable' to economic cycles and say that construction businesses attribute high risk to direct employment and investment in human resources as a result. Farmer (2016) also highlighted this economic condition as a key issue in his report and described it as low predictability that drives a lack of confidence in workforce investment. Farmer (2016) also discussed low profitability as a barrier to construction skills investment which Reina (2017) attributes to economies of scale and says that they cause investment in skills to be stymied by a lack of financial capital.

The relationship between construction, economic cycles and skills has been discussed consistently through relevant literature and is well understood by industry observers. Numerous commentators have discussed its effects, notably including: Latham (1994), Egan (1998) and Farmer again in 2016. Economic cycles create an environment of poor predictability and damage the confidence of organisations to invest capital in human resources that may be lost in the next economic downturn. Talent that is acquired during an upward trend in a cycle may migrate to other industries when the cycle enters a downturn and is unlikely to return to the industry afterwards (Latham, 1994). MacKenzie and Kilpatrick and Akintoye (2000) investigated this and added the rise of self-employment and sub-contracting to the list of factors stymying investment in skills.

Self-employment has been driven by the industries lack of confidence in owning its own workforce because they become a burden when the economy suffers downturns. Farmer (2016) describes this as a fear of being left “holding the baby” when company finances are strained. The UK Department for Business Innovation and Skills (2013) cites a figure of only 17% of indirectly employed construction staff investing in skills. They describe the culture of low profitability and unstable economic conditions as an ‘earn or learn’ culture. Currently there is little evidence within the available literature for practical solutions to constructions economic weakness but a move towards technology and digitisation may offer some solutions. A much smaller, more productive and technologically enabled workforce may require less capital to maintain through economic downturns and also require less investment to upskill.

3.6 Workforce productivity and modernisation

Farmer (2016) described construction productivity as ‘stark’ in comparison to other similar industries like manufacturing. The industry favours self-employment and sub-contracting that form barriers to workforce engagement. This may damage productivity as engaged employees are reportedly more productive and companies with high benchmarks for engagement are reportedly on average 21% more productive (Ernst & Young, 2017).

This is not strictly a UK issue though. Reina (2017) states that construction productivity lags globally and is either stagnant or diminishing in Europe and the USA. Reina attributes this to a multitude of factors and believes it can only be overcome by the adoption of technology and investment in digital skills. Mahamid (2013) doesn’t agree and suggests major factors that affect productivity; work quality, communication and cooperation, financial status of the organisation and worker experience. Mahamid (2013) suggests that improvements in these areas would yield improvements in productivity. Whilst Reina details an alternative digital environment, Mahamid is focused on gains within the traditional framework. Both options may yield gains but there is little evidence to suggest there is any scope for good improvements to the productivity of the traditional construction workforce as it has been stagnant for such a long period. Digitalisation may be the only realistic option for the disruption and change that is required to yield productivity gains.

The McKinsey Global Institute (2017) published a report on global construction productivity and they claim a figure of \$1.6 trillion missing from the global economy due to low productivity in construction industries. They also cite investment in technology and innovation and skills as measures to overcome the challenge. Roper and Du and Love (2008)

agree with this and state that skill levels consistently improve productivity and skill levels are a proven contributor to the effective generation of value from innovations. The UK government has highlighted construction productivity as a core challenge to its infrastructure delivery goals. It lists damage to living standards and long-term economic growth as some of the results of poor construction productivity. The UK government states that the UK is a highly attractive investment destination due to its world class regulatory regime and open business practices, if constructions productivity were to match that of other UK industries it could take full advantage of the available investment. The UK government supports the adoption of digital technologies and skills as major measures required to yield productivity gains (Infrastructure and Projects Authority, 2017).

It is useful here to understand how productivity is calculated; the Office for National Statistics in the UK (ONS, 2017) provides productivity in the units of output per hour, output per job and output per worker. This is calculated by dividing overall output (Gross Value Added, GVA) by units of labour input (per hour, per job and per worker). Much of the literature refers to productivity increases through the adoption of technologies, what this means in reality is the reduction in size of the workforce so that the GVA is divided by fewer units and the productivity result is higher. There seems to be a reluctance to simply state that employment needs to be reduced in favour of efficient processes and machines. This may be because the suggestion risks polarising the issue and causing alarm amongst those who fear changes associated with advanced technologies.

4. Skills of a sustainable construction workforce

4.1 Current skills need

The UK construction industry is heavily reliant on traditional skills and suffers consistent shortages. The Royal Institute of Chartered Surveyors (RICS) reported in November 2017 that 62% of businesses were reporting stymied growth due to a shortage of available skills; in 2012 the outcome of the same survey was an average of 40% (RICS, 2017). These statistics point towards a significant worsening of the situation over a relatively short period. The Construction Industry Training Board (CITB, 2016) reinforces the RICS findings and quote positions in the industry as hard to fill:

- 21% in 2011
- 36% in 2014
- 47% in 2016

CITB state that the cause of the recruitment difficulty is 88% attributable to a lack of the necessary skills in those that are available for recruitment (CITB, 2016). RICS reports the shortages most acute for professional skills with up to 64% of businesses reporting difficulty filling positions; 44% reported the same problem for trade related roles (RICS, 2017).

Khayyat and Lee (2014) discussed the shift in economies of developed countries like the UK and suggest that the increase in technological knowledge is causing a rise in the demand for upskilled labour and a decrease in the demand for low skilled labour. They say that at all levels there is an increasingly higher requirement for technological knowledge. This may be a significant contributor to current skills scarcities as human resources are adapting to the requirements of digitalising global economies.

4.2 Future skills need

The National Infrastructure Plan for Skills 2015 reported that the UK construction industry would need to fill 100,000 new skilled positions by 2020 to deliver the infrastructure projects already in the pipeline at that time. They also cite a figure of 250,000 workers that will need to be retained and upskilled to deliver the UK investment plan over the next decade (HM Treasury, 2015). The industry actually doubled that target and employed around 200,000 more people between 2018 and the reports publication in 2015 (Rhodes, 2018) but the skills scarcity reportedly deepened rather than resolved. That may be because the skills required to address the demand are more closely associated with the future operating environment rather than the traditional. The large numbers of new people being employed in the industry may not possess the skills the industry actually requires.

The UK construction industry is adapting to operate within the digitalised economy of the modern UK. This is in response to industry 3.0, the third industrial revolution, and the technologies it has made available. New processes like Building Information Modelling (BIM) are driving the industry towards full digitalisation. Tools enabled by processes like BIM enable the easier incorporation of machines and automation into construction and may also aid the industries adoption of off-site fabrication processes. The skills required for these changes to the industry are different to traditional construction skills and present a significant challenge in meeting future workforce needs. Digitalisation isn't only applicable to the construction industry and the skills required within digitalised operating environments may be more portable than traditional construction skills and so the talent pool is smaller because it is shared amongst a wider selection of industries. Gay (2017) states that this digital revolution is changing all economies and societies and is itself a powerful driver of growth. That growth is driving an increase in demand for digital skills and as the demand for traditional construction practices will likely diminish in the digital economy, the demand for new portable digital skills will likely increase.

Gelder (2010) discussed the changes in society, such as globalisation, that are making operational environments more complex. He says that such big changes in Information Technology (IT) haven't occurred since the renaissance. He says that we are now obliged to use computer-based technologies and as these technologies become more and more important, former traditional skills are becoming of less use to us. He describes digitalisation as an "IT-driven spiral" to substantial automation. The more of these technologies we use, the more we need, the more powerful and useful they become.

5. Discussion

The literature review revealed several distinct industry failings that interact and sustain each other in a complicated and entrenched web of relationships. The failings have developed within the industry over a long time and they now hold back its modernisation during a period of intensive global economic and societal changes.

A global lack of skills is cited repetitively in academic and popular literature as a drag on the efficiency of most industries. Modern operating environments are complicated and require a higher level of knowledge or training than historical operating environments. This 'new' reality means that the demand for talent has never been higher and construction now has to compete with other industries that offer much more attractive opportunities.

In order for the construction industry to be a competitive employer of talent it must begin to address the barriers highlighted within this report. Implementing the necessary changes requires sound guidance and standard solutions that the industry is currently lacking.

The issues in the industry are deeply entrenched within its culture and successful change is likely to require a long and sustained campaign from industry leaders and promoters. That long term 'campaign' could begin with the understanding of the failings provided by this review.

6. Conclusion and recommendations

If the construction industry in the UK is to survive in its current form then it must take ownership of its workforce, reskilling and upskilling it to meet the needs of today and that of the future. It must focus on digitalisation of its processes to yield the productivity gains associated with sustainable practices and align this modernisation with its skills agenda.

This review revealed six distinct barriers to a sustainable workforce that the industry will need to focus on if it is to work towards sustainability. A standard route to a sustainable workforce could be developed from further research in to these distinct barriers and the causal relationships that result in a poor industry image.

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The Impact of Training and Staff Development on the Sustainability of SMEs and New Business Ventures: A Review of the Literature and Research Methods to Explore the Link

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Abstract

This is a working paper which reviews the literature that studies the way in which new enterprises or developing SMEs deploy staff training and development, and the impact this has on their growth and development. The paper further discusses a proposed methodology for examining the subject in the context of SMEs and new business ventures in the Kingdom of Bahrain. The impact of training and staff development has been extensively covered in the literature but there is comparatively little research which looks at this specifically in the context of Bahraini SMEs and takes into account the specific work practices and culture of organisations within the Kingdom. It is hypothesized that these may considerably influence the design and implementation of training initiatives and how their impact should be measured in the Kingdom of Bahrain. Although there is not yet a general consensus on the extent to which training contributes to the overall success and sustainability of enterprises (nor indeed how such success can be accurately measured) there is a considerable body of literature which supports the view that organisational success is closely allied to effective human resource practices – and in particular training and staff development. When studying the link, however, it is important to consider the influence of political, social, and cultural factors which may influence and constrain the strategies which business organisations adopt in order to achieve their business goals and objectives. The paper discusses a proposed methodology to empirically measure the uptake, integration and perceptions of impact of training and staff development from the perspective of new enterprises and SMEs operating in the Kingdom of Bahrain.

Keywords: Training, staff development, sustainability, SMEs, ventures

1. Background

The purpose of this paper is broadly set in the context of studying the way in which new enterprises or developing SMEs in the Kingdom of Bahrain engage in staff training and development and the impact that this has on their growth and development.

The impact of training and staff development has been extensively covered in the literature though there is comparatively little research which looks at this specifically in the context of Bahrain and takes into account the specific work practices and culture of organisations within the Kingdom which are particularly important when examining the subject. (Bishop, 2008; Damoah, 2016; Dembiras et al., 2011). Although there is not yet a general consensus on the extent to which training contributes to the overall success of enterprises (nor indeed how such success can be accurately measured) there is a considerable body of literature which supports the view that organisational success is closely allied to effective human resource practices – and in particular training and staff development. (Laforet, 2016; Richard et al., 2009; Towler, Watson and Surface, 2014).

Any study which seeks to examine the impact of staff training and development on new enterprises and SMEs requires a study on the external factors which influence the establishment and development of new ventures as well as examining how more established SMEs value and use training in their business ventures. To do this requires a detailed examination of the context in which new enterprises and SMEs operate and this is in turn impacted upon by political, social, and cultural factors which both influence and constrain the strategies which they adopt in order to achieve their business goals and objectives. (Kelliher and Henderson, 2006; Parthasarathy and Gupta, 2017).

There are very few studies which examine the impact of training and staff development from the perspective of new enterprises or how, in the case of SMEs, training contributes to the enterprise life cycle at different stages of the development of the enterprise. However, its significance has for some time now been recognised as a potential reason for the failure of new ventures in the year following start up (Watson

and Hogarth-Scott, 1998). There are also very few studies specifically in the context of Bahrain with the exception of a very small-scale study on managerial skills training (Al Bahar et al., 1998) and a small empirical survey of SMEs which emphasises the need for more detailed research (Alrabeei and Ramprakash, 2014). Indeed, there are also a limited number of publications which focus on the Gulf States or Middle East Region.

Like many other countries, the government of the Kingdom of Bahrain has recognised the importance to the economic prosperity of the country by growing new businesses and encouraging entrepreneurial ventures. The drive towards this is heightened in the Kingdom because of the fact that historically the native Bahraini population has generally looked to the public sector for employment and the government in its economic vision is promoting a more 'entrepreneurial culture' and is actively supporting this, in part through its training initiatives and support for small business ventures. However, in a study centred on Bahrain it must be recognised that there are thus important cultural factors which may impact on the research. It has frequently been noted in the literature that HR practices (which include training and development) are not universally applicable across all cultures (Youssif Abu Keir, 2017). In particular the impact of Islamic work practices and the historical development of employee relations are likely to play an important factor in any examination of working practices within Bahrain.

This also needs to be examined in light of a comprehensive study of the way in which the government and its various agencies support the local work force within the Kingdom. In particular it needs to incorporate a consideration of the procedures to apply for funding and obtain an approval for a funding of training for employees. These should be based on any requirements to conduct training needs analyses and a consideration of how the impact on the enterprise is measured. Government support is consistently stressed in the literature as being of crucial importance but the manner in which it is provided varies widely (Nolan and Garavan, 2016). Robertson went as far as to suggest that 'their success in upgrading themselves technologically may depend crucially on subsidised educational and training infrastructure provided by their governments' (Robertson, 2003). It is, however, also important to learn from lessons from the past. As noted by Lawless, 'In the past, too many government sponsored initiatives have presented valuable learning resources which have been wasted because the target small business audience have failed to utilise them.' (Lawless, Allan and O'Dwyer, 2000).

With regard to many of the training schemes within the Kingdom (which co-ordinates training for business development in Bahrain) training schemes, there is a need to further study the impact of these trainings in supporting the needs of new enterprises. In general, the measures used to study training are mostly based on volume of training undertaken rather than the outcome of the training on the performance of new enterprises. There are currently no well-defined key performance indicators to define the parameters to measure success of training initiatives and objectives need to be more clearly stated and linked more clearly to the diverse portfolio of needs across a large number of diverse enterprises.

2. Research Problem

In the past, one of the issues faced by SMEs and start-up ventures in Bahrain is attracting talented workers. Enterprises tend to seek talented external candidates to fill vacancies, which can be costly and is not always successful in terms of growing a successful enterprise. In particular in organisations in Bahrain, the reliance on seeking external expertise exceeds that of growing the potential of internal workforce. Consequently, that results in the development of high costs in recruiting and selection, and moderate costs in training and development (T&D).

The research problem is therefore not confined to examining the existing infrastructure to support new enterprise development and SMEs through training but also in looking in more detail at the training offered and the potential link between that and successful growth of new enterprises.

Given the lack of published research and reliable data it will be important to engage in a holistic examination of the training requirements of SMEs and start-up companies in the Kingdom of Bahrain and determine the critical success factors which impact on their performance. This will involve an examination of the type of training provided for new and developing enterprises (and its relevance to the needs of the enterprises), barriers to engaging in employee training in new enterprises and small and medium sized enterprises, and gaining a perspective from those involved in such enterprises about what they perceive to be the main features of training which is required to support them in the early stages of growth or in SMEs.

Relevant research questions are thus:

- What are the main types of training which are accessible to new business developments and SMEs in the Kingdom of Bahrain?
- What are the perceptions of the owners/managers of new enterprises of the importance and relevance of training to achieve business success and profitability?
- What is the stated purpose of such training and how well are the objectives of the training met in practice?
- What are the gaps perceived by new or recent start-up companies in terms of meeting their training needs?
- From the experience of a range of SMEs what type of training have they found most valuable in growing their capacity to develop and grow their businesses?
- What internal mechanisms are used by enterprises to determine their training needs?
- What, if any, is the evidence that training is positively correlated with business success in new enterprise development and in SMEs in the Kingdom of Bahrain?

3. Literature Review

The advantages of training are well documented in the literature (Horwitz, 1999; Johnson and Loader, 2003; Copley, 2013; Padachi et al., 2016) as is the importance of SMEs. As Lange pointed out in 2010 "SMEs play a pivotal role in sustaining employment and creating income and prosperity" (Lange, Ottens, and Taylor, 2010). However, it has also been noted in the literature that the growth of SMEs and the recognition of their economic importance in the developed world in the 1970s and 1980s was not accompanied by a consideration of the need to carefully consider training and development within organisations (Horwitz, 1999; Kelliher and Henderson, 2006). Whereas the importance of training was being increasingly recognised the literature at that time was generally restricted to larger corporations and well-established business organizations (Bishop D. 2008). The benefits of formal training (and accredited training) from external organizations have not been widely considered in the context of small or new enterprises. However, a relatively recent study confirmed the 'intuitive link' between 'human capital' and business success in the context of Asian SMEs. (Vandenberg and Trinh, 2016). In that study the researchers defined human capital in two ways - the average education level of the workforce and the engagement of the enterprise in formal training. They found that firms with a more educated workforce and those that offered formal training had higher labour productivity, and furthermore both 'human capital' inputs had an independent impact on productivity (Vandenberg and Trinh, 2016)

In the literature on barriers to training in small enterprises the issue is dealt with in terms of four main themes (Paul, Parthasarathy & Gupta, 2017). These can be summarised as being:

- organisational culture,
- financial considerations,
- issues related to access and provision of training and, linked closely to all of these
- the awareness of the benefits of formal training.

The authors of this paper would argue that these should be refined to incorporate a consideration of the broader environmental culture in addition to organisational culture and rather than 'awareness' of the benefits of formal training the emphasis should be on the 'perceptions' of the benefits of formal training. The authors suggest that this gives a more accurate framework within which research should be focussed.

3.1 Organisational and Environmental Culture

Organisational culture

Cultural considerations are generally dealt with in terms of organisational culture and much of the literature still focuses on these in a western context. Organisational culture can be defined as shared perceptions of organisational work practices within organisational units. It includes dimensions such as autonomy, external orientation, interdepartmental coordination, human resource orientation, and improvement orientation

With respect to this small to medium sized enterprises are often characterised as being typically insular and self-reliant. It has been observed by several writers on the subject that training on the job and more informal training is generally favoured by small organisations (Webster, B et al. 2000). Training, it is

claimed, is often implemented only when a specific need is identified and there is not a consideration of staff development as part of a wider strategy for continuous development and growth (Padachi et al., 2016). While there are benefits which can be identified for staff learning in the context in which they are working it is often financial considerations which drive the manager/management of SMEs to favour this approach as opposed to formal training or accredited courses. This is true not only of the direct financial cost of providing training but also in the potential significant loss of the investment in training and in intellectual capital arising from 'poaching' of staff by other organisations (Panagiotakopoulos, 2011). In the view of some commentators the mobility of staff from SMEs to larger more established corporations is partly facilitated by SME employees that larger organisations may offer more job security and frequently can offer better working terms and conditions and remuneration packages.

It has been noted that the single most important factor in organisational culture in small enterprises is the competency of the owner(s) and the attitude which personal preferences and biases have on the development of the organisation. This is a very significant area for research. The observation has been frequently made that the results of any empirical study conducted tend to be inconsistent (Demirbas et al, 2011; Nolan and Garavan, 2016) and the reasons for conflicting findings should be carefully analysed – particularly from the perspective of more over-arching cultural considerations of the geographic location and politico-economic system in which the organisation functions.

Environmental Culture

It is clearly important to look more broadly at cultural considerations when considering the developmental needs of SMEs in developing countries and economies.

Thus, while there are 'cultural' issues which are generally applicable to SMEs there needs to be a wider consideration of issues which impact on attitudes to training and staff development in particular geographic contexts.

It is important therefore when researching barriers to training provision to look carefully at the context in which human resource management practices are implemented in the country being studied and there is a growing body of literature in HR which deals with the influence of social, political and religious influences on the way in which HR is deployed to give organisations competitive advantage.

National culture can have a very important impact on what HR practices are adopted, how they are adopted and how they are perceived. Badawy, (1980) asserted that social attitudes and cultural values in Bahrain are distinctive and differentiated from other geographic regions. While his research is very dated there has not been any significant publication which refutes many of the conclusions and observations he makes on the situation in Bahrain and thus it will be important to test these assumptions carefully when undertaking empirical research. It is important, therefore, to identify the significant difference and in reviewing the literature in general on Islam and management, there is consensus that organisational culture and managerial behaviour is shaped and influenced by Islam, tribalism, state control (including a consideration of the general economic and political situation) and Western influences.

Within Bahrain it has been noted that in terms of skills development there is a view that it is more cost effective to 'buy in' new skills when they are needed. In addition, recruitment itself is done on the basis of looking at the short-term need of the organisation to maximise profit.

In addition, in small and medium-sized companies, managers are finding that there is a tension caused by practices which require different national or ethnic groups to be treated differently and accorded a different status in the workplace. In the increasingly competitive and global world in which business is conducted businesses must develop their staff and provide encouragement for them to feel involved and valued. Previously the extensive employment of foreign workers effectively meant that HR had to identify an appropriate candidate with the right skills and agree administrative detail on pay and conditions. This is no longer the case and in seeking to develop the best possible work force HR managers have an important role to play in attracting, developing and retaining Bahraini employees who can demonstrate they have appropriate skills and expertise. Of paramount importance to training and staff development however, is that the management function itself must change from being based around a "control paradigm" which Atiyah (1996) describes as "management by fear of sending you home" to a focus on management which actively fosters and develops its workforce (Atiyah, 1996). While Al-Rasheed reported in 2001 that Arab management was largely traditional and in particular frequently suffered from a lack of delegation of authority, this perception is beginning to change as organisations are more willing to adopt practices which they believe will make an impact on organisational performance.

3.2 Financial Considerations

Financial considerations are significant but can only be studied in the context of the particular SME or new venture which is being examined and the governmental structures and policies which facilitate access to funding. These are particularly challenging for developing economies. Access to capital investment and subsidies vary considerably within political jurisdictions and can be largely influenced by governmental policies which dictate the macroeconomic climate in which private enterprise is supported (Abor and Quartey, 2010; Richard et al, 2009).

3.3 Access to Provision of Training

Access to training is specifically linked to the geographic region in which the SME is located. Generally, from the literature, however, it can be fairly confidently asserted that in developing economies access to training is more limited than in the western world. (Yin Bai, 2017; Damoah, B. et al. 2016, Thassanabanjong, Miller and Marchant, 2009; Abor, 2010). Specifically it is important to consider the type of training and mode of delivery. As Hashim and Wok point out there is a marked bias towards training approaches which are more appropriate for large scale enterprises. (Hashim and Wok, 2013). In addition, several authors have noted that evidence suggests SMEs are less likely to participate in training than larger enterprises. To counter this problem several authors have advocated the use of online learning (both synchronous and asynchronous) to provide increased flexibility of delivery (Taran, 2006) but this of course has also to be considered in the light of cultural factors and in the Gulf Region online learning delivery is often not favoured as an option (Lawless, 2000; Lewis and Thornhill, 1994)

In terms of access to training in Bahrain, the work of training providers is of crucial importance and their contribution made in supporting training initiatives for SMEs should be systematically documented. However, there has been no research which is targeted specifically at the SME sector and which is based on an empirical study of the opinions and views of individual managers. While much of the literature from developing countries suggests that access to training is poor and awareness of potential benefits tends to be negative there is a need to provide more up to date data and specific context-based research to establish whether this is still a valid conclusion with respect to attitudes of the SME sector in Bahrain.

3.4 Perception of the potential benefits of training and development

As noted above, in terms of the potential impact of training and staff development on organisational success there is a large body of literature which claims to have established a positive relationship. The literature, however, is sometimes inconsistent and while many studies claim to have established the link there is also a large body of literature which is critical about the methodologies used to come to reported conclusions. Nonetheless, the evidence for improvement in organisational performance across a large and diverse number of business organisations is substantial (Saastamoinen et al., 2017; Susomrith, and Coetzer, 2015; Roffe, 2007.). The authors of this paper hypothesize that a reason for the diversity of findings in studying of the link between training and development and organisational success is a lack of clear definition. Despite the fact that there is a wide variety of frameworks and methods which are involved in training and staff development this is not often made clear in the literature. Similarly, the definition of organisational success is very loose. According to Richard *et al.* (2009), the analysis of a company's organisational performance is based on an examination of the company's goal or objectives and comparison with three specific outcomes: firstly financial performance (which as was also the case in a study by Satiman (Satiman, 2015) was measured by examining profits, return on assets, return on investment (ROI), and other standard measures used to assess the financial 'health' of an organisation); product market performance (measured in terms of sales and market share of the product or range of products); and shareholder return (measured in terms of the economic value added and in terms of total shareholder returns). However, a broader definition of operational performance in an organisation is a theme which comes up frequently in academic literature. Again, there is a need to provide clarification and definition of this concept. (Fleetwood and Hesketh, 2006). The earliest and still one of the most commonly used general classifications is that provided by Venkatraman and Ramanujam (1986), who adopted a strategic management perspective and focussed measurement more towards profitability and productivity and drew a clear distinction between financial and operational performance, with the emphasis on the latter.

It is important, therefore, that the benefits of training are clearly defined and solid arguments can be put forward if awareness of benefits or potential benefits is to be increased.

In terms of a review of the literature it should be noted that while many publications note the importance of examining enterprises at various stages of their development there are no significant discussions of the attitudes and practices adopted by new enterprises towards training and staff development - although it is sometimes touched upon tangentially (e.g., De Faoite et al. 2004). There is a fairly substantial body of literature on preparation for launching a new venture and in particular subjects such as development of business plan and consideration of marketing strategies are comprehensively covered (Copley, 2013). However, there is no consideration of forward planning for training as part of a strategic plan to grow the enterprise or studies on how this is taken into account by those launching a new venture.

4. Research Methods

From the existing literature, it is clear that in order to make a significant contribution to our knowledge of how training and development can positively impact organisational performance, it is necessary to conduct focussed and detailed research, which involves all of the significant stakeholders in promotion and development of new and developing business ventures, in Bahrain. This involves the following actions:

4.1 Empirical Study of Training Providers and actual and potential recipients of Training

The research must survey new enterprises and training providers and it is important to define clearly the design of any survey questionnaire to gather the significant data concerning the adoption of training in SMEs and new enterprises within the Kingdom of Bahrain.

Additional data to provide context is important and thus input must be solicited from bodies such as:

- Bahrain Chamber of Commerce
- Ministry of Labour
- Economic Development Board
- Tamkeen

The survey questionnaire should not be confined to gathering statistical and demographic data but must also use open questions to determine the perceptions of both enterprises and training providers on the needs (and for enterprises) the adequacy of the training offered. This will provide the basis for a comparison of how both trainers and trainees perceive training opportunities reflect the needs of new enterprises in terms of coverage of subjects and relevance. It will also assist with exploring the barriers to training which may be both practical (cost, availability, time factors etc.) and cultural factors which may impact on perceptions of usefulness or necessity.

Interviews and focus groups are important to gain richer data on the attitudes to training and perceptions of its usefulness by managers of new and recently established enterprises. This is very important. Interviews provide the opportunity to gather data which reflects their perceptions of managers in terms of how they view training and explore more deeply why such perceptions are held. This also assists in determining the rationale for working practices which they have been adopted and gives context to views on the extent to which training is valued and directly address potential barriers which SME managers face in engaging in training opportunities. Furthermore, as noted by Al Bahar notes, 'there is a strong preference within Arab culture for business transactions of all kinds to be based on personal contact' (Al Bahar, Peterson and Taylor, 1996, p.27). Organisational development and organisational structure have a major influence on how successful organisations are in achieving their goals and it is thus important that any study on the impact of training practices on the performance of organisations is set within a clearly defined context of internal and external influences on the particular organisation.

4.2 Population and Study Sample

The survey must be sufficiently broad to cover a representative sample of organisations and initial research would suggest that a minimum of 80 enterprises in Bahrain should be targeted. On available data this is a realistic number in terms of the current growth statistics in new enterprises in the Kingdom of Bahrain. The population size should be carefully monitored and if necessary increased if during the course of the research additional stakeholders are identified and thus a 'snowball sampling' approach to data collection

is appropriate (Noy, 2008). The constituent sample will be influenced by data provided from established lists of enterprises sourced from governmental bodies. The selection needs to be made on the basis of size and type of enterprise and the research base for sampling will ensure that there is a diversity in terms of size of enterprises, the number of years the enterprise has been established, the sector in which the enterprise operates and the extent to which it can be categorised as a 'family business'. It is useful at this point to note that there are variations in how the term SME is understood. The European Commission definition is often adopted. This categorises SMEs as firms with 10 to 99 employees (small) or 100 to 499 employees (medium). However, Abor's definition of SMEs in developing countries is preferable (i.e. 5-19 workers (small) and 20-99 workers (medium)). (Abor and Quartey, 2010) Ideally, the research should include enterprises which have 'failed' but the authors recognise the difficulty which may be faced in engaging with owners/managers of such enterprises and the need to treat the responses which they make separately from ongoing enterprises.

4.3 Data Analysis Strategies

The data collected will be amenable to analysis using SPSS (Statistical Package for the Social Science) to support statistical tests and correlations. However, more significantly, the analysis of qualitative data requires textual analysis techniques to explain and aid the understanding or interpretation of the people and situations to help in providing a meaningful explanation based on context. Tools such as NVivo and other textual analysis software can be used to facilitate this.

Member checking must be used to provide an assurance that those interviewed or participants in focus groups are in agreement with the analysis prior to its being used to draw and inferences or conclusions.

5. *Brief overview of ethical considerations*

There are very few ethical issues which are associated with the research other than general issues which impact on the ethical conduct of any piece of research. Participants must be aware of the fact that any information they provide will be treated in confidence and will only be used for the stated purpose of the research. Names of participants must not be used except with their express and documented consent.

6. *Conclusion*

A key challenge facing not only SMEs (noted by many researchers working in different areas of the globe and specifically for Bahrain as noted by Alrabeei and Ramprakash in 2014), is access to well qualified human resources. The research proposed here is based on the hypothesis that training and staff development is an important factor in all stages of the life cycle of new enterprises in Bahrain and this study will make a significant contribution to better understanding the relationship between training and the ability of new enterprises to thrive.

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The UK Water Industry Issues and Challenges

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Abstract

The UK water industry has evolved over the years from being a public body in the early nineteenth century to a private sector in 1989 through the Water Act. These changes have been and are still driven the challenges the water industry continues to face. They include population growth and increase in water demand, need for collaboration, technological advancements, increasing economic demands, environmental requirements, climate change, rising energy costs, availability of adequate resources, people and skills, and changing customer and regulator expectations. The water industry has been investing emerging technology to plug the gap to addresses these challenges by gaining clarity and putting corrective measures in place. Through the Price Review (PR) submissions, water companies forward how they intend to commit spending in five-year cycles. The latest PR19 submissions, (made 2018, regulator outcome in 2019) saw the water companies commit to ambitious leakage reduction targets, lowering water bills and capital expenditure to meet customer and regulator needs. Yet, only three water companies had their submissions approved to proceed on delivering their plans, with 14 asked by Ofwat to make resubmissions. Therefore, the aim of this study is to explore, examine and understand water industry issues and challenges and how they are being addressed. A qualitative case study was used for the collection and analysis of data with the results obtained through review of water company supply chain processes, documents, observations and semi structured interviews. This study has identified the key challenges that the water industry face is that of meeting ever increasing customer and regulator expectations as well as future uncertainties; unpredictable weather patterns and climate change being at the forefront. The water industry and its supply chain are already investing in latest emerging technology in asset management, resources, organisational changes and putting customers first in all their activities. The study concludes that the water industry has been moving on from being reactive to proactive to better face the customer and regulator expectations and future uncertainties' challenges using emerging technology and changing organisational cultures. It is recommended that this approach continues to be followed and invested in more, as it has so far proved effective in other areas of capital project delivery. This will enable the water industry to face the issued and challenges that it continues to face.

Keywords: Water sector, Sustainable goals, successful implementation

1. Introduction

The UK water industry developed through industrial revolutions, population growth, with an increase in water demand due to increasing economic demands. Water supply and treatment was the responsibility of over 2,400 bodies, with the majority being councils. The legislation introduced in 1945 formed the basis of today's water supply management framework and enabled recovery after the second world war. A drought in 1959 and flooding in 1960 led to the creation of the Water Resources Act in 1963. This was revised in 1973 Water Act which saw creation of ten public regional water bodies, responsible for funding, planning and long terms infrastructure development (Ofwat and Defra, 2006). These regional bodies failed to meet their environmental standards during the 1970s and 1980s which required adoption of new European legislation. The Water Act 1983 was then introduced which also aimed to address economic challenges reducing government's decision making and authorities permitted to seek private funding. Full privatisation of the water industry was in 1989 through the Water Act to enable funding the water industry infrastructure needs (Ofwat and Defra, 2006, Bailey, 2003 and DWI, 2015). This led to the creation of three regulatory bodies which represented the public interests, namely The National Rivers Authority (superseded by the Environment Agency), Office of Water Services and Drinking Water Inspectorate (Lobina and Hall, 2001). The Water Act in 1989, created privatised water companies with a comprehensive framework, standards, regulations and independent current day regulators (DWI, 2015).

These UK water industry consists of large regional water companies who are monopoly suppliers to most consumers. They are responsible for providing water services, using private funding to maintain the water

supply infrastructure. At the same time, they should continue comply with European, national drinking water, and environmental regulations implemented by Defra, the Welsh government, the Environment Agency (EA) and the Natural Resources Wales (NRW) (Lobina and Hall, 2001, Ofwat and Defra, 2006 and NAO, 2015).

In England alone, there are nine large water companies covering different geographical regions providing both water and sewerage services. These include Anglian Water, Northumbrian Water, Severn Trent Water, South-West Water, Southern Water, Thames Water, United Utilities, Wessex Water and Yorkshire Water. There are also other various smaller, local water and sewerage water companies which include (a) Albion Water, (b) Independent Water Networks, (c) Peel Water Networks, (d) SSE Water, (e) Thames Water Commercial Services and (f) Veolia Water Projects. There are other twelve water companies that provide “water only” services and consists of Affinity Water, Bournemouth Water, Bristol Water, Cambridge Water (South Staffs), Cholderton and District Water, Dee Valley Water, Essex and Suffolk Water (Northumbrian), Hartlepool Water (Anglian), Portsmouth Water, South East Water, South Staffs Water and SES Water (The Environment, Food and Rural Affairs Committee, 2018).

2. *Water Industry Challenges through the years*

The history of the water industry shows that there have been efforts put forward into achieving collaborative working, encourage efficiency to obtain the best value for money. This yielded limited positive results, with regular legislation changes to address the shortfalls, up until privatisation (Ofwat and Defra, 2006). Back then, the water industry was identified as not investing enough in maintaining the water supply infrastructure due to public funding restrictions (DWI, 2015). However, the water companies’ reputation was poor after privatisation as they were deemed expensive, with the cost of water increasing by 50% in the first four years, whilst performance was poor (Lobina and Hall, 2001). Latham (1994) and Egan (1998) also highlighted vast inefficiencies and lack of integration in the construction industry, in which the the water sector depends in its delivery (Bailey, 2003). One of the concerns rased by Lobina and Hall (2001) was the lack of investment with assets expected to last for 280 years and 1,000 years in some cases. On the other hand, directors were receiving very high salaries.

A severe drought in 1995 uncovered great investment weaknesses in the private water sector which had been deemed as lacking incentive or drives to reduce leakage. The water companies had not invested enough in maintainance of the water infrastructure, but rather chose to pay investor dividends. Ofwat had to set leakage targets for the first time, achieving reducing it from 31% in 1994/95 to 22% in 1999/2000 (Lobina and Hall, 2001). The Environment, Food, and Rural Committee (2018) identified that the water industry has made little progress in improving leakage during the last five to ten years. In response to these findings, Ofwat set a target of 15% leakage reduction during 2020 to 2025. However, Steve Robertson, the CEO of Thames Water stated that detecting water leakage is challenging due to having massive networks. Water companies are facing penalties by Ofwat for failing to meet leakage target, Thames Water being the latest to be fined £55 million for missing customer commitments, with an additional £65 million being paid back to its customers (The Environment, Food and Rural Affairs Committee, 2018).

The history of the water sector indicate that there hasn’t been incentives to save water over the through privatisation as public did not trust the water companies who were not doing the same (Lobina and Hall, 2001). The Environment, Food and Rural Affairs Committee, (2018) identified the need to challenge the water companies to reduce water consumption rates in order to reduce the water demand. The committee was pushing for ambitious targets which could lead to innovation within the water sector. However, some of the financing arrangements and high shareholder dividend payments and debt ratios will cause distrust from customers and the water sector and derail the ambition to reduce water consumption. There is strong evidence that metering customer water supply reduces water use and can be used to detect leaks. Hence it was recommended that customers are metered so that they can pay what they use, rather than use outdated systems. This also helps to communicate the value of water to customers (The Environment, Food and Rural Affairs Committee, 2018).

Other investment challenges which face the water companies included more properties being at risk of sewer flooding, poor water quality and pollution events. A North London poisoning event caused by an outbreak of cryptosporidiosis in March 1997 led to compensation payments by the water company but the DWI was not able to prosecute at that particular time. Several successful prosecutions between 1989 and 1997 totalled 260 (Lobina and Hall, 2001). In 2018, water companies continued to fail to prevent serious pollution incidents, thought to be worsened by past penalties seen as operational costs. However, the latest threat of fines up to 1% of turnover is seen as adequate to put pressures on water companies to mitigate and reduce pollution (The Environment, Food and Rural Affairs Committee, 2018).

3. Regulatory Challenges

The policy and regulatory frameworks for the water industry in England and Wales are set by Defra as well as the Welsh government (NAO, 2015). Table 1 below summarises the regulatory roles.

Table 1 Regulation of water in England and Wales (The Environment, Food and Rural Affairs Committee, 2018)

Organisation	Regulatory role
Defra and Welsh Government	Set the overall water and sewerage policy framework in England and Wales, including setting standards, drafting legislation and creating special permits (for example, drought orders)
European Union	Sets European water, wastewater and environmental standards
Ofwat (England and Wales)	Promotes competition, sets price limits, ensures that water companies can finance and properly carry out their functions, promotes economy and efficiency
Environment Agency (England) and Natural Resources Wales	Regulate water quality and industry waste, work with partners to reduce flood risk and promote sustainable development
Drinking Water Inspectorate (England and Wales)	Checks that water companies supply water that is safe to drink and meets the standards set in the Water Quality Regulations, by carrying out inspections and checking tests that water companies carry out on drinking water

The regulatory frameworks have significantly contributed to the improvement of environmental and water quality benefits. Ofwat expected the water companies to invest £44 billion in improving services, resilience and protecting the environment between 2015 and 2020. The 2014 price reviews put pressures on water companies to demonstrate customer engagement in setting up prices and making key decisions, in cases setting more demanding performance targets (NAO, 2015).

The economic regulation has become complex over the years, as there has been a push to mimic and create competition in a diverse England and Wales water sector. For instance, the Ofwat price review process has become longer and more detailed and has become more onerous for some water companies (The Environment, Food and Rural Affairs Committee, 2018).

4. Future Challenges

At the start of AMP 6, Ofwat put great emphasis was placed on meeting future needs based on climate change, growing population which are putting pressure on the water resource. (Defra, 2011). It is predicted that water supplies will become scarcer with expectation of frequent, intense and longer droughts across England Wales. Climate change and population growth are anticipated to have the greatest impact on water resources with some rivers already drying up. The UK experienced one of the warmest summers in 2018 and subsequent drought across the UK led to a hosepipe ban in Northern Ireland and drought permits in north west England. Extreme cold weather, "beast from the east" in February and March 2018 caused water pipe bursts which left 200,000 customers without water for more than four hours and thousands cut off for days. This led to several water companies being criticised by Ofwat and the government for lack of planning and response to their customers. (The Environment, Food and Rural Affairs Committee, 2018).

The UK government has continued to identify lack of integration in the construction industry (HM Government, 2013), which is the supplier of products to the water industry (Bailey, 2003). The water sector has been challenged to be at the forefront of digital economies, through "Digital Britain" to embrace technology, and by adopting new tools which are led by data, as we are now living in a digital world (BIS, 2009). For the water sector, the UK government set up a Task Group, BIM4Water following the publication of the Construction Strategy (BIM4Water, 2015). This is a cross industry group to support implementing new ways of working through Building Information Modelling (BIM), which is a business change, in the way projects are delivered, through collaborative working. This is taking years to fully embed as it requires investment in people, processes and systems to yield quality, cost and programme benefits achieving efficiency targets (BIM4Water, 2015). These efficiency targets set by the UK government include 33% cost efficiency, delivering 50% faster and achieve 50% reduction in greenhouse gases emissions (HM Government, 2013).

Ofwat (2018) highlighted that a new challenge faced the water sector in 2017 when competition was opened for the retail market through the Water Act 2014. Ofwat has challenged the water companies to improve performance and encouraging competition. The UK water sector competition falls into three

categories namely, (a) for water and sewerage customers (b) amongst contractors for provision of services to the water companies and (c) for international contracts. Other forms of competition include regulator “comparative competition” in which water companies are compared to one another on performance to encourage efficiency. The other being ownership or corporate companies’ control; since they are private, best performing water companies can acquire those performing poorly (Bailey, 2003).

The water industry history indicates that the sector continues to face similar challenges it faced before and after privatisation though vast improvements have been made over the years (NAO, 2015, The Environment, Food and Rural Affairs Committee, 2018 and Lobina and Hall, 2001). Water leakage is still an issue, the sector needs to show more integration and collaborative working, as well as respond to economic demands, technological advancements, climate change and unpredictable weather patterns. Hence this research looks into why these challenges still exist and what the water companies are currently doing to address them at project delivery level. This research aims to fill some of the gaps that exist in understanding how water companies are addressing challenges at project delivery level to meet current and future targets.

5. *Research Methodology*

The nature of the research to investigate how the water sector is addressing challenges involves understanding how it has evolved over the years, its plan to meet regulatory targets and effects of a changing world. This led the research to adopt a qualitative approach which is focused on understanding people or organisational behaviours, what is happening by what people do or say (Gillham, 2000). Naoum (2007) states that research must be undertaken to match data availability. This research used the water and construction industry guidance documents, past studies for literature review which include UK government white papers. It also included interviews of two senior project delivery managers within the parent water companies, two interviews of supply chain project managers / engineers as well reviewing internal documents, intranet, project delivery processes and observing behaviours within a project delivery setting to understand attitudes and perceptions in two water companies.

The research followed the case study approach, regarded comprehensive, and can incorporate multiple data sources to provide detailed account of complex phenomena in real life which the study required. Four water companies in England and Wales formed the study cohort for primary data collection.

6. *Water Companies Outcome Focus*

History of the water industry has led the regulators to put a spotlight on future water management in which water companies need to be innovative and be more customer focused. Regulators also advised water companies to remain attractive to investors by removing barriers to competition, allow new water industry players and sustain efficiency to improve customer service (Defra, 2011). The water companies have responded to these new challenges by shifting their investment from being project specific but rather outcome focused to meet Ofwat requirements. In one water company, project documentation that underpin project delivery have had outcome statements incorporated to meet Ofwat targets. An example was on one scheme in which the outcome was reduction of flooding events for a set budget, programme whilst adhering to industry quality standards and recommendations. This outcome statement supported project statements submitted to regulators to indicate how they intend to meet targets. However, there have been challenges by faced by both the water company and its contractors in implementing this approach as they shift from being project specific for successful project completion.

The water company’s commitment to Ofwat will need the water companies and its supply chain to collect, store, process, exchange, maintain asset data, information, knowledge and manage it to show that the outputs meet the outcome promise made during the price reviews (The Environment, Food and Rural Affairs Committee, 2018). The research identified that the outcome focus has initiated new thinking by the contractors to innovate and find efficient solutions to identified problems. One of the water company project delivery managers interviewed pointed out that they needed to justify capital expenditure as a business in terms of outcomes, rather than works carried out, stressing out the question “What issues have we resolved or what outcome statements have we addressed” rather than what have we built. Being in the wastewater branch, the project delivery manager pushed for schemes to meet reduction in flooding from sewers to meet Ofwat (2019) targets of achieving 80% reduction in pollution incidents. Getting the price right can no longer be viewed as the benchmark for managing the water companies, but measured against delivering all the set criteria, internally and externally for Ofwat, DWI and Defra, (NAO, 2015).

7. *Preparing for the Future*

The privatised UK water industry operates on five-year cycles, called Asset management Period (AMP) in which water companies submit price reviews to Ofwat which detail plans on delivery customer needs and wants, the latest being PR19, i.e. Price Review 2019. (Ofwat, 2018). According to the National Audit Office (2015), it was expected that the water companies would spend £44 billion between April 2015 and March 2020, having spent £126 billion since privatisation. The study revealed that water companies are looking beyond AMP6 for capital expenditure and that they have already started investing for AMP7. The review of the four water companies' intranet suggested early commitment for future expenditure. Some of this expenditure is on ensuring water supply resilience for drought relief and ensuring that there is enough water during emergency situations. Results of the ongoing studies are being used to inform price review submissions with named schemes that are currently in construction being part of the long-term water resilience strategies. One water company had identified £15 billion of required investment in providing resilience in water supply and resources management. Part of this investment included entry into the retail water market.

One of the research key findings was the use of historical lessons learnt in informing future investment in water supply infrastructure. The Institution of Civil Engineers, (2017), stated that the current model used to deliver and operate most of UK infrastructure is broken and often produces assets and networks that are expensive, perform poorly and fail to exploit advances in emerging technology that is transforming other industries. However, the study identified that the water sector is putting great effort to drive out inefficiencies by embracing IT, especially collaborative working through BIM, which indicates a shift from the traditional ways of managing data, information and knowledge (BIM4Water, 2017).

There has been an increase in the use of IT to capture, manage and disseminate data, information and knowledge. The four water companies studied were part of the BIM4Water task group which encouraged greater collaboration through use of emerging technology and implementation of best practice. More asset data and water availability, conveyance and storage are being collected through on-site surveys. Underwater smart drones and sub-marines are being used by one water company to carry out asset surveys, which was not possible before to inform future investments. This data and information are being used to create smart models and solutions using accurate data and information, thus meeting the target set by BIM4Water and "Digital Britain". Greater collaboration is being achieved through this new way of working, but more needs to be done to address the challenge of interoperability of different software. However, the study found that water companies are still in early stages and more investment in staff training, software and hardware is required. One project manager interviewed highlight that not all staff were fully competent in the use of latest IT in the construction industry and acknowledged that more needs to be done over the years as it is a new way of working. This supports the findings by the research carried out by BIM4Water (2017) which highlighted the need to embrace technology and tools for water project delivery. Organisations are using intranets to share good practice, knowledge to remove inefficiencies and stop reinventing the wheel.

8. *The Immediate Challenge*

Already the water companies are expected to spend £50 billion within the next AMP7 cycle (2020-2025) which is around 13% higher than the current AMP6 (2015-2020) cycle. However, household bills are expected to fall by 4% in England with the biggest leakage reduction target of 16% in over 20 years. Ofwat's initial assessment of the water company's business plans approved that of three water companies and have requested the rest of the water companies to strengthen their submissions before approval. The study revealed that the water companies are now aligning their internal outcomes with those required by Ofwat. This has stretched some of the resources for some water companies who had to make adjustment to meet targets and reprioritise schemes for regulator outcomes. One water company project delivery manager highlighted a challenge he faced to be innovative, efficient and deliver for less. These efficiency targets were communicated to the water company contractors who had to continue to find efficiencies through procurements of products and services.

9. *Conclusions and Recommendations*

The study has revealed that the water industry has faced challenges to become more collaborative, more cost effective and reduce pollution up to privatisation in 1989 which aimed to solve the issues. The creation

of the regulatory bodies DWI, Ofwat and the EA with the Water Act 1989 aimed to take into account the performance of the water companies. There were some improvements in the performance of the water companies' but there was always the need for greater collaboration to drive cost and programme efficiencies.

The UK government call for the construction industry to be at the forefront of technology has pushed the water sector to implement relevant IT systems and tools. The water sector is referencing industry guidance through the BIM4Water Task Group, the Construction Strategy 2025 and Digital Britain. Hence the water industry has been investing more in emerging technology, especially BIM to address challenges brought by adherence to regulator requirements and effects of unpredictable weather patterns and climate change. This however has come with in its own challenges of moving from business as usual for project delivery which the water companies are addressing through further investments.

This study has identified the key challenges that the water industry face is that of meeting ever increasing regulator expectations. Three water companies had their business plans submissions approved to proceed on delivering their plans, whilst 14 were asked by Ofwat to make resubmissions. Yet the water industry has been moving on from being reactive to proactive to better face the regulator expectations and future uncertainties' challenges using emerging technology and changing organisational cultures.

It is recommended that the water companies continue to align itself with the construction industry best practice, embracing technology and using new tools. There should be an investment increase in the use of these tools as they so far proved effective in other areas of capital project delivery. This will enable the water industry to face the issues and challenges that it continues to face.

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Application of Construction Waste Minimisation Approaches at the Design Stage: A Systematic Review

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Abstract

With the rapid development of construction technologies and the acceleration of urbanization, massive construction activities can be found across the world resulting in the quantities of construction waste to increase at a high rate, leading to significant environmental and economic impact. The design stage has been recognised as a significant stage for the prevention of construction waste. This paper presents a review of the literature published in leading journals through Science Direct and Scopus databases within current construction waste minimisation (CWM) approaches during the design stage in terms of their implementation level and barriers, in order to identifying research gaps for future studies.

Keywords: Construction waste, waste minimisation, sustainability, design stage.

1. Introduction

Construction waste generates a number of significant environmental problems, such as the diminishing of landfill space, large consumption of raw material resources, pollution and contamination. According to a report by Transparency Market Research (2012), the volume of construction waste generated worldwide every year will nearly double to 2.2 billion tons by 2025. Figures published by the UK Government reveal that construction and demolition waste in the UK is around 120 million tons per annum (Osmani, 2012), 900 million tons of construction waste are generated every year in the European Union (Bravo et al., 2015), and more than 1.5 billion tons in China (Huang et al., 2018).

Such that is the urgent need for efficient waste management system. advocacies of waste management of construction activities for environmental protection have been promoted around the world. Various organizations globally have been founded by Governments to support the construction industry to better manage construction waste. For instance, in the UK, a number of institutions such as Waste & Resources Action Programme (WRAP) and the Construction Industry Research and Information Association (CIRIA) have been established. These institutions guide the construction industry towards waste minimisation with the support of their publications, workshops, best practice examples and guidance.

Construction waste generation is related to various causes throughout the entire project lifecycle, which are: design, construction and demolition stages. The design stage plays a critical role in construction waste minimization (CWM) as there is a consensus in literature that the most significant sources of construction waste originates as a result of poor design and insufficient waste minimisation practises on-site (Baldwin et al., 2009; Llatas, 2011; Wang et al., 2014; Ajayi et al., 2016; Polat et al., 2017; Osmani, 2017; Aleksanin, 2018; Ajayi & Oyedele, 2018a). According to Osmani et al., (2006), 33% of wasted materials arose because designers failed to design-out-waste.

As a result, several approaches have been established and developed over the years in order to reduce the generation of construction waste at the source during the design process. These approaches have been broadly categorised under four groups; design-out-waste practises, technological approaches, behavioural approaches and legislations (Yuan et al., 2018). Within each category, there is a number of approaches that has been adopted in numerous research projects in different countries. For instance, low-waste building technologies such as prefabrications and design applications has been implemented in many construction projects worldwide and had been proven to be very efficient in CWM (Li et al., 2014; Cheng et al., 2015; Umar et al., 2016; Bilal et al., 2017; Hwang et al., 2018; Zhang et al., 2018).

Furthermore, effective design-out-waste practises, such as: construction waste estimation, modern design techniques, and low waste procurement systems, are increasingly applied in modern methods of construction, and many construction companies are incorporating through support of regulations and policies (Osmani et al., 2008; Li, et al., 2015; Zhang et al., 2018). Several governments around the world are promoting application of these practises through various conduits (Beldek et al., 2016).

Moreover, behavioural approaches have been addressed in a number of studies due to their significant affect towards successful CWM (Osmani et al., 2008; Osmani., 2017). The role of human factors in CWM has gained more attention from researchers since most common causes of construction waste generation can be largely influenced by designers' attitude and their waste minimization behaviour (Kulatunga et al., 2006). For instance, several studies focused on enhancing the knowledge and understanding of architects and designers regarding the techniques and benefits of minimising waste through education programmes and training courses to improve their CWM behaviour (Zoya Kpamma & Adjei-Kumi, 2011; Li et al., 2015; Osmani, 2017; Mahpour & Mortaheb, 2018).

However, despite active research being conducted in this area worldwide, the findings are fragmented. Therefore, this paper aims to undertake a comprehensive review of existing studies to identify the different types of waste minimisation approaches adopted during the design stage, to gain a profound insight in the impact of such methods, and highlight any barriers encountered in their application in order to identify research trends and gaps for future studies.

2. *Research Method*

This research was conducted by using a systematic review approach of the literature relating to CWM. The method employed followed a process of a comprehensive search for relevant publications for eligibility through an explicit inclusion and exclusion criteria to gather a substantial important studies which focus on related subjects. To reduce bias in this process, an objective and transparent approach was adopted, including both quantitative analysis and qualitative reviews.

The literature review was undertaken by using Scopus and Science direct databases as they are considered two of the leading and comprehensive bibliographic citation index organisations. The terms "construction waste", "management", "minimisation", and "reduction" were used to select any paper where it was found in the title, abstract and/ or keywords. In each time, each of the three terms ("management", "minimisation", "reduction") where used separately with the term "construction waste" with the logical operator "and". Following such, the search ended up identifying 625 research papers for this review. The inclusion criteria of the literature were primarily based on the direct relevance to the subject of published articles from 2008 to 2018, therefore, and after screening the titles and abstracts of the paper, identifying further studies via reference lists, and excluding any duplications, a total of 85 papers were recovered and the full text was retrieved. A few articles were excluded after analysing full text as they did not possess a direct relevance to the subject, making a total of 79 papers for review. Figure 1 illustrates the methodology criteria for this research review.

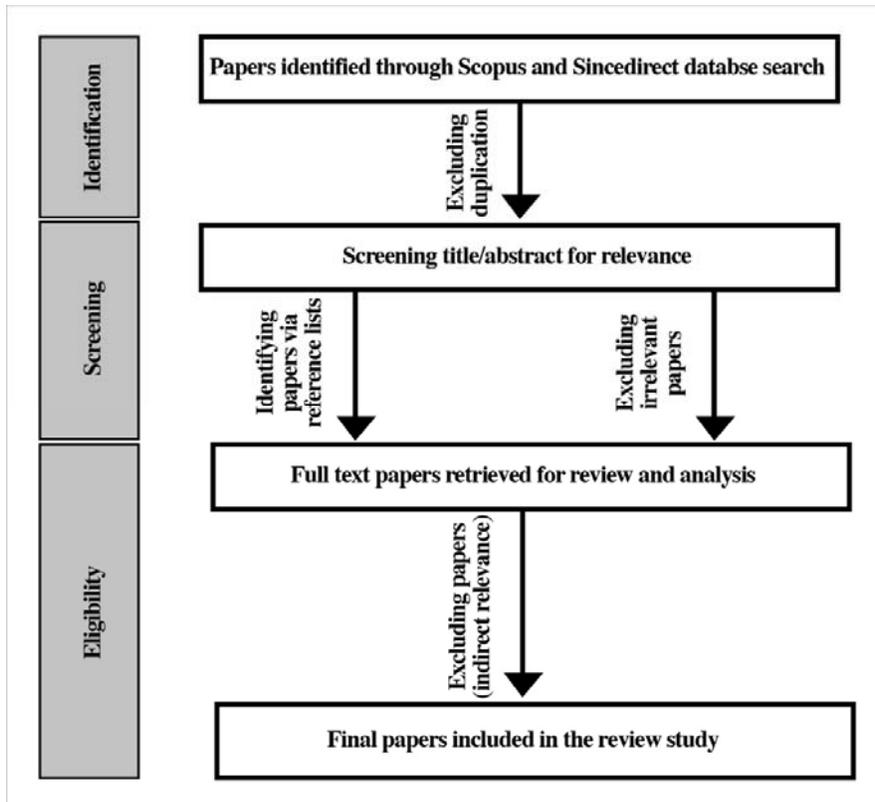


Figure 1: Methodology the research review.

After extensive review of the retrieved papers, the major CWM approaches in the design stage were summarised based on their frequencies of occurrence. Subsequently, these approaches were categorised in terms of their nature under four groups namely; technological approaches, design-out-waste practises, legislations, and behavioural approaches (See Table 1).

Table 1 Categorisation of the reviewed papers by groups of CWM approaches.

CWM approaches' category	Number	CWM approach	Reference
<i>Design-out-waste practises</i>	1	Proper design and documentation including; <ul style="list-style-type: none"> • Standardisation of design • Modern design techniques • Fewer design changes • Adequate and proper documentation and detailing 	Baldwin et al., (2009) Lu & Yuan., (2010) Arif et al., (2012) Adedeji et al., (2013) Mahamid & Elbadawi., (2014) Wang et al., (2014) Alshboul & Ghazaleh, (2014) Hashemi et al., (2014) Wang et al., (2015) Domingo., (2015) Udawatta et al., (2015) Osman et al., (2016) Umar et al., (2016) Ajayi et al., (2016) Polat et al., (2017) Ajayi & Oyedele., (2018a) Moussavi Nadoushani et al., (2018) Banihashemi et al., (2018) Ding et al., (2018) Pratoommanee & Wethyavivorn., (2018)
	2	Construction waste estimation modelling	Mah & Al-Hussein., (2008) Hettiaratchi et al., (2010) (Llatas., 2011) Hobbs et al., (2011) Mercader-Moyano & Ramírez-De-Arellano-Agudo., (2013) Noor et al., (2013) Sáez, Del Río Merino, Porras-Amores, & González, (2014) Mahayuddin & Pereira, (2014) Sáez, Porras-Amores, & Del Río Merino, (2015) Bakshan et al., (2015) Llatas & Osmani, (2016) Umar et al., (2016) Lu et al., (2016) Ghanimeh et al., (2016) Carpio et al., (2016) Bilal et al., (2017)
	3	Low waste procurement management including; <ul style="list-style-type: none"> • Correct and precise quantification of materials employed • Low waste materials purchase <ul style="list-style-type: none"> - Pre-assembled/pre-cut materials - Materials with reduced packaging - Recycled materials • Use of standardised material 	Gamage et al., (2009) Mahamid & Elbadawi., (2014) Khahro et al., (2016) Beldek et al., (2016) Ajayi et al., (2017) Ajayi & Oyedele., (2018b) Zhang et al., (2018)
	4	Collaborative design process including; <ul style="list-style-type: none"> • Early involvement of contractors • Adequate interaction and coordination of design between various stakeholders 	Wang et al., (2008) Osmani., (2013) Li et al., (2014) Domingo., (2015) Osmani., (2017) Akinade et al., (2018) Nursin et al., (2018)

<i>Technological approaches</i>	5	The use of Prefabrications/ Hybrid concrete construction	Baldwin et al., (2008) Jaillon et al., (2009) Baldwin et al., (2009) Lu & Yuan., (2010) Begum et al., (2010) Kozlovská & Spišáková, (2011) Hamid & Anuar Mohamad Kamar, (2012) Lachimpadi et al., (2012) Wang et al., (2014) Tam & Hao, (2014) Li et al., (2014) Cao et al., (2015) Wang et al., (2015) Khahro et al., (2016) Zhang et al., (2018) Hwang et al., (2018) Ding et al., (2018)
	6	Adoption of building information modelling (BIM)/lean concept	Bilal et al., (2015) Liu et al., (2015) Cheng et al., (2015) Mollasalehi et al., (2016) Akinade et al., (2016) Mazlum & Pekerçli, (2016) Won et al., (2016) Aleksanin, (2018) Akinade et al., (2018) Mesaros et al., (2018)
	7	Design application technologies	Umar et al., (2016) Tahmasebinia et al., (2018) Afolabi et al., (2018)
<i>Behaviour approaches</i>	8	Increasing the awareness of Construction waste causes and minimisation techniques by providing training and relevant knowledge	Osmani et al., (2008) Zoya Kpamma & Adjei-Kumi, (2011) Osmani., (2013) Moreton et al., (2016) Osmani., (2017) Liu et al., (2018)
	9	Increasing the awareness of CWM importance in terms of: <ul style="list-style-type: none"> - Environmental performance - Cost reduction by providing education and relevant knowledge	Wang et al., (2008) Li et al., (2015) Mahpour & Mortaheb., (2018) Pratoommanee & Wethyavivorn., (2018) Nawi et al., (2018)
<i>Legislations</i>	10	Emphasising organisational regulations, programs and policies toward CWM.	Osmani et al., (2008) Li., et al., (2014) Li et al., (2015) Elizar, Suripin, & Wibowo, (2017) Ajayi & Oyedele., (2017) Zhang et al., (2018)

3. Results and Discussion

3.1 Content analysis

According to Table 1, the design-out-waste practises and technological approaches respectively accounts for (51%) and (31%), whereby the design-out-waste practises is deemed to be the most important category since it contributes the major proportion of research. Less than 20% of these studies focused the behavioural approaches and legislations, with only three approaches identified in both categories. It can be noted that the latter two approaches has not been sufficiently researched despite their importance, especially the role of human behaviour, as according to a number of authors (Osmani et al., 2008; Li et al., 2015; Liu et al., 2018; Mahpour & Mortaheb, 2018), human behaviour is critical to the successful attainment of desired CWM outcomes, and thus, requires further investigation. The percentage of each category based on its frequency of occurrence in the reviewed papers is illustrated in a pie chart (Figure 2).

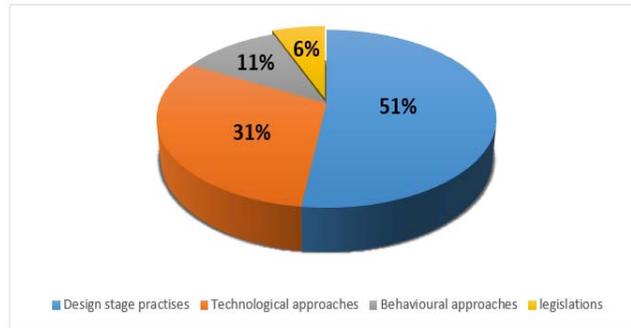


Figure 2: CWM approaches group's classification (percentage).

From the results shown in Table 2, the majority of the studies focused on one or more particular type of CWM approaches (see figure 3), such as appropriate design and documentation, the use of prefabrication, and construction waste estimation. Appropriate design and documentation (A1) attracted the highest attention and achieved a frequency of occurrence of 20 papers. Additionally, construction waste estimation modelling approaches (A2) (16 papers) was in the area of focus from a number of authors (i.e. Mahayuddin & Pereira., 2014; Sáez et al., 2014; Carpio et al., 2016) and it is considered a vital approach toward achieving successful CWM outcomes.

Moreover, the use of prefabrication and precast elements (A5) (17 papers) was the most utilised method among the technological approaches. Other approaches such as increasing awareness of CWM techniques (A8) (6 papers), and benefits (A9) (5 papers) in addition to the development and implementation of organisational policies (A10) (6 papers), was not researched as heavily. Finally, design application technologies were the least adopted approach (A7) since it accounted for only 3 studies among the reviewed papers. However, the utilisation of technological tools and application in CWM, is starting to appear more in recent publications especially for the on-site construction operations.

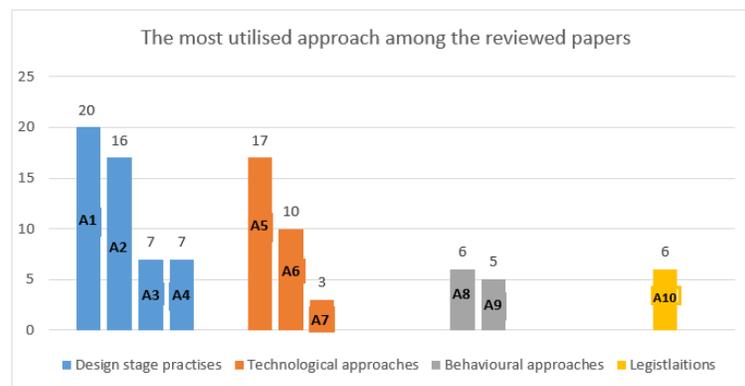


Figure 3: Frequency of the waste minimisation approaches among the 79 reviewed papers.

Thus, in undertaking this review, a number of key points from the existing studies on the influence of these approaches towards CWM during the design phase were identified. A review of each point is discussed in the following subsection.

3.2 CWM approaches: opportunities and challenges

CWM remains unsatisfactory due to the increased amount of construction waste generated worldwide every year Slowey., (2018, March 13). Reviewing the literature strongly indicates that the design stage is a critical and decisive stage, since construction waste generation can be prevented at reduced at the source. Therefore, researchers have tried to address this issue by developing effective approaches and smart design in order to achieve the best results. The forthcoming debates

demonstrate the finding of this study in terms of the benefits and challenges regarding the adoption of the CWM approaches identified in table (2.1).

Design-out-waste practises

Effective design processes lead to competent construction operation, and therefore, low waste generation. According to Adedeji et al., (2013), design standardisation and accurately prepared design documents are key underlying measures for mitigating waste in construction projects. Such practice prevents waste generation from cutting uneconomical shapes (Polat et al., 2017) and over ordering materials (Ajayi & Oyedele, 2018a). Additionally, appropriate design and detailing can help in CWM by reducing the design changes during the construction stage; if less changes are made within the design, rework can be avoided (Polat et al., 2017; Pratoommanee & Wethyavivorn, 2018). However, frequent design changes and change orders are sometimes requested by the clients which can disrupt the workflow in the construction process and produce waste, therefore it is necessary to identify and confirm the client's requirements clearly at the pre-tender and pre-contract stages in order to limit post-contract variations. Some studies focused on design in terms of proficiency in design tasks and using modern design techniques (Ajayi et al., 2016; Moussavi Nadoushani et al., 2018); it is considered as an added advantage as it will save time and cost during construction process in addition to CW minimisation, hence implications for professional development and training are very effective and practical solutions.

Several researchers have recommended utilising construction waste estimation approaches during the design process (Mahayuddin & Pereira, 2014; Sáez et al., 2014; Carpio et al., 2016). This approach is a proactive step for preventing waste generation, since it is used for construction waste performance analysis by providing contractors with forecast and details of the overall quantity of possible waste generation. This will help baseline to benchmark and develop an integrated waste management system during the course of construction (Lu et al., 2016). Although this approach can sometimes suffer from poor accuracy of predicting construction waste generation since it largely depends upon the development of waste data collected from previous construction projects, which might vary considerably from one project to another from a whole manner of reasons (such as client changes, poor workmanship etc.). Nevertheless, it still can assist designers and contractors to gain an initial idea of on-site waste generation and eco-costing of construction waste.

Moreover, researchers have highlighted the importance of low waste procurement management (Gamage et al., 2009; Mahamid & Elbadawi., 2014; Ajayi et al., 2017; Ajayi & Oyedele., 2018b). Selecting standardised materials, matching the specification of design to suit the building's expected lifetime, in addition to precise quantification of materials employed, are both key measures and critical success factors for CWM (Khahro et al., 2016; Ajayi & Oyedele., 2018b). Other studies (i.e. Huang et al., 2018) focused on other procurement measures, such as low waste materials purchase, such as recycled and pre-cut materials, as this will encourage recycling and reuse of wasted material through the increased demand on such products.

Finally, researchers emphasised the importance of enhancing communications in the implementation of CWM practises during the design stage (Domingo., 2015; Nursin et al., 2018, Aleksanin., 2018). These studies argued that construction waste can be reduced by having early involvement of contractors and clients, and clear communication between the construction project's stakeholders during the design process. This way, all parties will be informed with important information and updates that will make them more engaged in CWM. Osmani., (2013) indicated that through measures such as regular meetings/updates, the awareness of project participants about CWM can be enhanced.

Technological approaches

Low-waste building technologies are not new to the construction industry. They are considered as one of the most important approaches to tackle the issue of CWM (Baldwin et al., 2009; Cao et al., 2015; Liu et al., 2015; Bilal et al., 2017; Zhang et al., 2018). This review identified two important technological approaches within the design stage. The first method was utilising precast/prefabricated building elements: it is the most typical technological approach as identified by the majority of the reviewed studies (Kozlovská & Spišáková ., 2011; Lachimpadi et al., 2012; Tam & Hao., 2014; Wang et al., 2015 [68]. Prefabrication was foreseen to be more effective in terms of CWM when compared with conventional construction methods (Kozlovská & Spišáková ., 2011). The significant benefits of using prefabrication includes; increasing productivity and quality, improving the environmental performance, tidier and safer working environment, and a reduction in the overall

construction process duration (Jaillon et al., 2009; Cao et al., 2015). However, there are still limitations when utilising this technological approach, such as; lack of storage area on-site, requirement of skilled labour and specialist equipment, increased transportation and logistics considerations especially for construction sites located in congested urban areas, and finally, higher construction cost especially if the precast units are only used in a small quantities (Jaillon et al., 2009; Zhang et al., 2018; Hwang et al., 2018).

The second technological approach is the adoption of building information modelling (BIM)/lean and design applications technologies. According to a number of studies, a BIM/lean management system is needed because of their vital role in minimising waste throughout the entire lifecycle of construction projects (Cheng et al., 2015; Won et al., 2016; Aleksanin., 2018; Mesaros et al., 2018). The implementation of BIM provides a holistic approach and organizes relevant knowledge required to tackle construction waste effectively at the design stage using an architecture-based layered approach (Akinade et al., 2016). Accordingly, BIM can help avoid irrational design decisions and collisions, enable the rapid exchange of information between project participants, improve coordination and communication among project stakeholders and most importantly, indicate any changes in the-planning process of construction projects (Aleksanin., 2018).

However, some barriers pertain in the way of successfully adopting BIM/lean systems. According to Akinade et al., (2016) and Akinade et al., (2018), a lack of knowledge and understanding among construction stakeholders regarding the functionality of BIM and how it works persists. Therefore, more attention should be paid towards solving this problem by providing appropriate training and educational sessions. Today, BIM is actively developing and gaining more attention globally, and research and development has led to significant benefits which can be gained by the adoption of such system throughout the entire project lifecycle.

Behavioural approaches

Human behaviour is critical to the successful attainment of desired CWM outcomes. The most common causes of construction waste generation can be prevented by changing people's attitude (Kulatunga et al., 2006). According to Moreton et al., (2016), enhancing the knowledge and understanding of construction waste origins, causes and minimisation techniques is essential in order to improve CWM behaviour. Osmani., (2017) noted that design waste is affected by the absence of CWM targets and practices. One of the reasons behind this is the lack of designers' understanding of design waste causes (Osmani., 2013). Moreover, increasing the awareness of the importance of CWM and the resulting benefits, such as environmental sustainability and project cost reduction, holds great influence in tackling CWM behaviour. It creates incentives which can motivate the project stakeholders and the construction workforce toward CWM ((Pratoommanee & Wethyavivorn, 2018). Nonetheless, a number of key constrains affect the adoption of such approaches towards the attainment of CWM behaviour. For instance, some designers and architects have the wrong perception regarding the responsibility of construction waste generation; they seemingly take the view that construction waste is mainly produced during site operations and is rarely generated during the design stages (Osmani et al., 2008). Additionally, some designers believe that CWM is not cost effective and takes more time to undertake (Moreton et al., 2016). Moreover, Li et al., (2015) indicated that lack of management support in providing educational courses regarding the importance of CWM can affect the motivation and willingness of the staff towards minimising waste. Finally, it can be noted that behaviour has not been sufficiently addressed by past research despite its significant importance towards CWM, as the majority of the causes underlying material waste are directly or indirectly affected by the behaviour of the construction workforce (Liu et al., 2018). Therefore, improvements and more attention should be paid in this area in future research.

Legislations

Organisational regulation and policies play a critical role in CWM by developing and promoting effective measures for minimising waste (Osmani et al., 2008; Yuan et al., 2012; Li et., 2015; Elizar, Suripin & Wibowo., 2017). According to the findings of this study, researchers have focused on the role of decision makers in terms of improving CWM performance at the design stage through emphasising relevant policies and regulations that promote a zero-waste culture. For instance, some studies suggested that regulations should be strengthen regarding the procurement of low waste construction materials (Li et al., 2014; Ajayi & Oyedele., 2017). Additionally, mandatory training programs which help to enhance the awareness of employees regarding the importance of CWM should be emphasised by the stakeholders during the design process (Li et., 2015; Elizar, Suripin &

Wibowo., 2017; Zhang et al., 2018). However, the focus on legislation, particularly governmental polices toward the implementation of CWM approaches at the design stage was very limited in research studies. A possible reason for this is that decision makers may have the wrong perception that governmental regulations are only effective during the construction process, were physical waste in generated. Therefore, authorities need to improve legislation at the design stage, with a solid enforcement plan, and effective methods of tracking of proposed measures.

4. Conclusion and recommendations

With the growing concern in the construction industry towards waste minimisation due to rise of environmental concern and economic impact, there is an urgent need for the promotion of effective CWM approaches. The design stage has been posited as a critical stage for preventing waste generated in construction projects. This paper presents findings of a systematic literature review related to CWM approaches during the design stage, in terms of their implementation levels and barriers, in order to identify research gaps for future studies. A summary of the key findings and recommendations are:

- Appropriate design and documentation were identified to be the most influential approach towards CWM according to the literature review. Through effective and smart design techniques, design changes and excessive material cut-offs can be avoided, which both are significant causes for excessive construction waste generation.
- Late and frequent design changes by project clients can impact on construction waste generation, therefore it is important to identify the client's requirements at the pre-tender and pre-contract stages in order to limit post-contract variations.
- According to the reviewed papers, prefabrication can highly enhance environmental performance, therefore effective planning and coordination for on-site storage and assigning skilled labours is very important as both factors are one of the most influential causes for low/inadequate implementation of such approach.
- According to this review study, there was a lack of governmental legislations focusing on the issues of construction waste at the design stage, therefore, authorities need to establish and develop effective polices with a solid enforcement plan towards achieving green design.
- Behavioural approaches has not been sufficiently researched and addressed based on the finding of this review, despite the important role of designers' attitude towards CWM. Therefore, more attention should be paid in future to ensure effective implementation of CWM measures.

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Assessment Method on United Nation Sustainable Development Goals, Applied for a Sustainable City, With a Focus on Greater Khartoum Services

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Abstract

The first approach for environmental sustainable development to the global community was introduced in 1992 in the United Nations conference on environment and development, the "Earth Summit", which took place in Rio de Janeiro, Brazil.(genda21). Defining Sustainable development as the one that meets the needs of the present generation without compromising the ability of future generations to meet their own needs.

Therefore, the study will focus on the United Nations Sustainable Development Goals UN-SDGs and the making of Sustainable cities. The aim of the research is to propose a framework to transform Greater Khartoum into a Sustainable city and to find out criteria for an Assessment Method that is applicable for Greater Khartoum. Which including: providing Safe affordable housing and basic services, Sustainable transportation, Sustainable home settlements in the three towns, Protect culture and Natural Heritage, Reduce Waste including water, air and solid waste, Public access, Green-space, Support positive economic, social and environmental links between urban and rural areas, National and local disaster risk reduction strategies, Interlinkages and implications for policy-making

In addition, the methodology of the research focuses on defining, identifying and measuring the indicators and sub-items. The measurement applied through survey and questionnaire. Distributed and distribute to all engineers specialized in architecture, urban, civil, electrical and mechanical engineers in the three cities (Khartoum-Khartoum North-Omdurman).

Finally, the outcomes of the research, applying the criteria of SDGs to evaluate the present situation in sustainable development criteria in Greater Khartoum; most of the indicator record results The research recorded results show that the goals were not achieved in most of the situations, between (20-30) especially in services (Table 1), waste management and open spaces are average (40-49). Will provide valuable recommendations towards improving the future and urban planning and sustainable development for the Capital city.

Keywords: Sustainable Development Goals, Greater Khartoum Sustainable City, measuring performance indicators (KPI) for Greater Khartoum.

1. Introduction

Greater Khartoum as a city consists of three towns (Khartoum, Omdurman and Khartoum North); it suffering from many environmental problems like waste disposal, increase of CO2 emission from cars and industrial areas, water waste. The increase in migration towards Khartoum city in the last 20th years; these caused problems in services such as education, affordable houses for those people, hospitals, the basic life needs in goods, homes. Hamid (2010) and HABITAT, (2009).

This research is aiming to find sustainable city indicators according to SDGs11 sustainable development goals No.11 for UN. To be applied in Greater Khartoum. The project consists of two phases; phase one is finding out the indicators for the assessment of the sustainable city in a general framework. Phase 2 is applying the indicators on Khartoum city to find key performance indicator (KPI) measurement and percentage for each criterion.

2. Literature Review

United Nations set up sustainable Development Goals in UN, (1992) in the United Nations conference on environment and development, the "Earth Summit", which took place in Rio de Janeiro, Brazil (genda21), Fox (2000).

UN SDGs (UN, 2018) published criteria indicators (1) Safe affordable housing and (2) basic services, (3) Sustainable transportation, (4) Sustainable home settlements in the three towns, (5) Protect culture and Natural Heritage. (6) Reduce Waste including water, air, and solid waste, Reduce water waste, air and solid waste, (7) Public access, Green-space. (8) Support positive economic, social and environmental links between urban, and rural areas, (9) National and local disaster reduction strategies, (10) Support least developed countries, including through financial and technical assistance, in building sustainable and resilient buildings utilizing local materials, (11) Interlinkages and implications for policy-making. Anderson, (2011) Studied measuring cities indicators for Sweden city focuses on the focus in vision, Indicator framework, indicator selection, stockholders participation, communication strategy visual design, the study ended by cases study. Commission, (2018) Discussed China Sustainable Index which consists of some indicators like basic needs, Recourses Efficiency, Environment Clean Lines, Built Environment, and Commandment to the environment. The Commission, (2018) Discussed the European tools for sustainable cities such as, change climate mitigation, sustainable urban mobility, sustainable land use, nature and biodiversity, air quality, noise, waste, water, energy, green growth and eco-innovation, energy performance, and governance. KAUST, (2013) presented proposal green building for certificate system for the KSA The development site, transport, atmosphere, indoor air quality, using environmental quality, water, energy, material, eco-innovation, culture, and labour. Ministry, (2018) discussed the parameters of Saudi Arabia smart city the indicators are smart buildings, mobility, security for citizens, healthcare, energy, digitization. Abdelmoneim, H., (2017) a presented paper about categories for the sustainable neighbourhood the indicators are sustainable site, neighbourhood design, pattern and construction, material and resources, water, Energy, environmental design process and emission and safety. Abdelmoneim, H., (2005) discussed the renewable energy resources in Greater Khartoum which including solar energy and wind energy.

UN-HABITAT, (2015) Published a report about Saudi Future Cities and announced the program (FSCP) the focus indicators are the program studied several cities in Saudi Arabia including Makkah city. UN-HABITAT, (2016) Published a report about Saudi Future Cities and announced the program (FSCP) in Al Medina, UN-HABITAT, (2017) Published a report about Saudi Future Cities and announced the program (FSCP) in Judah city.

HABITAT, (2018) Published a report about Saudi Future Cities and announced the program (FSCP) in Al Riyadh city, the main indicators are urban government and legislation, productivity, infrastructure productivity, quality of life, equity and social. Environmental and sustainability. UN, (2018) and Forum, H. L. P., (2018) discussed and published UNSDGs.

3. Methodology

The research is based on UN SDGs for sustainable cities. Therefore, the methodology first starts by define, identify then measure the indicator which are safe affordable housing and basic services, sustainable transportation, sustainable home settlements in the three towns, protect the culture and Natural Heritage. Reduce waste including water, air and solid waste, public access, green space, support positive economic, social and environmental links between urban and rural areas. National and local disaster risk, reduction strategies, Interlinkages and implications for policy-making. Consequently, after a comprehensive literature review in urban indicators applying in Europe, Asia and on the region, the researcher applies the survey and questionnaire through Google survey in the social media, focus on engineering groups. The results were analyzed in tables and figures. Finally, the results were discussed for the conclusion.



Figure 2: UNSDGs, The research focuses on goals No.11, sustainable cities

4.1 Define the indicator

Commission, (2018) define the indicator as “Indicator: a parameter, or a value derived from parameters, which points to, provides information about, and/or describes the state of a phenomenon/environment/area, with a significance extending beyond that directly associated with a parameter value”.

4.2 How to identify the indicators

- 1) The indicator should be remarkable
- 2) In addition, it could be measured as a percentage
- 3) Consequently, The measures could be updated
- 4) Furthermore, It required good data based on monitoring



Figure 2: Shows the three main components of sustainable development, source: Commission, (2018)

4.3 How to measurement the indicators

The indicator could be measured by survey and Questionnaire. The researcher applies the survey and questionnaire through a Google survey in the social media, focus on engineering groups. The results were analyzed in tables and figures

Table 1 The evaluation scale

The evaluation	The evaluation scale	The meaning of the evaluation
Very strong factor	(70-80)	Achieve the goals There are policy, plan, apply, measured, with benchmarking and recycling the process after 5 years
Strong Factor	(60-69)	Achieve the goals There are policy, plan, apply, measured, with benchmarking
Moderate	(50-59)	Achieved the goals There are policy, plan, apply, measured
Weak	(40-49)	Not achieve the goals
Very Weak	(0-39)	Not achieve the goals

4.4 The survey and questionnaire.

The survey distributed by Google forms through many engineering groups in social media, Architects, urban Eng., surveys Eng., mechanical Engineer, civil and Electrical Engineer. The number of response is 100.



Figure 3: Google Seatlite image, Greater Khartoum including the three towns (Khartoum, Khartoum North, and Omdurman). The circle shows the limit of the study. Khogali, H., (2019)

5. Results

The results are shown in the following figures from Fig.4 to Fig.17. In addition, Table 1 shows the average result for each indicator and table 2 showed the checklist results evaluation for each indicator the average result is recorded as safe affordable houses (20%), clean energy (16%), clean water (19%), good health (22.6%), good education (17%), and transportation (15%), reduce waste (40%), sustainable home settlement (15%), public access to green space (30%), disaster reduction and strategies (29%), support least development strategies (29%), support positive economics (30%) and interlink to policy making (21%), all the results were below the average and not achieved the goals.

The results are shown in the following:

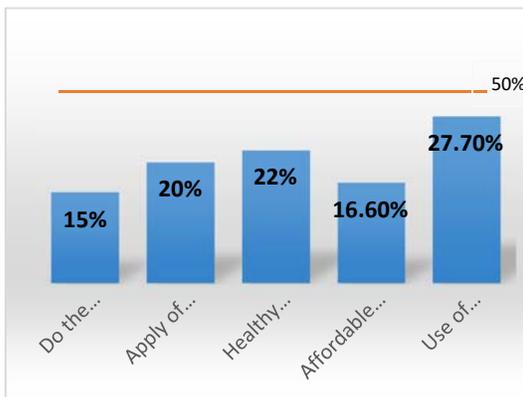


Figure 4: Shows the Affordable housing results

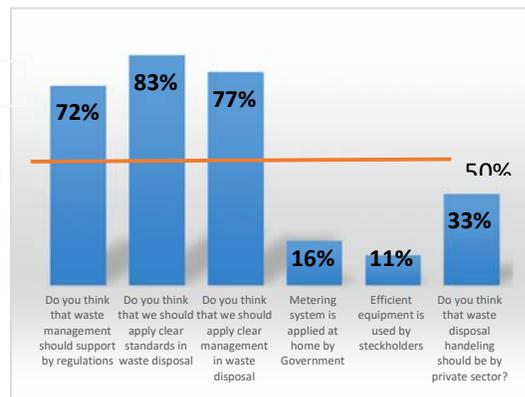


Figure 5: Shows the Services: Water efficiency results

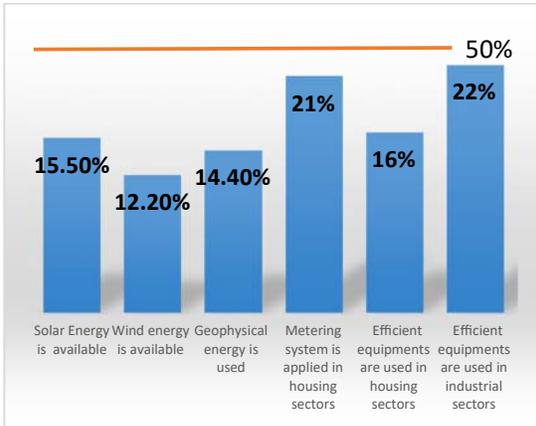


Figure 6: Shows the results of Clean Energy

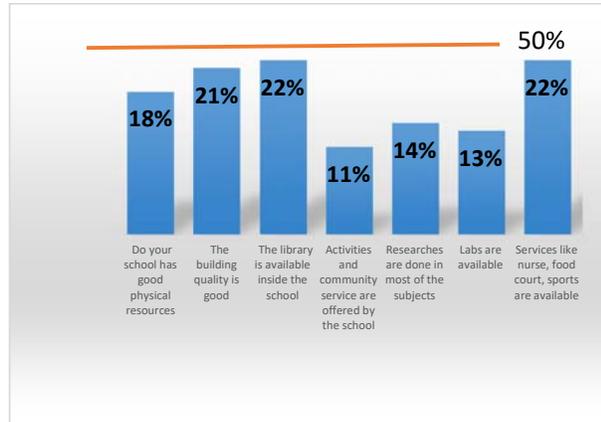


Figure 7: Shows Education efficiency results

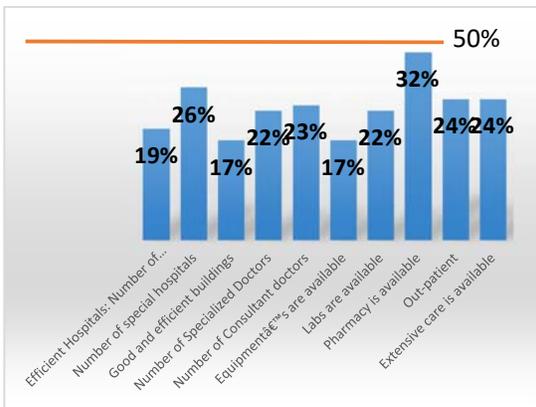


Figure 8: Shows Hospitals efficiency results

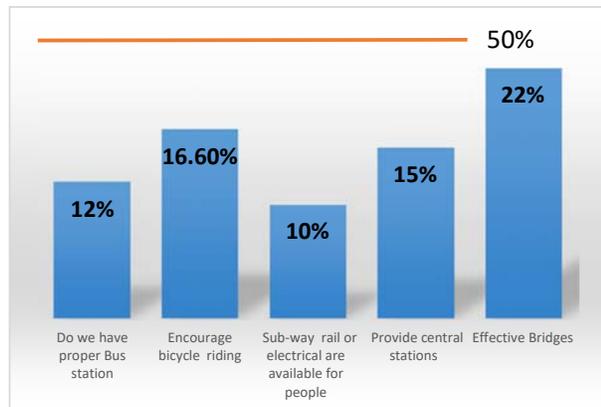


Figure 9: Sustainable Transportation results

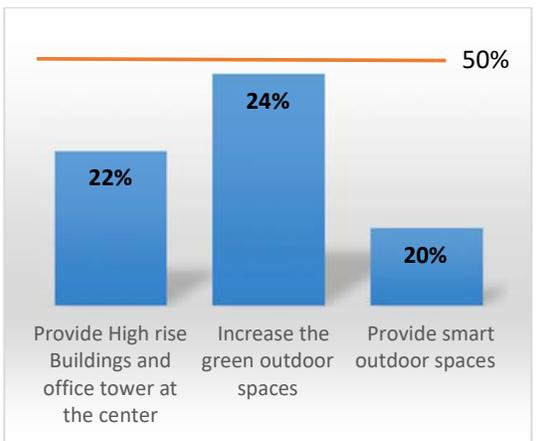


Figure 10: Shows Sustainable homes results

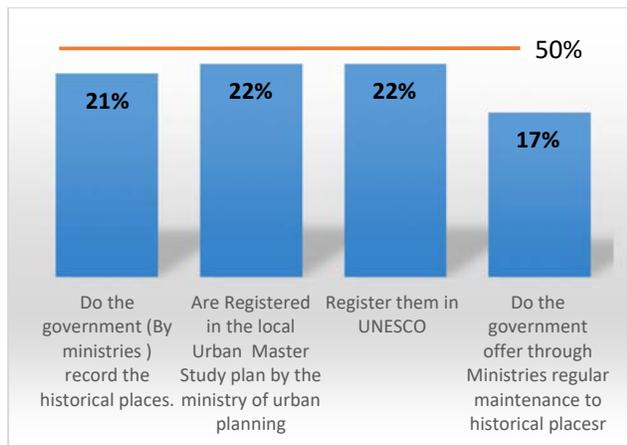


Figure 11: Shows protect the culture and natural heritage results

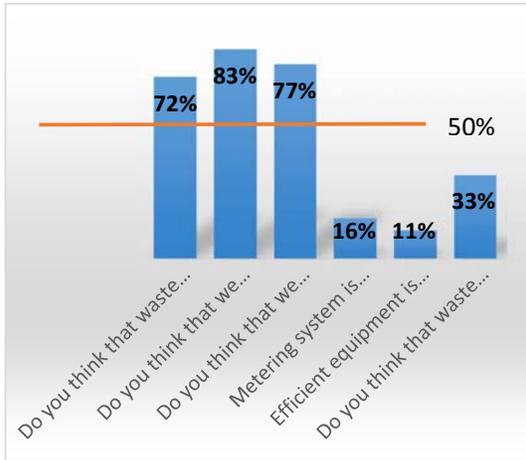


Figure 12: Shows waste disposal results

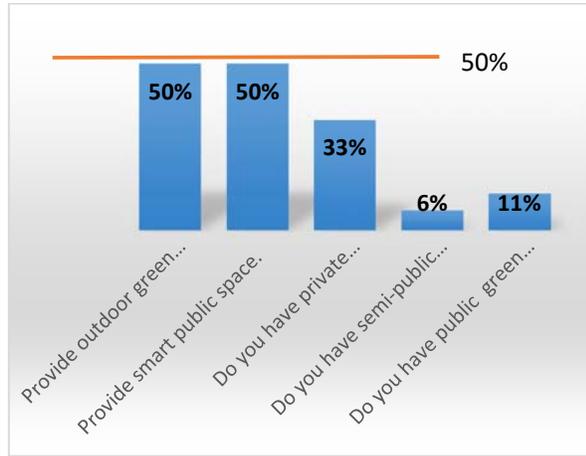


Figure 13: Shows Green space results

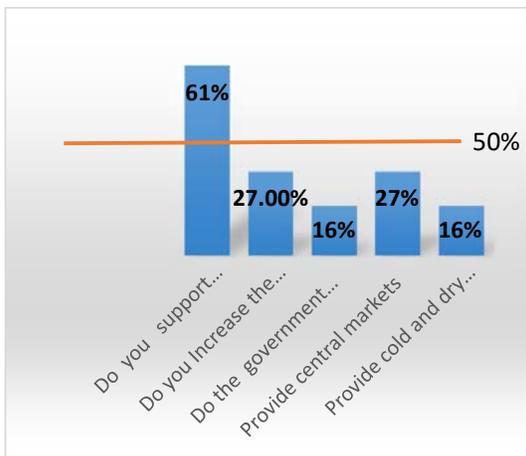


Figure 14: Shows support positive economic, social and environmental links between urban and rural areas

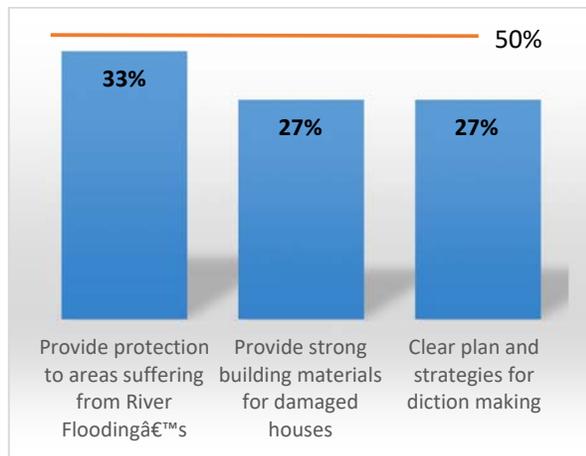


Figure 15: Shows national and local disaster risk Reduction strategies

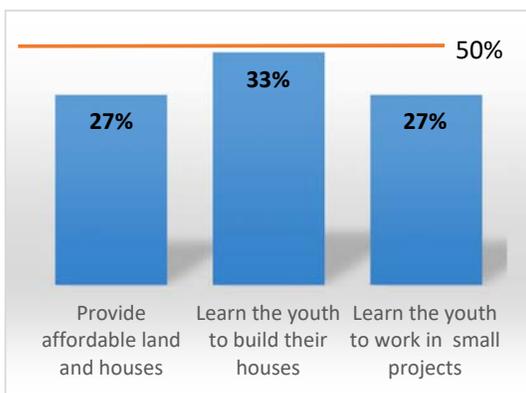


Figure 16: Shows the results of supporting the least countries

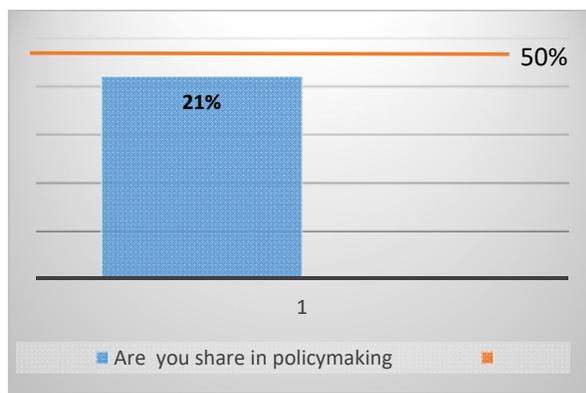


Figure 17: Shows the results of interlinks and implications for policymaking

6. Discussion

The Discussion shows in depth all the points here related to SDG's, the study focuses on Goal no 11' Make cities inclusive, safe, resilient and sustainable.

6.1 Safe affordable housing and basic services

Greater Khartoum affordable houses are (80%) and 20% lived in illegal houses. The average result of the survey is shown in table 1, 20% which is evaluated according to the scale as weak. The results of the survey were shown in Fig. 4 as follows:

- Do the government apply for global building standards (15%), and apply of local sustainable building standards (20%), the stockholder's (22%) builds healthy houses, and the government (16.6%) and use of local building materials (27.7%) provide affordable houses.
- The Challenges is providing sustainable affordable houses, the use of local building materials and the researcher.
- Note that all the result for this indicator is below the average (20%) and the indicator has not achieved the goals. The priority for improvement is applying of global and local sustainable buildings standards.

6.2 The Services

6.2.1 The drainage system infrastructure

The drainage net in Khartoum 2 since The Colonial period. Other places used well and septic tank by 70%, Gravel and Sand for illegal areas by 20%, which contaminate the underground water (Yassin, 2013). The average result for clean water is shown in table 1, which is 19.3, which is evaluated according to the scale as very weak. The result of the survey in water efficiency shown in Fig. 5 as follows: Efficient potable water for drinking is used and available (25%), a water-metering system is applied (21%), do you use grey water recycling (12%). The challenges are increasing quality according to the World Health Organization (WHO) standards. Enhance monitoring for the current situation. Identifying its impact on Human Health and encourage people to follow orientations. The average result for the clean water indicator is (19.2%), the result of the indicator is below the average, and the indicator has not achieved the goals. The priority for improvement is applying the WHO standards for potable water.

6.2.2 Clean energy

The results were shown in figure 9 solar energy is available (15.5%), wind energy is available (12.2%), geophysical energy is used (14.4%), metering system is applied in the housing sector (21%), and efficient equipment is used in the housing sectors (16%) efficiency is used in the industrial sector in operation (22%). The challenges are applying renewable energy like solar energy and wind energy and others in Greater Khartoum. The solutions for the future could be applying more projects using solar energy and wind energy; the government could help in establishing solar plant by sharing with investors in this field. The average result for clean energy is (16.8%), the result of the indicator is below the average, and the indicator is not achieved the goals. The priority for improvement is applying energy efficiency plans and policies including solar energy system for housing and industrial sectors by the government and the stockholders.

6.2.3 Efficient education

The results for education efficiency shown in fig. 7 is as follows:

The results of quality education were shown in figure 6: Do your school has good physical resources (18%), and the building quality is good (21%), the library is available inside the school (22%), activities and community service are offered by the school (11%). The researchers are done in most of the subjects (14%), are the labs are available (13%) and the services as a nurse, food-court, and sports are available (22%). The result for the indicator is below the average (17%) and the indicator has not achieved the goals. The priority for improvement is applying a better education, improvement the buildings quality, providing libraries with good numbers of books, eBooks, digital libraries, encourage the students for reading and writing researches, good activities such as sports and community participation.

6.2.4 *Efficient hospitals*

The result of efficient hospitals shown in fig 8 as follows:

Do the government offer efficient hospitals (19%), number of special hospitals (26%), good and efficient buildings (17%), number of specialized doctors (22%), number of consultant doctors (23%), equipment are available (17%), labs are available (22%), pharmacy is available (32%), outpatient (24%) and extensive care (24%). The challenges are establishing green and sustainable hospitals, providing efficient equipment and supportive treatment for all people. The result for efficient hospitals is below the average (22.6%) and the indicator not achieved the goals. Good solutions for the future are built up efficient hospitals by supporting and help of investors.

6.3 Sustainable transportation

In the three towns (Khartoum, Omdurman, and Khartoum North), there are main transportation bus-stations was built out of the centre to reduce the disadvantages of heavy traffic. There are new bridges like Tuti Island and Almak Nimer new bridges constructed on 2008 and 2009 consequently. (UN-HABITAT, 2016). The result according to the survey shown in fig 9 as follows:

Do we have proper bus station (12%), and encourage bicycle riding (16.6%), the subway is available (10%), provide central station (15%) and effective bridges (22%).

The challenges are constructing of new roads especially ring road, subway around the three towns and more new bridges. The result for the indicator is 15%, the result of the indicator is below the average, and the indicator has not achieved the goals. The priority for improvement is applying efficient bus station, subway, central bus station, efficient bridges and ring roads.

6.4 The sustainable homes settlements in the three towns

Reduce the physical expansion over the agriculture lands; urban sprawl is increasing in Greater Khartoum. The results from the survey are shown in fig 10 as follows:

Provide high-rise buildings and office tower at the centre (22%), increase the green outdoor spaces (24%), provide smart outdoor space (20%).

Challenges are increasing the high-rise buildings, improve the outdoor environment in a landscape, apply to smart outdoor gardens and parks, and improve the transportation system. Establishing of new sustainable urban community and housing. Using proxy indicators.

The result for the indicator is 22%, the result is below the average and the indicator has not achieved the goals. The priority for improvement is applying high-rise buildings and providing green space at the centre of Greater Khartoum.

6.5 Protect culture and Natural Heritage

The local building regulations for the National Capital of the Republic of Sudan, and the environmental framework Planning, (2014) by The Ministry of Housing in Khartoum stated the primary setting taking into account historical places and buildings preservation like Khartoum University buildings, Abdel Ghaume Gate, Al Mahdi old Palace, some of Churches In Khartoum. The results from the survey are shown in fig 11 as follows:

Do the government record the historical places (by the ministries) (21%), are registered in the local urban master plan (22%), register them in UNESCO (22%) and offers regular maintenance (17%).

Challenges are Identify the historical places and register them in UNESCO Global Historical places. Many historical places in Greater Khartoum were found since the colonial period and Othman Architecture.

The result for the indicator is 20.5%, the result is below the average and the indicator has not achieved the goals. The priority for improvement is registering the historical places in UNESCO offers regular maintenance and re-use.

6.6 Reduce Waste

The waste is including water, air and solid waste: Greater Khartoum is suffering from solid waste, gaseous and water waste. The average result is 48%, which is evaluated according to the scale as average The results from the survey are shown in fig 12 as follows:

Do you think that waste management should support by regulations (72%), Do you think that we should apply clear standards in waste disposal (83%), Do you think that we should apply clear management (77%), meeting system is applied (16%), efficient equipment is used by stockholder's (11%), and do you think that waste disposal handling should be by private sector(33%).

Challenges: Government and NGOs should set up regulations and management solutions for private and industrial sectors in order to minimize the solid, gaseous and water waste. Increase quality according to WHO standards. Enhance monitoring for the current situation. Identify its impact on Human Health and encourage people to follow orientations.

The result for the indicator is 40%, the result is within the average, and the result has achieved the indicator. Priority for improvement is setting up regulations for waste management and monitoring.

6.7 Public access

Public space is improved, and the government removes Khartoum Hospital to the suburb area. As well as the International Khartoum airport will be removed to the suburb area in Omdurman and reuse its place of public green space. The result from the survey is shown in fig 13 as follows:

Provide outdoor green space (50%), provide smart public space (50%), do you have a private garden in your home (33%), do you have a semi-public green area at the centre of your neighbourhood (6%) and at the centre of your city (11%).

The average result is (30%) the result is weak.

Challenges: Transportation efficiency, as well as the, improve road structure, and its drainage net, provide more of public space improvement, more land allocated and reuse these areas for recreations. Provide safety urban space especially for children and women.

The result for indicator public space is 30%, the result is below the average, and the indicator not achieved the goals. The priority for improvement is applying the public space in all urban levels especially at the middle of the neighborhood and at the centre of the three towns.

6.8 Support positive economic, social and environmental links between urban and rural areas

To provide a global overview of the state of urban policy at the national level and serves the purpose of monitoring this indicator through four categories: Feasibility, Diagnosis, Formulation, and Monitoring and Evaluation (SDGs). Greater Khartoum has a strong relationship with the suburb areas, especially in the agriculture industry, Cattles and animals industry. The Government between Greater Khartoum and the rural areas established fast roads. The results from the survey are shown in fig 14 as follows:

The questions of the survey and the results: Do you support positive economic, social and environmental links between urban and rural areas (61%), do you increase the industry in the rural areas (27%), do the government provide fast and efficient roads (16%), provide central markets (27%), provide cold and dry store (16%). The average result is (29.5%), the result is weak.

Challenges are providing fast and proper transportation system between the Greater Khartoum and the rural areas, Provide central market to welcome these products with cold and dry warehouses, control the prices of these products, regular maintenance of these roads, and support the industry in the rural areas.

The result for the indicator is 30%, the result is below the average and the indicator not achieved the goals. The priority for improvement is supporting the industries in rural areas, providing fast roads and central markets with all the facilities could help in a successful process.

6.9 National and local disaster reduction strategies

Supporting sustainable and resilient cities and human settlements and the achievement of the SDGs requires that disaster risk reduction integrated into core social, economic and development planning (SDGs). Greater Khartoum suffering from flooding, Abdulla (2008) stated in his M.Sc. research that Sudan suffered the most destructive floods during the last 20 years. Many cities, especially Khartoum (the capital of Sudan). In addition, the minor earthquake happened in 1946, 1988, 1993, 2010 and 2013 between 3 to 5 Richter. Without any serious effect. The results from the survey are shown in fig 15 as follows:

Provide protection to the area suffering from river Nile (33%); provide strong building materials for damaged houses (27%), a clear plan and strategies for diction making (27%).

Challenges are applying the polices to protect the areas suffering from flooding the River Nile
 The result for the indicator is 29%, the result is below the average and the indicator has not achieved the goals. The priority for improvement is applying strategies for protecting the areas suffering from flooding the River Nile.

6.10 Support the least development countries

Including through financial and technical assistance, in building sustainable and resilient buildings utilizing local materials. The construction industry has a significant impact on material extraction, consumption of natural resources and human comfort (SDGs). Greater Khartoum attracting people from South Sudan, Ethiopia, Eritrea, and from East and West Sudan. The migration reach 20% of the total Khartoum Population Most of them lived in illegal houses. The Ministry of Urban Planning with UN-HABITAT program me to have a good on-going plan to own these lands and provide services for water and energy. The result from the survey is shown in fig 16 as follows:

Provide affordable land and houses (27%), learn the youth to build their houses (33%) and learn the youth to work in small projects (27%).

The average result is 29% and it is weak Challenges are providing safe, low-cost houses, provides services like energy and water, waste disposal to those people. Incur rage people for jobs; construct their houses by bricks and stones.

The result for the indicator is 29%; the result is below the average, the result not achieved the goals. The priority for improvements is providing affordable land, learn the youth to build their houses and allocate the land for them.

6.11 Interlinkages and implications for policy-making

Connect the SDGs to urban policies and a clear impact on cities and human settlements. Challenges: update and link the local building regulations for the National Capital of the Republic of Sudan, and the environmental framework (Planning, 2014) by The Ministry of Housing in Khartoum. The result from the survey is shown in fig 17 is (21%), the result of the indicator is below the average, and the indicator not achieved the goals.

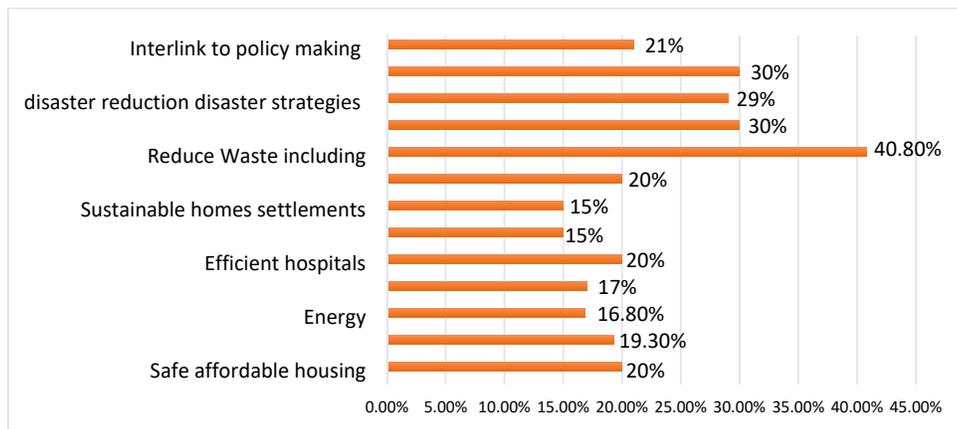


Figure 18: The evaluation for all indicators and the average result

Table 2 The Evaluation of the results for each indicator.

No. of indicator	Indicator	Percentage	Evaluation	Result
1	Safe affordable housing	20%	Weak	Not achieved the goals
2	Services			
2.1	Water efficiency	19.3%	Weak	Not achieved the goals
2.2	Energy	16.8%	Weak	Not achieved the goals
2.3	Efficient education	17%	Weak	Not achieved the goals
2.4	Efficient hospitals	20%	Weak	Not achieved the goals
2	Sustainable transportation	15%	Very Weak	Not achieved the goals
4	Sustainable homes settlements	15%	Very Weak	Not achieved the goals
5	Protect culture and Natural Heritage	20%	Very Weak	Not achieved the goals
6	Reduce Waste including water, air and solid waste	40.8%	Average	Not achieved the goals
7	Public access, Green space	30 %	Weak	Not achieved the goals
8	Support least developed strategies	29%	Weak	Not achieved the goals
9	Reduction of disaster strategies	29%	Weak	Not achieved the goals
10	Support positive economic	30%	Weak	Not achieved the goals
11	Interlink to policy making	21%	Weak	Not achieved the goals
	Average result	25%	Not achieve the goals	Not achieved the goals

7. The Research Outcome

The research outcome are summarized in Table 2 and Figure 18

- 7.1 The research outcomes is finding general framework assessment Method to Evaluate Greater Khartoum in SDGs, No.11 in all categories under sustainable city. Which are: providing Safe affordable housing and basic services, Sustainable transportation, Sustainable home settlements in the three towns, Protect culture and Natural Heritage, Reduce Waste including water, air and solid waste, Public access, Green space, Support positive economic, social and environmental links between urban and rural areas, National and local disaster risk reduction strategies, Interlink ages and implications for policy-making
- 7.2 Reporting the present situation, challenges and future plan for each indicator.
- 7.3 Providing monitoring for the present achievements for each indicator in SDGs applied in Greater Khartoum.
- 7.4 Providing sustainable affordable houses and use of local building materials
- 7.5 Applying the WHO standards for potable water regular maintenance and improvement
- 7.6 Applying energy efficiency plans and policies including solar energy system for housing and industrial sectors by the government and the stockholders.
- 7.7 The priority for improvement is applying a better education, improvement the buildings quality, providing libraries with good numbers of books, eBooks, digital libraries, encourage the students for reading and writing researches, good activities such as sports and community participation.

- 7.8 For hospitals good solutions for the future are building up efficient hospitals by supporting and help of investors.
- 7.9 The priority for improvement is applying efficient bus station, subway, central bus station, efficient bridges and ring roads.
- 7.10 The priority for improvement is applying high-rise buildings and providing green space at the centre of Greater Khartoum.
- 7.11 The research recommends protecting the historical and cultural places; by record them in Khartoum strategic plan, regular maintenance, and record them in UNESCO world heritage places.
- 7.12 Reducing solid, water and gaseous waste, set up regulations for people, and companies to manage the waste will be effective.
- 7.13 Public access, to the green space in different levels of the urban, indoor garden, intermediate green space at the middle of the neighbourhoods, and large green space and smart public space at the middle of the city.
- 7.14 Providing solutions for local disaster, reduce risk, and provides strategies, Set -up strategies in managing, the disaster especially in flooding season will be effective.
- 7.15 Supporting least developed countries, by providing suitable, healthy homes and services to them, allocate the land, encourage youths to build their homes, and learn them small projects
- 7.16 Linking the SDGs to local urban planning policies and to policymaking strategies.

Table 2 The assessment method to evaluation the Sustainable City indicators according to SDGs

No. of indicator	Focus indicators	Evaluation Range					Evaluation Evaluation from 5/5
		Strongly disagree 0% - 24%	Disagree 25%-49%	Average 50%	Agree 51-75%	Strongly Agree 76%- 100%	
		○	⊗	❖	●	✓	
1	Safe affordable housing						
	Do the government Apply of Global building standards?	○					1/5
	Apply of Local Sustainable Building Standards	○					1/5
	Healthy houses are built up by the stockholders	○					1/5
	Affordable Houses are provided by the government	○					1/5
	Use of Local Building Materials		x				1.25/5
2	Services						
	Water efficiency	○					1/5
	Energy	○					1/5
	Efficient education	○					1/5
	Efficient hospitals	○					1/5
3	Sustainable transportation						
	Do we have proper Bus station						
	Encourage bicycle riding	○					1/5
	Sub-way rail or electrical are available for people	○					1/5
	Provide central stations	○					1/5
Effective Bridges	○					1/5	
4	Sustainable homes						
	Provide High rise Buildings and office tower at the center	○					1/5
	Increase the green outdoor spaces		x				1.25/5
	Provide smart outdoor spaces	○					1/5
5	Protect culture and natural heritage						
	Do the government (By ministries) record the historical places?	○					1/5
	Are Registered in the local Urban Master Study plan by the ministry of urban planning	○					1/5

No. of indicator	Focus indicators	Evaluation Range					Evaluation
		Strongly disagree	Disagree	Average	Agree	Strongly Agree	Evaluation from 5/5
		0% - 24%	25%-49%	50%	51-75%	76%- 100%	
	Register them in UNESCO	○					1/5
	Do the government offer through Ministries regular maintenance to historical places	○					
6	Reduce Waste disposal						
	Do you think that people manner is the basic problem of the waste					✓	5/5
	Do you think that waste management should support by regulations					✓	5/5
	Do you think that we should apply clear standards in waste disposal					✓	5/5
	Metering system is applied at home by Government	○					1/5
	Efficient equipment is used by stockholders	○					1/5
	Do you think that waste disposal handling should be by private sector?		x				1.5
7	Public access, Green space						
	Provide outdoor green space			❖			1.5/5
	Provide smart public space.			❖			1.5/5
	Do you have private garden in your home?		X				1.5/5
	Do you have semi-public green area at the center of your neighbourhood?	○					1/5
	Do you have public green space at the center of your city? Open to everyone?	○					1/5
8	National and local disaster reduction strategies						
	Provide protection to areas suffering from River Flooding		x				1.25/5
	Provide strong building materials for damaged houses		X				1.25/5
	Clear plan and strategies for diction making		X				1.25/5
9	Support least Development countries						
	Provide affordable land and houses		X				1.25/5
	Learn the youth to build their houses		X				1.25/5
	Learn the youth to work in small projects		X				1.25/5
10	Support positive economic, culture and environmental links to ruler areas						
	Do you support positive economic, social and environmental links between urban and rural areas				•		1.5/5
	Do you Increase the industry in rural areas	○					1/5
	Do the government Provides fast and efficient roads		x				1.25/5
	Provide central markets	○					1/5
	Provide cold and dry stores		X				1.25/5

No. of indicator	Focus indicators	Evaluation Range					Evaluation
		Strongly disagree	Disagree	Average	Agree	Strongly Agree	Evaluation from 5/5
		0% - 24%	25%-49%	50%	51-75%	76%- 100%	
11	Interning ages and support policy making						
	Are you share in policymaking	o					1/5

Source: Adapted by the researcher

8. Acknowledgements

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Waste Management Approaches and Challenges in the Construction Industry within the Kingdom of Bahrain

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Abstract

The construction industry is solely responsible for a large portion of total material waste, which is considered the largest portion of global waste. Waste generation statistics in Bahrain's total waste equals to about 1.5 million tons. Evidently, this significant amount of generated waste by the construction industry is a growing problem which requires planning, management and monitoring. Construction waste management studies in Bahrain are conducted with a focus on waste generation during construction stage and waste tools that aim for post-occurrence measures of waste management; leaving the industry with little strategies on waste minimization and ideally waste prevention. Meanwhile, some actions were taken to make a difference in this field and suggest that construction waste could be significantly reduced by considering several design factors that tend to impact waste.

This study aims to explore the status of construction waste management in Bahrain. It also assesses the recycled materials in the industry with regards to its usage, benefits and the approaches to overcome the barriers in this field. The data was collected through questionnaires that were emailed to 120 participants and got a 41 % response rate. The paper elaborates the industry, examination, and investigation of the preferred methods of waste disposal. Practices in Bahrain have been precisely highlighted in this research paper. The paper additionally adopts the essential strategies and measures towards educating all stakeholders in the construction industry from designers and architects to clients and contractors.

Keywords: construction waste, management, recycling, sustainability.

1. Introduction

The idea behind recycling of the concrete and cement took birth after World War II. The process involved grinding and crashing the old ruins of cement that were used to manufacture and make aggregate (Ajayi et al., 2015). Studies conducted, also covered the various ways in which recycled concrete mix could be used in the construction industry. Compared to the other sectors in the world, the construction industry has one of the highest shares in the business market (Gautam, 2009). Bahrain's construction sector; in specific, has gained a lot of momentum after the financial crisis of 2008 (Amer, et al., 2011). The sector is pushed to grow by heavy government spending and investment. The total investment or the total value of the projects that have been planned is valued at around 52 billion dollars (Aliaga, 2006).

The economy of Bahrain, as compared to the other GCC countries, according to the below chart is more diversified. The government is taking robust initiatives to boost big construction projects. Keeping this in mind, the private companies have been given a lot of construction projects for more expansion and building.

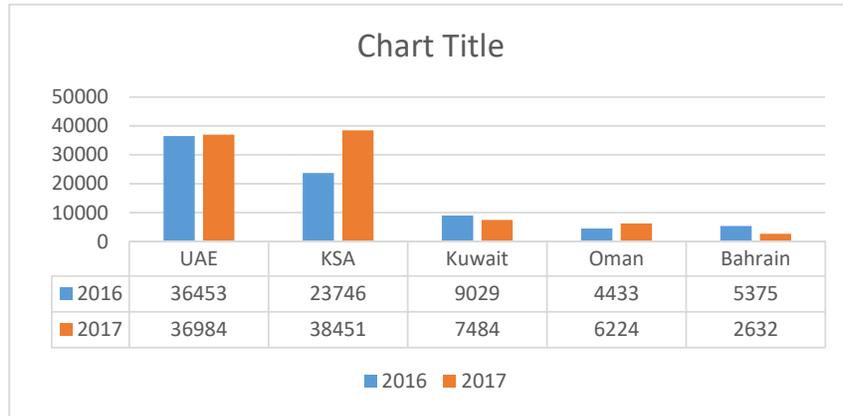


Figure 1: Investment in Construction in GCC (Kalla, 2011).

However, the process of construction approvals is a tedious task; this mainly discourages foreign companies from investing in construction projects. As the country is dependent on gas and oil, there is always the risk of price fluctuations, and the changes in these prices impact other sectors as well (Rousseau, O., 2018).

As Bahrain, has limited space, this waste impacts the landfills a great deal and efforts are being taken to improve the effectiveness of waste generation of the construction industry. Therefore, this paper seeks to understand the perception of the contractors in the construction towards sustainable waste recycling and also the barriers and problems it faces.

2. Literature Review

2.1 Construction Waste Management

Construction waste is basically anything generated as a result of construction and then abandoned, regardless of whether it has been processed or stockpiled, comprising surplus materials from site clearance, excavation, construction, refurbishment, renovation, and demolition (Saleh 2016). Statistics ensure that the waste generated by the construction industry in Bahrain is the reason for a 13 % increase in the waste generated (Rousseau,2018).

Thus the Municipality to handle waste management was first set up in the year, 1919 in the Kingdom of Bahrain. In the year, 2000 the Central Municipality decided to contract out the waste management services to third parties, one of the leading companies in Bahrain signed a 5-year contract with Bahrain, for the assistance of waste management (Awomeso et al., 2010). According to the contract, the company will help Bahrain by providing eco-friendly services. The company utilises the latest technique and innovation in waste management approaches and provides value to customer service.

However, improper management of construction waste can lead to environmental, health, and economic issues. Consequently, investors lack the incentive to invest in a country that is characterised by poor waste management of its industries. People also fall sick due to the harmful environmental impacts that stop them from working efficiently, which in turn harms the economy. Hammoud et al. (2017), states that the waste from the construction industry is generated right from the first stage of inception to the final stage of completion. The table below shows the causes of construction waste from the contractual phase until the operations on-site; these problems are mainly due to mistakes in the contract documents, design error, poor coordination, etc.

Table 1 Origins and Causes of Construction Waste (McGrath, C. 2001).

Source	Cause of Waste
Contractual Phase	-Mistakes in the contract document -Contract document not being finished on time
Phase of Design	-Unclear Objectives -Errors in design -Change in design and plans -Poor communication and coordination -Client changes in the last minute
Purchase	-Order errors in specification and details -Supplier not supplying on time. -Lack of budget.-Over-estimation.
Delivery and transportation	-Damage while in transit. -Poor loading methods.
Management and coordination	-Lack of proper supervision. -Lack of management on site. -Confusion on site. -Improper usage of materials.
Handling of materials	-Materials not packed properly. -loose materials. -Materials lost during transport. -Improper methods of storage. Distance from warehouse and site.
Operations on site	-Accidents. -Time or budget pressure. -Poor skills and craftsmanship.
Remaining	-Waste from over preparation of mortar.
Other factors	-Weather. -Unforeseen risks.-Vandalism.

2.2 Challenges of waste management in Bahrain

According to Mani, (2016) that though the government is trying to take a lot of initiatives to manage waste generation in Bahrain, there are still a lot of challenges faced.

- There is a lack of clear guidelines and framework, for the collection and disposal of the wastes of constructions.
- Lack of strict penalties and fine for not recycling construction waste and decreasing the waste disposal in landfills.
- The landfills are overflowing and that is causing a strain on the limited area of Bahrain. It also gives rise to toxic gases and other environmental hazards.
- There is a lack of accurate and reliable data on the rate of waste generation, the actual ways of treatment and the use of natural resources and the use of land.
- As the waste recycling process is expensive, there are not many recycling facilities in Bahrain.

2.3 Construction Waste reduction Hierarchy

The waste hierarchy is a model that has been adopted by many countries such as France, Germany, UK and Sweden (Kimani, et al, 2007). The hierarchy consists of multiple methods lead to minimising construction waste; such as reuse, recycle and reduction and disposal on landfills. The figure below shows the different approaches of construction waste management that is used as methods to handle waste and serve as liable options. Hence reduce and conserve materials is considered as the best method, while the method of disposal is the worst.



Figure 2: Construction Waste Hierarchy (Kimani et al., 2007).

Aspects such as site waste management plan could be adopted to avoid construction waste, this aspect aims at improving the efficiency of materials and resources that are used in the construction phase, by following the principles laid out in the waste hierarchy that employs factors like reuse and recycling as a means of illegal dumping by construction projects (Koutsogiannis, 2018). Sustainability is another approach of reducing construction waste; this approach should be increased as green buildings not only are cost savers but also reduce the waste and use renewal bale sources that can be reused and recycled (Mawed et al., 2017). Additionally, recycling of construction waste reduces the pressure on landfills where these wastes are dumped, which ultimately leads to the decline in carbon dioxide emissions. The process of prefabrication involves the gathering of materials, like floor slabs, walls and beams off-site rather than on-site. This process directly reduces the amount of labour needed. (Begum, et al., 2010).

2.4 Construction Waste Management Scenario in Bahrain

Rousseau, (2018) found out through an investigation that over four thousand tons per day of municipal waste are generated in Bahrain, which is collected from the five governorates by private collectors who transport this waste to the Asker Landfill in Bahrain, which is approximately 25 km away from the City Centre. The dumping of wastes in landfills and sea bodes has deteriorated the marine life of Bahrain. The major cause for the destruction of coral reef in Bahrain has been due to the disposal of building materials and construction waste in the river bodies (Blackman, 2010). The limited land area that is available in Bahrain is the main reason behind waste management complications, and hence, the waste management approach is being privatized in Bahrain. Therefore, in the year 2000, the Municipality in Bahrain conducted a study to see the feasibility behind contracting the waste management outside to third parties. Privatizing the waste management sector has brought in a lot of benefits such as new skilled labour, better fleet and lower cost. The private companies also adopted improved recycling methods to manage the waste (Aliaga et al., (2006).

2.5 Green Construction in Bahrain

Amer et al. (2011) emphasise the fact that sustainability and green initiative in the construction industry is one of the most important goals for the Ministry of Urban Planning in Bahrain. He adds that there are six main features that have been adopted in the model list of green building requirements.

- Location
- Materials and Resources
- Internal Environment Quality
- Energy Efficiency
- Water
- Management

Besides these elements, there were other secondary elements recognised as well-

- Building Orientation
- Insulation of the Building
- Shading

- Power Saving Lights
- Sensor Taps
- Solar Power Panels

According to statistics, sustainable buildings have managed to save water and electricity by thirty percent and also costs associated with maintenance and operations by 15 percent (Mawed et al., 2014).

2.6 Drivers of Waste Management Technologies

Osmani (2011) illuminates that the main driver behind waste management approaches is to handle the waste efficiently so that the negative impact on the environment is reduced. He also assures that the adoption of private companies handling waste management approaches was so that the latest technology can be adopted for implementing waste management tools. On the other hand, construction companies need to move away from their focus of location and price, and also focus on social responsibilities and consider the engagement of shareholders and stakeholders. (Yunpeng, 2011).

3. Research Methodology

There was a lack of sufficient data and literature available in the construction industry in Bahrain; hence the research approach adopted a combination of both quantitative data (survey) and qualitative sources of data (open-ended questions survey). The survey was divided into three parts; first part covered the construction waste management awareness in Bahrain and used close-ended questions with the Likert scale where the answers for the questionnaire allowed the respondents to give their agreement or disagreement to a particular question. It ranges from 1 to 5 where 1 strongly agrees, and 5 strongly disagrees.

The second part covered Benefits and Barriers of Using Recycled Materials in the construction industry of Bahrain, and was divided into three sections and used also closed-ended questions but with the multiple-choice format. The third part used open-ended questions which discussed the recommendations to overcome the barriers in construction waste management industry in Bahrain.

The targeted populations were of engineers, manufacturers and contractors in Bahrain, who're surveyed through email where 50 out of 120 respondents. The precise method that had been used is judgment sampling under non-probability sampling as a prior judgment has been made based on the findings of literature review, that clarified that construction companies and contractors dealing in the construction industry would be suitable for this research paper.

4. Data Findings and Discussion

The scientific process of managing waste is a major challenge that is faced in the gulf region, because of the high per capita generation of waste. Due to the features of high growth in the industry, the boom in the construction industry, increase in population and urbanization, waste generation has increased leading to an issue of waste management. Statistics reveal that the amount of waste generated is more than 120 million tons, annually, in the GCC countries. Therefore, the following questionnaires were presented to explore the level of knowledge about sustainable methods of waste management approaches in the construction industry of the Kingdom of Bahrain, where 50 out of 120 participants responded. The pie chart below shows the response rate of the questionnaire that was emailed. This covers the questionnaires for all parts.

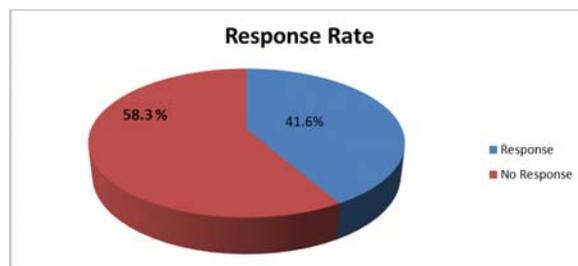


Figure 3: Response Rate

Part ONE- Construction Waste Management Awareness in Bahrain

Participants were asked five questions to understand the level of awareness of contractors towards sustainable methods of waste management approaches in the construction industry of Bahrain, the feedbacks were summarized in the below sections:

- 1) Participants were asked whether the construction industry has a negative **impact on the environment** and whether sustainability is an important factor while considering a project design, almost 40 % of the respondents strongly agreed while only 6% strongly disagreed. This shows that the contractors are very much aware of the harmful effects that construction waste has on the environment. It also reveals that contractors fully realise the importance of taking sustainability factors into consideration.
- 2) When participants asked whether **current green regulation rules** need to be improved by adopting more recycling methods, basically a large number of them agreed as 70% strongly agreed while 0% strongly disagreed. This shows that the construction industry is open to adopt new ways to implement recycling in its waste management approach to reduce waste and costs in the long run.
- 3) The third question was about the **cost of adopting green and sustainability techniques**, and if these techniques are not more than its long term benefits. The results proved that 30% of the respondents showed their strong agreement, while 16% of them strongly disagreed. This, unfortunately, reveals that there is still little hesitance about the cost of waste separation for recycling being a lot.
- 4) When participants were asked if **waste management and minimizing techniques should be adopted at an earlier stage** right from the beginning to the end of the project, the majority of them strongly agreed (80%) while only 4% disagreed. This depicts that people are more aware of the risks of construction waste and its environmentally dangerous effects.
- 5) The last question was whether contractors have less **knowledge about waste separation and waste recycling technologies**. The results showed that though contractors are aware of the need for recycling, there is less information on how to implement it as 20% strongly agreed and 15% strongly disagreed.

The above-mentioned part of the survey reveals that there is sufficient knowledge about the importance of adopting green and sustainability methods in the construction industry of Bahrain. Currently, though sustainable technologies are being taken seriously and are on the rise, there is a lack of forced legislation or law that makes it compulsory to practice recycling the waste materials.

Part TWO: Benefits and Barriers of Using Recycled Materials in the construction industry of Bahrain

To explore the recycled waste materials and the benefits and barriers of using them in the construction industry of the Kingdom of Bahrain, the second part of the questionnaire was divided into three sections:

A- Usage of the Recycled Materials

The first section of this questionnaire deals with the usage of recycled materials. Participants were asked about the usage of **roof shingles** as recycled material in construction. The results shown in the chart below proves that the most popular use of roof shingles is in hot mix asphalt. Aggregate is also a common used material as it is very widely used in road construction.

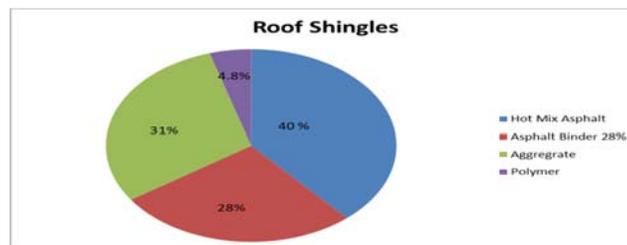


Figure 4: Usage of Shingle

Participants were asked about the usage of kiln dust in Bahrain construction Industry. The figure below shows that most of them agree that using kiln dust in soil stabiliser greatly enhances its texture and also improves the strength of the soil.

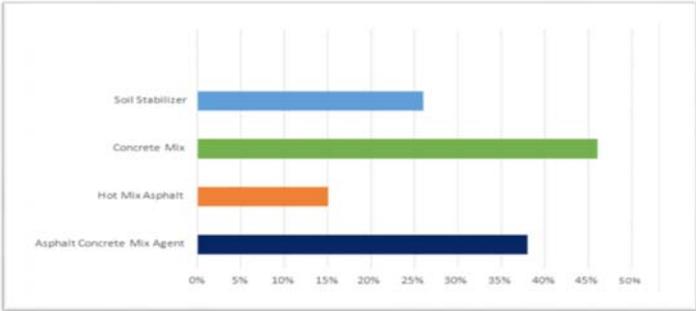


Figure 5: Usage of Cement Kiln

The usage of fly ash in Bahrain’s construction industry was also put into question where it was found out through the figure below that the use of aggregate and concrete mix in fly ash is the highest at thirty-six percent, followed by the usage of asphalt and aggregate at thirty-three percent.

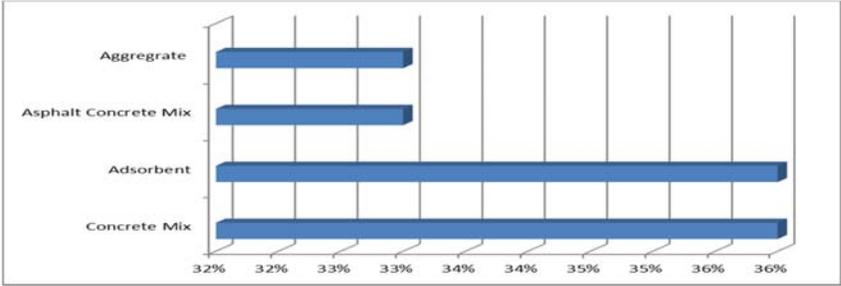


Figure 6: Usage of Fly Ash

The following results of the below chart show that the glass in the construction industry of Bahrain when recycled is used as a mix in aggregate, in concrete it helps to improve the look and the charm of the concrete.

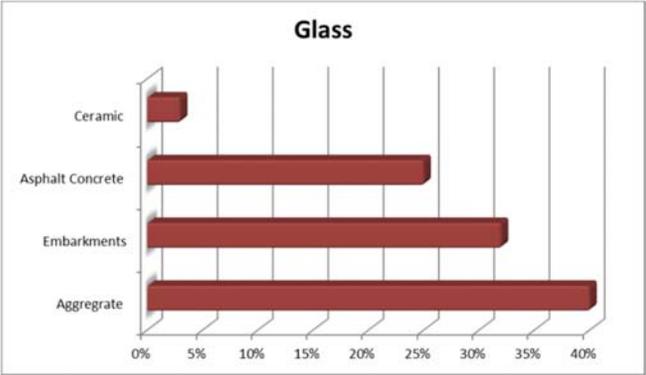


Figure 7: Usage of Glass

At last when asked about the usage of concrete in the construction industry of Bahrain participants reveal; as shown in the chart below, that the main usage of the concrete is in aggregate, and its usage in the construction industry for cement production gives the same result when raw aggregate is used, when it is used till twenty-five percent.

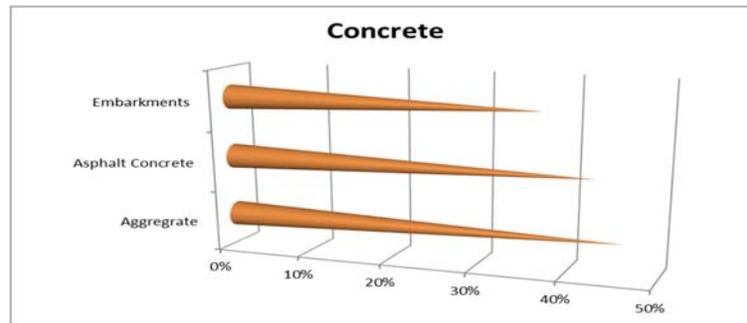


Figure 8: Usage of Concrete

B- Benefits of Using Recycled Materials in the construction industry of Bahrain

The second section dealt with the data collected to find out the advantages of using recycled resources in the construction industry of Bahrain. The advantages of this were categorized under three main headings: social, environmental, and economic benefits. The questionnaire was designed such, so that the respondents could rank the perceived benefits of using recycled products, in terms of the above three categories. The findings were as follows-

- Economic benefits received the highest ranking as 46 percent of the respondents felt that it saves cost (40%) and enhance the performance of the construction industry (6%)
- Environmental benefits ranked in second, as 55 percent of the respondents stressed the importance of the fact that it helps the environment (35%) and reduces air pollution (20%).
- Social benefits ranked in third, with 21 percent of the respondents feeling that it creates jobs for people in the recycling industry and increase awareness (10%)

These results are presented in the chart below:

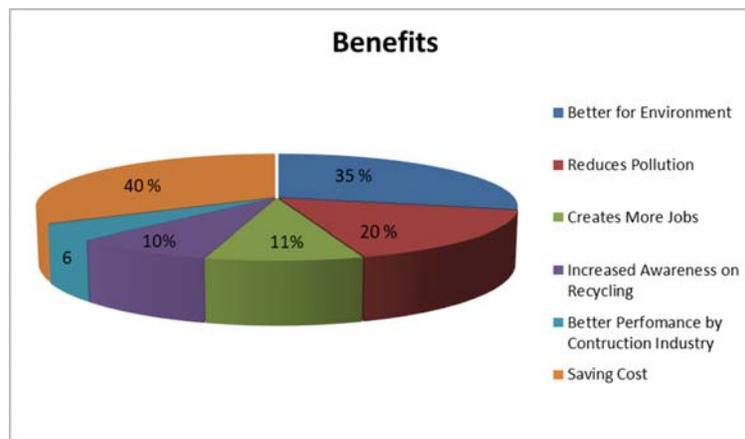


Figure 9: Benefits of Using Recycled Materials

The above pie chart shows that one of the main benefits behind the contractor's usage of recycled products was the saving cost factor. Hence this was found to be the greatest benefit of it as it is less expensive as compared to using new and raw materials for construction purposes. Using these materials also reduces the cost of transportation and the cost of waste disposal. Hence the saved money can be used for better and efficient things.

The environmental benefit of using recycled materials is that it helps to reduce emissions of dangerous and toxic gases that are released from the landfills due to dumping and disposal of waste on them.

Using these materials is also beneficial for society as this creates more jobs for people who are skilled in the recycling and manufacturing industries. This improves the living conditions of people and also increases the economic conditions of the country, as people have more means to spend on goods and

services. It also creates awareness about the use of harmful products and the benefits of using recycled materials.

Using recycled materials can also improve performance; Materials like slag and fly ash are used to make concrete longer lasting and durable. They have a lot of benefits over using raw and new products.

C-Barriers of Using Recycled Materials in the construction industry in Bahrain

The data gathered for the third section mainly represents the barriers that were perceived while using recycled materials in the construction industry in Bahrain.

These barriers are depicted in the chart below:

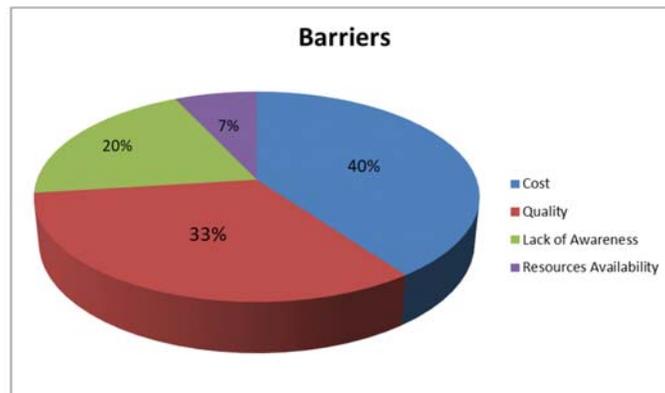


Figure 10: Barriers of Adopting Recycled Materials

The respondents stated these barriers-

- 40 % of the respondents found the cost of recycling to be a barrier.
- The second was the quality of the recycled material; it got 33 % of the votes of the participants.
- 20 % of the respondents felt that lack of awareness was the third barrier in using recycled materials
- Resource Availability was the factor least considered as a barrier with only 7 percent

According to the pie chart, the cost is the highest-rated barrier for constructing companies in using recycled materials. Though recycled materials cost cheaper than raw materials, it is costly to segregate the waste from the materials. Cost is also incurred while storing and inspecting raw materials.

The second barrier is the quality of the raw materials. It is a general perception amongst the contractors that the quality of raw materials is not as good as the quality of the raw materials that are used. Hence this is a major reason why recycled materials are easily not so easily accepted by contractors and the construction industry. The third barrier is the lack of awareness as many people are not aware of the consequences of not using recycled product and the harm it poses to the environment. The contractors are not usually aware of the benefits of using recycled products and how it contributes to the environment being saved. Even though these individuals belong all to the construction industry, they all have different attitudes towards using recycled materials.

The last barrier is the ease of availability of materials in the market of the construction industry. As the use of recycling materials is not widely prevalent, as there are not many contractors and construction companies in the market demanding for the same. They also lack the expertise and the technology required to recycle the materials.

Part THREE: Recommendations to overcome the barriers in construction waste management industry in Bahrain

An open-ended survey was additionally added to the recommendation to overcome the previously mentioned barriers in Bahrain. The recommendations provided are as follows:

- There should be proper laws and guidelines for using recycled resources. They could also make it compulsory for construction companies to use the resources.
- Incentives can be given as a means to encourage companies to adopt using recycled materials.

- Proper training can be given to the contractors and engineers on the usage of recycled materials.
- Increase in awareness through seminars, ads and posters.
- Opening up of recycling companies.
- Quality of the recycled resources should be maintained.

5. Main Findings of the Construction Waste Management Approach in Bahrain

The key findings of the waste management scenario in Bahrain are as follows.

- The waste generated by the construction industry is about 4,000 tons per day.
- The government has encouraged and outsourced the waste management to various third parties, for better, cost-effective and eco-friendly approaches.
- The government is also increasing the number of green and sustainable projects in the country. There are about 40 green buildings on the pipeline in Bahrain.
- Research findings also revealed that a recycling unit had been set up in Bahrain for the purpose of recycling industrial and construction waste, to reduce the negative impact on the environment and conserve the natural resources.
- Research findings also revealed that contractors in the construction industry of Bahrain are also aware of the need to adopt sustainable ways and adopt the process of recycling ways.
- The findings also revealed that though contractors are aware of the advantages of using recycled products, there are certain barriers that prevent the construction industry in Bahrain from adopting it on a wide scale. The barriers are the high cost of waste segregation and the perception of recycled materials being considered poor.

6. Conclusion

The overall study targets were to explore the status of the construction waste in Bahrain, and recycled materials in the industry with regards to its usage, benefits and barriers. The Literature review shed light on the concept of waste, and it also explored the different sources by which waste is generated. It touched on the topic of sustainability and the uses of recycled materials used in the construction industry. It was found out that, all stages involved in the construction process, like the contract phase, the purchasing phase, the material phase, transportation, material storage and material handling are the main causes of waste generation in the construction industry. However, the paper's scope does not cover handling all the issues and sources in detail. The literature review presented different researches that helped to form the basis for the research aim of this paper. The literature review discussed the waste hierarchy that is the general way of waste minimizing in the construction industry. It also revealed the fact that waste general poses several threats and bad effects on the environment. The importance of adopting the usage of recycled materials which reduce the negative impact on the environment, people, and economy was also discussed.

The government's efforts in Bahrain were highlighted hence the government is taking a lot of initiatives to reduce the total waste generation, even though very less is recycled and most of the waste is disposed in the landfills. Thus the Bahrain Government is making a lot of progress to promote recycling methods and promote its potential advantages. The findings revealed that there is a lot of awareness about these methods. The contractors agreed that the adoption of recycled methods needs to be increased.

On the other hand, the advantages and barriers of using recycled materials in the construction industry of Bahrain were also discussed. The uses of the recycled materials confirmed the findings of the literature review. There were also several benefits associated with the usage of recycled materials in the construction industry. The advantages were grouped into three main groups of economic, environmental and social.

Nevertheless, the quality of recycled materials is perceived to be of inferior quality, which is a major misconception. This prevents the construction industry and the contractors from using recycled materials in their projects. Eventually, this paper shows that the most preferred method of disposal is landfill disposal as it is the easiest.

7. Recommendations for Future Work

- The future work can implement the following:
- A cost analysis of the life cycle can be done on the recycled materials.
- Study on the new technologies and methods to reduce waste generated can be studied and explored.
- The future survey could explore to understand in detail why companies are hesitant to recycle their wastes.
- A future study could also aim to find out in detail the process of exactly how the waste is managed and separated in the construction industry.
- A comparative study could be done in the waste management approaches in Bahrain and other countries around the world.

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Artificial Intelligence Solutions to Environmental Problems- Possible Applications in Bahrain

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Abstract

Artificial Intelligence (AI) has had numerous applications in the recent years promising solutions to complex problems facing human lives. From Healthcare, transport, finance, entertainment to military, government and space applications, AI is going to be a game changer on the problems that face humanity specially with the advent of enabling technologies such as high-speed communications and high speed-small sized processors. In the environmental sector, AI research has been focused on several environmental problems which promises new solutions to ill-defined problems relating to environmental protection, reducing air pollution, wastewater management, water pollution, preserving marine life and many other problems. The AI technologies in this regard are developing every day and thousands of companies that utilize human and machine intelligence to perform various tasks exist.

Bahrain has had several environmental challenges given its land size, location, climate and the increased population and industries. The Supreme Council of Environment has identified the main environmental challenges that face the kingdom in the coming years which include: wastewater treatment specially that from desalination of sea water, ground water pollution given the continuous rise in water consumption, marine life and biodiversity given the land dredging and reclamation projects and air pollution from oil refineries, aluminum manufacturing and power plants.

In this paper, the potential use of AI technologies for environmental applications in Bahrain is investigated given the uniqueness of its environmental problems where unconventional solutions could be developed. The paper attempts to map the possible AI solutions to these problems in order to stimulate research in this area for the case of Bahrain. It is seen that complex environmental problems in Bahrain where traditional approaches could fail can be the subject of AI research and technology development.

Keywords: Artificial Intelligence, Knowledge-based systems, environmental protection, air pollution, wastewater management, water pollution, marine life.

1. Introduction

The population growth and the extensive industrial development in the Kingdom of Bahrain have resulted in several environmental challenges. Bahrain's principal environmental priorities as indicated in a report by the Supreme Counsel of Environment of the Kingdom (the Supreme Counsel of Environment of the Kingdom of Bahrain 2019) has been focused on wastewater treatment and management specially that from desalination of sea water, ground water pollution given the continuous rise in water consumption and seawater intrusion, marine life and biodiversity given the land dredging, reclamation projects and climate change which results in rising sea levels, and finally air pollution from oil refineries, aluminum manufacturing and power plants. A recent study of the Public opinion on the most important environmental issues in Bahrain (Statista, 2019) showed that pollution from industries and hazardous waste, ground water contamination, waste management, pollution of the sea are the top environmental challenges that face the country.

The uniqueness of these challenges come from the fact that the kingdom has a relatively small in size, is an island and is potentially fast growing in population and industrialization which all may result in very challenging environmental problems. For example, wastewater treatment has been a big challenge to Bahrain and is continuing to be a source of threat to the sea water and marine life. With more than 100,000 m³ of waste water overflowing the water treatment plant and dumped in the sea, continuous monitoring of effluent characteristics on continuous basis is required, for finding yearly pollution load to the marine environment specially that of aluminum plants, water desalination plants and oil refineries (Juma H., 2005). With regards to ground water pollution of the water table with sea water resulted in

salinity of the soil, which has reflected negatively on agricultural environments and reduced the area of the agricultural land (the Supreme Counsel of Environment of the Kingdom of Bahrain 2019). Air pollution due to extensive gas emission from cars and industries is causing increased temperatures and degradation in air quality in a small land size promising a significant issue to the inhabitants of the kingdom.

Although several measures and policies have been adopted by the government to address the above challenges, significant problems still arise everyday as the country is expanding both geographically, demographically and industrially. Therefore, all of the above challenging problems to the environment in Bahrain require non-traditional solutions as traditional solutions may not be able to track the exponential growth of pollution to sea, water and the air due to the exponential growth of population and industries in a fast-developing country.

Recent developments in Artificial Intelligence (AI) have motivated researcher to look into non-traditional solutions to challenging environmental problems. AI has been the enabling technology to many developments in environment protection technologies. AI is based on machine intelligence where machines mimic cognitive functions that humans have such as learning and problem solving. AI is classified into a number of types based on the complexity and the problem-solving ability of the system. Weak (Narrow) AI Machines are made to respond to specific situations but cannot think for themselves while strong (general) AI machines are able to think and act just like a human and to learn from experiences (Miaillhe, et. al., 2017). Examples of narrow AI include 1. machine-based deduction systems of formal statements from logical expressions, 2. knowledge-based systems which deal with methods to model and gather expertise; software to simulate human expertise and to support experts 3. pattern analysis and pattern recognition: inductive analytical processes in general, machine learning in particular; 4. robotics: autonomous control of robotic systems, i.e. autonomous systems; 5. smart multimodal human-machine interaction: analysis and "understanding" of language (in conjunction with linguistics), images, gestures and other forms of human interaction (Federal Ministry for Economic Affairs and Energy, 2019).

In the context of environment monitoring and protection, significant research has been done on application of AI to a variety of environmental problems. AI has been used in developing Environmental Decision Support Systems where AI knowledge-based techniques has been integrated with tasks such as monitoring, data analysis, communication, information storage and retrieval (Cortès, U., et. al, 2000). AI technologies help overcome the problem of huge amount of environmental data and their dynamic nature when these are used in making decisions about the environmental protection strategies. AI has also been used in modeling of waste water treatment plants in order to enhance their efficiency and capacity. Intelligent trashcans and waste sorting robots in Garbage dumps, have been a revolutionary concept in the waste management sector. Costa, B. S., et. al, 2018).

This paper focuses on predicting the use of AI in a number of environmental problems that face the kingdom of Bahrain. The following sections present the main environmental challenges unique to the kingdom of Bahrain and attempts to propose AI-based solutions to these problems shedding light on research directions in this field. These environmental challenges are based on a number of sources such as the report on the "State of the environment in the kingdom of Bahrain" published by the Directorate of Environmental Assessment and Planning -the supreme council of environment (Directorate of Environmental Assessment and Planning, 2009) as well as other individual research articles on the most significant issues that face the environment in Bahrain. The last section provides conclusions and directions for future research.

2. Wastewater Treatment

Bahrain has been investing in waste water treatment plants and sludge incineration plants since the early 80's of the last century. However, the significant increase in population and the expansion of industries has resulted in a significant problem to the capacity of wastewater treatment plants. These plants discharge considerable quantities of treated wastewater which has high concentrations of Ammonia and heavy metals into the marine environment. The main plant for domestic waste water is the Tubli wastewater plant which receives over 190,000 m³ per day of domestic wastewater from all over Bahrain of which 40% are treated to the secondary level and 60% to the tertiary level. A sizeable fraction of the treated wastewater is discharged into the sea. Treated wastewater discharged into the sea reaches approximately 130,000 m³ per day. Other wastewater plants were installed to address the wastewater from industrial and sea water desalination sources but all these use traditional approaches to wastewater treatment (Directorate of Environmental Assessment and Planning, 2009).

The problem with the performance and efficiency of waste water treatment plants is that the process is highly complex as it is composed by several operational units- which makes it difficult to implement an automatic process control over the wastewater treatment plant. In general, the process is ill structured as there is a lack of understanding of the biochemical process and the interrelationships between different characteristics of the system. Furthermore, the sludge process used in the treatment plant is highly dependent on the unforeseen changes experimented by live beings (microorganisms). Therefore, the performance and efficiency of the plant operation can only be enhanced if the supervisory control system is able to react to the changes and deviations of the inputs to the system which are highly varying (Sánchez-Marrè, et. al, 1996).

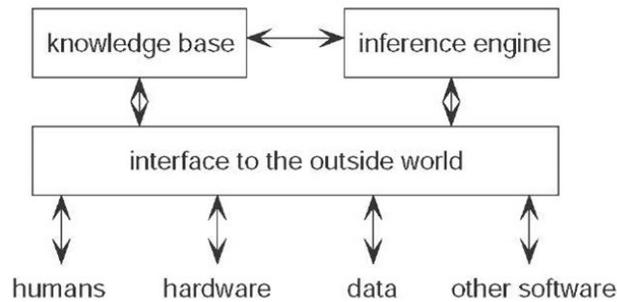


Figure 1: Knowledge-based systems (What-When-How, 2019).

AI research in this area has been focusing on utilizing Knowledge-Based control systems in the modeling and design of wastewater treatment plants to enable the different elements of the process to learn from previous cases (specific experimental knowledge) and to acquire the domain knowledge (general expert knowledge) in order to overcome some of the main drawbacks of classical control techniques. A knowledge-based system allows deriving new knowledge based on reasoning system through a knowledge base and an inference engine as shown in Figure 1 (Jabbar, H. K., et. al, 2015), (Krovvidy, S., et. al 1991). Therefore, knowledge-based control system can address usual abnormal situations and unusual abnormal situations in wastewater treatment plants.

Another direction in research in this area is the use of artificial neural networks, and adaptive network based fuzzy inference system In wastewater treatment plant modeling and control such as pump station control, optimization of energy use, control of additives in treatment, control of an activated sludge plant, control of non-linear pH neutralization, optimization of nitrogen removal and aeration energy consumption in wastewater treatment plants (Skipworth, P., 2019).

3. *Protecting Marine life*

With the increased sea water pollution, sand dredging and land reclaiming and rise of water temperature, protecting the marine life especially sea grass, coral reefs and mangroves in Bahrain has become very challenging. The harmful effects of industrialization and the resulted pollution of the sea will continually result in a shortage of fish stock which requires non-traditional approaches to management of the coastal regions (Directorate of Environmental Assessment and Planning, 2009).

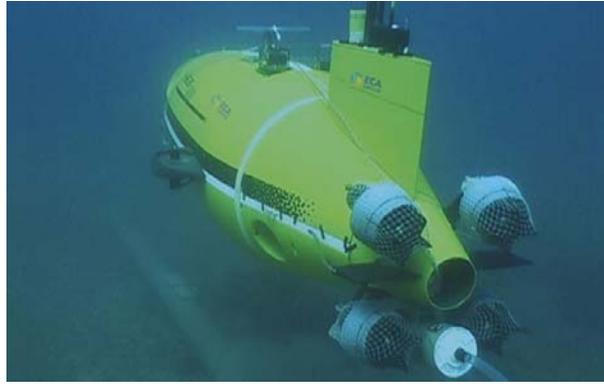


Figure 2: The Alistar 3000 autonomous underwater vehicle (ECA Group, 2019).

In this area, AI can help predict the spread of invasive species, follow marine litter, monitor ocean currents, keep track of dead zones and measure pollution levels (Cho, R., 2018). The main AI technology in this field is the AI-based Autonomous Underwater Vehicles (AUV's) and underwater robots which can be used to track and count fish in order to build an open living database of marine health and fish population, deep sea assessment and also Real-time monitoring of pollution levels of the sea. Figure (2) shows an example of AUV's used for marine life monitoring (Marttila P., 2019).

4. Oil Spills Detection

In 2003, the coasts of Bahrain suffered from a severe oil spill where an oil slick was detected 20 miles north of Bahrain's northern coast which inflicted serious damage to the marine environment. In response to this incident as well as other oil spill incidents, the government established the National Oil Spill Response Command Centre in the fishermen's harbor in Sitra. The center is equipped with ICT technologies to facilitate combating slicks, including telephone lines, fax machines, internet network, and display screens that broadcast live images from the spill site (Directorate of Environmental Assessment and Planning, 2009). The Government of Bahrain has developed the National Contingency Plan to Combat Oil Spills in order to maintain readiness for combatting oil slicks in the territorial waters of the kingdom (The Supreme Council for Environment-Bahrain, 2019). Furthermore, The Supreme Council for Environment has also provided a reporting system for Individuals, Businesses, Governmental Entities, and NGOs to report on oil spill accidents in the Kingdom of Bahrain (The eGovernment National Portal - Kingdom of Bahrain, 2019).

In this context, AI offers a number of solutions for detection and early warning of oil spills through the use of Artificial Neural Networks in the classification of Synthetic Aperture Radar (SAR) images which are extensively used for the detection of oil spills in the marine environment, as they are not affected by local weather conditions and cloudiness. The main problem with detection of oil spills from SAR images is that most detection techniques rely on detecting dark areas in the image. However, due to nonlinearities in the image data, the problem becomes very complex. ANN's can be used to simultaneously handle non-linear data of a multidimensional input space in the oil spill classification problem. Results of research showed that ANN have been superior to other image classification approaches in detecting oil spills on SAR images (Topouzelis, K., 2003), (Kubat, M., et. al, 1998).

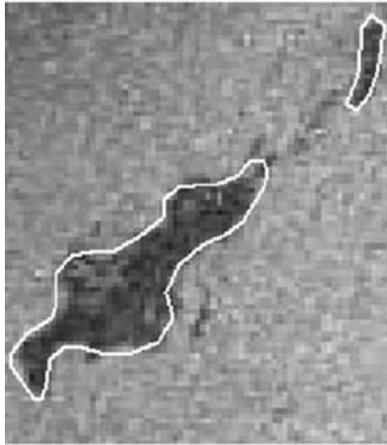


Figure 3: Oil spill detection from SAR images using ANN (Gstatic, 2019).

5. Ground Water Pollution Detection

There are several problems that face the water sources of Bahrain. The first is the seawater intrusion to groundwater and which results in increased salinity levels rendering it not suitable for drinking. The groundwater salinity in Bahrain ranges from 2,000 to 10,000 ppm is much higher than international levels (usually less than 500 ppm). The second problem is the groundwater contamination by septic tanks and oil well borings in some areas of the Kingdom (Directorate of Environmental Assessment and Planning, 2009). Figure 5 shows a Water Strata Systems in Bahrain aquifers. The salinity of the drinking water sources has severely affected wildlife habitats, plants and animals, and the biological diversity of such habitats. Furthermore, the increased salinity of ground water has driven many agricultural lands out of production leading to desertification.

AI can play an important and useful role in this area. Significant research has been done on using AI for development of smart monitoring system that will enable quality control and detection of chemical and/or bio-contamination and a preemptive risk management. The AI-based water contamination quality control systems are based on using advanced sensing technology coupled with pattern recognition techniques such as Support Vector Machines (SVMs), and Artificial Neural Network (ANN). The use of these technologies will help offer accurate severity level assessment of water quality (Tinelli, S., et. al, 2019).

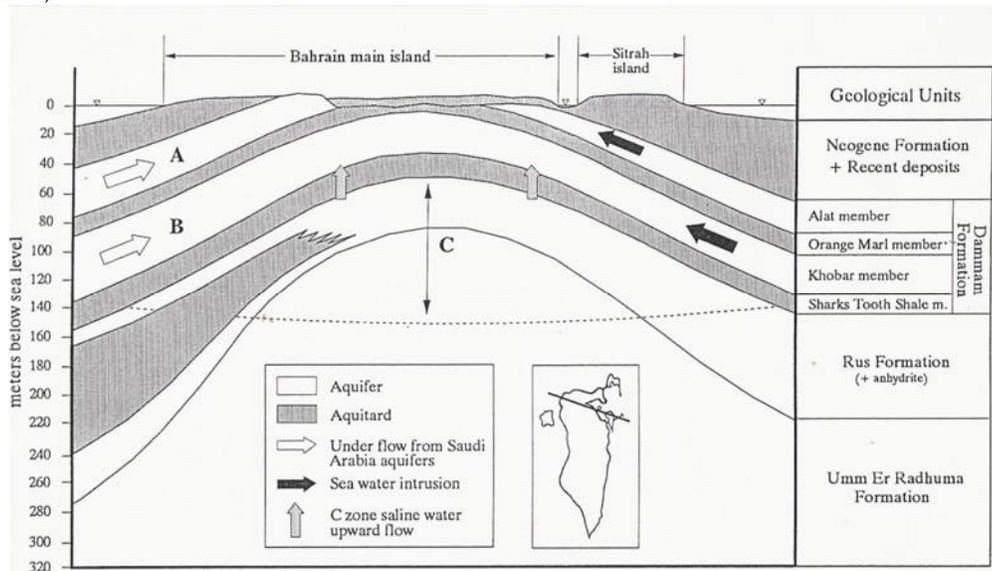


Figure 5: Drainage, Extraction and Water Strata Systems in Bahrain (Directorate of Environmental Assessment and Planning, 2009).

6. *Conclusion*

The most important challenges that face the environment of Bahrain has been presented and analyzed against possible solutions based on Artificial Intelligence technologies. The significance of this study stems from the fact that these problems are unique and require non-traditional solutions given the location, land size and the rapid growth of the country's population and industries. AI offers many solutions to these problems that face the environment in Bahrain and will potentially enable sustainable growth of the country in the future specially with the 2030 Economic vision of the country (E-Government Bahrain (2019). which focuses on the continued development of the Kingdom's economy and building a better life for every Bahraini. It is with no doubt that this vision requires solutions to the accompanying environmental problems which cannot be attained without utilizing future technologies such as AI technologies.

The presented research attempted to provide directions for decision makers in developing the future environmental strategies and for researchers to consider future AI solutions in their attempts to address the environmental problems of Bahrain.

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Reasons for Implementing Smart Cities Initiatives: An empirical study

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Abstract

Cities around the world are meeting a growing demand to be more liveable, secure, and more convenient. Significant urban growth is taking place on an unprecedented scale, bringing about evident environment and societal impacts. The rapid population growth and increased urbanisation increased the negative impacts; drive the consumption of resources causing resource shortages, increasing environmental pressures and infrastructure needs. Also, it drives growing demands from citizens to deliver a better quality of life and to do so in a sustainable way. "Smart Cities" is seen as a possible remedy for the challenges that urbanisation generates, and as an enabler of a sustainable and liveable urban future. Governments, city leaders and decision makers undertake smart city projects to invest in social capital and ICT infrastructure that fuel sustainable growth and enhance a quality of life. This paper examines the predominant reasons for smart city initiatives from the municipal decision makers' perspective. The study is based on the findings of a survey conducted via 65 participants from various small and medium enterprises and large organisations. The overall results show that the three major reasons for the implementation of smart city initiatives are: to reduce resource consumption, to improve quality of life, and to enhance sustainability performance.

Keywords: Smart cities, innovation, reason, knowledge economy.

1. Introduction

The term "smart city" is a catchphrase that draws increased attention among many scholars, research institutes, universities, firms, policymakers and governments around the world (Camboim et al., 2018; Bibri and Krogstie, 2017; Caragliu et al., 2011; and Neirotti et al., 2014). The number of publications and projects related to smart city grows exponentially in the last ten years (De Jong et al., 2015; Lee et al., 2014). However, there is no consensus about what is a smart city and what really makes a city smarter (Albino et al., 2015; Angelidou, 2015; Neirotti et al., 2014). Ruhlandt (2018) noted that, the label "smart city" is a fuzzy concept and the absence of a commonly accepted smart city (SC) definition makes implementing and governing SC initiatives and developments difficult. Bibri and Krogstie (2017) noted that the form of contemporary cities has been viewed as a source of environmental and social problems. Yigitcanlar et al., (2018) noted that despite representing only about 2% of the geographic space and accommodating over 50% of the world population, cities consume about 70% of the world's resources and hence are major consumers of energy resources. Furthermore, cities today are significant contributors to greenhouse gas (GHG) emissions (produce 80% of GHG emissions) due to the density of urban population and the intensity of related economic and social activities, in addition to the inefficiency of the built environment (Bibri and Krogstie, 2017). Moreover, it has been estimated by the United Nations that by 2050 66% of the world's population will live in cities (United Nations, 2015). This implies significant challenges pertaining to environmental and social sustainability (Bibri and Krogstie, 2017; OECD, 2012). Cities urgently need innovative organizational and institutional arrangements to solve a great variety of extant and emerging technical, physical, and social problems (Gil-Garcia et al., 2015). Towards this end, there is an urgent need first to develop, apply, and mainstream innovative solutions and sophisticated methods in the area of urban planning and development. This urgency is also to overcome the challenges of urbanization (European Commission, 2014, United Nations, 2015).

The concept of 'smart city' attempts to describe and design an integrative and comprehensive image of city development for today and the future. The term "smart city" is increasingly being used to include most of the important technological aspects, human capital and physical infrastructure (Chourabi et al. 2012; Hollands, 2008; Nam and Pardo, 2011). Mohanty et al., (2016) noted that one of the formal definitions of the smart city is "a city "connecting the physical infrastructure, the information-technology infrastructure,

the social infrastructure, and the business infrastructure to leverage the collective intelligence of the city". Scholars from different disciplines and practitioners from different professional fields have sought a variety of smart city models and approaches that can contribute to tackling these challenges. In accordance, Ruhlandt (2018) noted that various cities across the globe see a possibility to address challenges by adopting the SC concept. Indeed, it is in such cities that the key to a better world—which is held by ICT—will be most evidently demonstrated. The prosperity of many cities and their ability to address their complex challenges is one of the key reasons why much attention has been given to smart city as an urban development strategy (Bibri and Krogstie, 2017). Academics and practitioners have attempted to develop new knowledge about smart cities and the reasons behind implementing smart cities initiatives. Nonetheless, the attention to the key reasons and drivers for implementing smart cities initiatives are less evident in the smart city literature. The current literature reveals the need for more empirical research on the experience of existing smart city initiatives, especially of the reasons for existing initiatives. In light of the above, this paper aims at disclosing a comprehensive overview of the concept of smart cities in terms of its underlying foundations and assumptions, and the key drivers for implementing smart cities initiatives.

2. *The Concept of a "smart city"*

In recent years, the development of smart cities is at the forefront of the urban discourse due to rapid urbanisation rate and associated socioeconomic, environmental and governance challenges, along with the global innovation leadership challenge (Belanche et al., 2016). Yigitcanlar et al., (2018) noted that, at the dawn of the catastrophic global climate change era, 'smart cities' came to the scene as a potential panacea to, somehow, reverse or ease the impacts of ill urbanisation, industrialisation, and consumerism practices. There are different views regarding the origin of the concept 'smart city' in the literature (Bibri and Krogstie, 2017). Nam and Bardo, (2011) noted that the concept of smart city is not novel, but in the recent years it has taken on a new dimension of using ICTs to build and integrate critical infrastructures and services of a city. Neirotti et al. (2014) argued that the origin of the concept can be traced back to the smart growth movement in the late 1990s. Yigitcanlar et al., (2018) noted that since 1990s, the smart city concept has evolved to mean almost any form of technology-based innovation in the planning, development, operation and management of cities. However, the literature revealed that it is only until recently that the concept has been adopted in city planning through the movement of smart growth (Yigitcanlar et al., 2018; Bibri and Krogstie, 2017; Batty et al.; 2012). Gil-Garcia et al., (2015) noted that there is no consensus on a specific and unique definition of a 'smart city'. Although the wide use of the concept today, there is still unclear and inconsistent understanding of its meaning (Ahvenniemi et al., 2017; Angelidou, 2015; Batty et al., 2012; Chourabi et al. 2012; Marsal-Llacuna et al., 2015; Neirotti et al., 2014). In view of that, a great number of definitions have been suggested different emphases, although academics, ICT experts, and policymakers converge on the use of ICT across all domains of smart cities (Bibri and Krogstie, 2017). Yigitcanlar et al., (2018) noted that although the initial rationale for the smart city developments was mostly related to environmental concerns, the practice, unfortunately, indicates that only marginal attention is paid to these concerns. Current practice is mostly unidimensional with technology at the core (Yigitcanlar, 2018). Bibri and Krogstie, (2017) noted that in essence, there are two mainstream approaches to smart city: (1) the technology and ICT-oriented approach and 2) the people-oriented approach (see Figure 1 and Table 1 for summary). Specifically, there are smart city strategies which focus on the efficiency and advancement of hard infrastructure and technology (transport, energy, communication, waste, water, etc.) through ICT, and strategies which focus on the soft infrastructure and people, i.e. social and human capital in terms of knowledge, participation, equity, safety, and so forth. For several authors the conceptualization of smart city is mostly based on the use of information and communication technologies (ICT) (Gil-Garcia et al., 2015). For example, Anavitarte and Tratz-Ryan (2010) argue that a smart city is "an urban area functioning and articulated by modern ICT in its various verticals, providing ongoing efficient services to its population". Similarly, for Washburn and colleagues (2010) a smart city is "the use of Smart Computing Technologies to make the critical infrastructure components and services of a city – which include city administration, education, healthcare, public safety, real estate, transportation, and utilities – more intelligent, interconnected, and efficient." Also, Kitchin (2014) conceives of smart city as one that monitors and integrates all of its critical infrastructures, optimizes its resources, plans its activities, and maximizes services. In fact, most of what could be considered the mainstream definitions of smart city sees ICT as the most important component of smartness. As to the second approach, Neirotti et al. (2014) describe smart city as a way of enhancing the life quality of citizens. Smart city entails human and social factors, apart from physical and technological factors (Galán-García et al., 2014). Lombardi et al. (2012) emphasize additional soft factors such as participation, safety, and cultural

heritage. Angelidou (2014) underscores the role of ICT to achieve prosperity, effectiveness, and competitiveness.

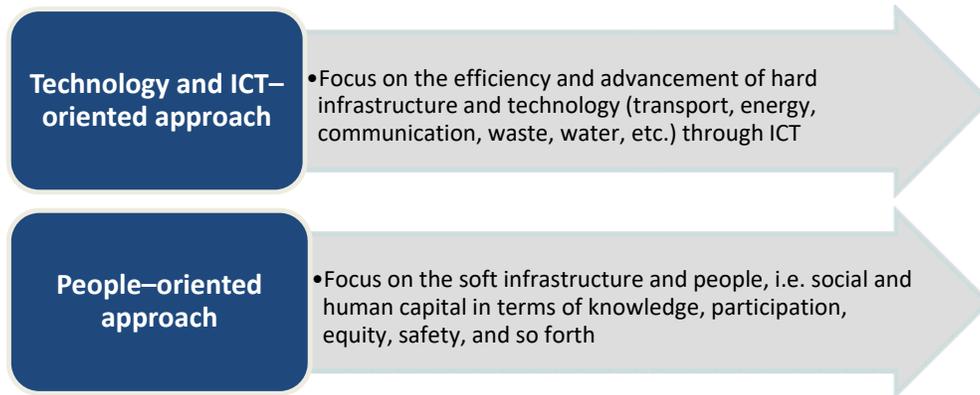


Figure 1: Mainstream approaches to Smart City

Table 1 Technology & ICT-oriented approach and People-oriented approach of smart cities.

Paradigm	References	Description
ICT-oriented approach	Anavitarte and Tratz-Ryan (2010) Angelidou (2014) Kitchin (2014) Marsal-Llacuna et al. (2015)	<ul style="list-style-type: none"> - A smart city is “an urban area functioning and articulated by modern information and communication technologies in its various verticals, providing ongoing efficient services to its population”. - Underscores the role of ICT to achieve prosperity, effectiveness, and competitiveness. - A smart city is one that monitors and integrates all of its critical infrastructures, optimizes its resources, plans its activities, and maximizes services. - By using ICT SC aim to optimize existing infrastructure, to increase collaboration among economic actors, to provide more efficient services to citizens, and to support innovative business models across private and public sectors.
People-oriented approach	Lombardi et al. (2012) Galán-García et al., (2014). Neirotti et al. 2014	<ul style="list-style-type: none"> - Emphasize additional soft factors such as participation, safety, and cultural heritage. Other views tend to put emphasis on services - Smart city entails human and social factors, apart from physical and technological factors - Describe smart city as a way of enhancing the life quality of citizens.

3. Key Drivers for smart cities initiatives

Cities are meeting a growing demand to be more liveable, secure, and more convenient (Kunzmann, 2014; Nam and Bardo, 2011). The current city model is producing more negative than positive externalities, which hinder cities to thrive and also accelerate their urban decline (Camboim et al., 2018). Current cities are complex systems that are characterised by massive numbers of interconnected citizens, businesses, different modes of transport, communication networks, services and utilities (Camboim et al., 2018; Kim and Han, 2012). Caragliu (2011) noted that the world population has been steadily concentrating in cities. Figure 2 shows the percentage of EU citizens living in cities (population living in areas classified as urban according to the country specific criteria selected by the UN); a massive rise in this percentage took place, from slightly more than 50 percent in 1950 to more than 75 percent of EU population being located in urban areas in the year 2010, and a forecast of about 85 percent within the next 40 years.

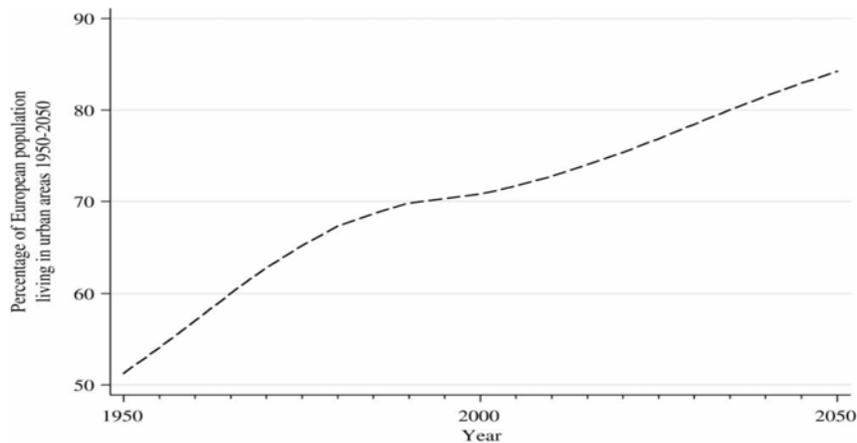


Figure 2: Percentage of EU population living in urban areas, 1950-2050 (forecast) (Source: Caragliu, 2011).

The population growth and increased urbanisation, which cities were not prepared for, increased the negative impacts, not only making cities lose their superb gains of proximity and density, but also making them hard places to live (Caragliu, 2011). Camboim et al., (2018) and Kim and Han, (2012) noted that the extensive rapid urbanisation, faced by several cities, raise a variety of technical, social, economic and organisational problems (e.g. traffic congestion, pollution and increasing social inequality) that tend to jeopardize the economic and environmental sustainability of cities. Moreover, the current city model no longer fits with the value creation principles of the new techno-economic paradigm (Camboim et al., 2018). Also, the creation of wealth in the 21st century flows through the innovation primacy, mostly enabled by knowledge-intensive digital applications widespread by creative and sustainable industries (Camboim et al., 2018; De Jong et al., 2015; Florida, 2014). Therefore, the current urbanisation problems necessitate an unprecedented paradigm change ways of urban thinking grounded in a holistic approach and long-term perspective with regard to the conception, planning, and development of the built, infrastructural, operational, and functional forms of cities (Bibri and Krogstie, 2017). The new paradigm encompasses a set of assumptions, principles and values, which can foster the emergence of new business models, new industries, new technologies, new market relations and new society (Florida, 2014). Camboim et al., (2018) noted that sustainability, connectivity, mobility, accessibility, transparency, inclusiveness, collaboration, diversity, and meritocracy are in the core of this revolution. These characteristics enhance and recover the importance of cities as the major catalysts for socioeconomic development. Ruhlandt (2018) and Neirrotti et al., (2014) claimed that a debate has emerged on the way new technology-based solutions, as well as new approaches to urban planning and living, can assure future viability and prosperity in metropolitan areas. In view of that, Neirrotti et al., (2014) noted that the concept of Smart Cities (SCs) has been the subject of increasing attention and it now appears as a new paradigm of intelligent urban development and sustainable socio-economic growth. Camboim et al., (2018) claimed that the smart city model emerges as a well-recommended alternative to cope with those issues and also encompasses the dynamics of the new paradigm in order to redeem the very essence of cities. Also, Nam and Bardo (2011) claimed that the initiatives of making a city smart have recently emerged as a model to mitigate and remedy current urban problems and make cities better as places to live. Hence some view smart city as an icon of a sustainably liveable city. Therefore, ICT has recently become part of mainstream debate on urban sustainability as well as urbanisation due to the ubiquity presence of urban computing and the massive use of urban ICT in urbane systems and domains. Indeed, data sensing and information processing are being fast embedded into the very fabric of contemporary cities while wireless networks are proliferating on a hard-to-imagine scale (Batty et al., 2012; Bibri and Krogstie 2017). This is underpinned by the recognition that the planning of cities as dynamic and evolving systems towards sustainability in terms of how they function and can be managed and developed necessitates smart, data-centric technologies (Bibri and Krogstie 2017). Table 2 summarise the reasons for implementing smart cities initiatives based on the literature review findings.

Table 2 Key reasons for smart cities initiatives

Reference	Reasons										Description
	Urbanisation problems	Technology (ICT)	Knowledge economy requirements	Innovation	Sustainability	Diversity, inclusiveness, and collaboration	Policy & Institutions	Community & connectivity of people	Economic growth and creation of wealth	Attraction & competitiveness	
Angelidou, (2015)	x	x	X	x							The technological advancements of recent years have enabled the development of a various solutions and products that use ICTs to improve urban function management in areas such as transport, energy, health care, water and waste.
Nam and Pardo (2011)	x	x	X		x		x				The unprecedented rate of urban growth creates urgency to finding smarter ways to manage the accompanying challenges. A demand for more liveable cities.
Kunzmann (2014)	x		x		x					X	Aiming to attract investors and tourists, or talents to demonstrate urban quality and competitiveness
Neirotti et al., 2014	x	x			x				x	x	Population growth and increased urbanisation raise a variety of technical, social, economic and organisational problems that tend to jeopardize the economic and environmental sustainability of cities. Environmental sustainability represents a fundamental determinant of urban living quality.
De Jong et al., 2015;	x				x		x	x	x	x	Regenerative development is possible due to the 'smart'

											innovation, which should help overcome the lingering trade-offs between environmental and socio-economic development associated with previous sustainable development efforts. To create better environmental, social and economic conditions and to enhance cities' attractiveness as well as their competitiveness.
Bibri and Krogstie, 2017	x	x		x	x						Rapidly evolving urbanization implies significant challenges pertaining to environmental and social sustainability. Contemporary cities have been viewed as a source of environmental and social problem. ICT has recently become part of mainstream debate on urban sustainability as well as urbanization by developing smart solutions for sustainability, optimizing efficiency in urban systems, and enhancing the quality of life of citizens.
Camboim et al., (2018)	x		x	x	x	x	x	x	x		Rapidly urbanization increased the negative impacts and made cities hard places to live. Also, current cities model doesn't fit with the value creation principles of the new techno-economic paradigm. Sustainability, connectivity, mobility, transparency, inclusiveness, collaboration, and diversity are in the core of the new paradigm revolution of smart cities

Caragliu & Del Bo, 2018	x	x	x	x	x	x			x	x	The world population has been steadily concentrating in cities. "Smart city" solutions allowing modern cities to thrive, through quantitative and qualitative improvements in productivity.
Yigitcanlar et al., (2018)	x	x	X		x		x				'smart cities' came to the scene as a potential panacea to, somehow, reverse or ease the impacts of ill urbanisation, industrialisation, and consumerism practices

4. Methodology

The aim of this study is to investigate the key reasons for implementing smart cities initiatives. In order to achieve this aim, a robust research methodology was considered essential. According to Pink et al., (2012) research methodology in social enquiry refers to far more than the methods adopted and encompasses the rationale and philosophical assumptions that underlie a particular study. Also, Dainty (2007) noted that the design of research methodology is an essential and difficult step in the research process. These, in sequence, impact the actual research methods that are used to explore a problem and to collect, analyse and interpret data. Therefore, the choice of research methodology is a crucial and difficult step in the research process. Given the complexity and the relatively newness and unexplored nature of the research problem at hand and the paucity of comparable research in the current literature of the concept of 'smart cities', a quantitative research methodology was adopted to collect and analyse data. Questionnaire surveys have numerous advantages instruments in the data collection process. They are cost-effective, efficient, and permit anonymity techniques; also they offer a wider geographical coverage for the sample population than other methods e.g. case studies or semi structured interviews could offer (Wright, 2005). For the purpose of the current study, a web-based, online survey was used to collect data. Gunn (2002) noted that "There is no other method of collecting survey data that offers so much potential for so little cost as Web surveys." Punch (2005) noted that Web surveys offer many advantages including low cost, speed, and ability to reach respondents globally. Gunn (2002) noted other advantages of Web surveys as a faster response rate; easier to send reminders to participants; and easier data processing. A robust questionnaire survey design is necessary to attaining reliable survey results and an applicable response rate (Bryman and Bell, 2007). Henceforward, these aspects are further clarified in the following sections.

4.1 Questionnaire Design

Questionnaire variables used in the study were derived from the literature review. The specific questions were written with focus on the response process, the utility of individual questions, and the overall structure and appeal of the questionnaire. The cover page introduced the research project and provided critical information such as a confidentiality statement and important notes for completing the questionnaire (Antwi and Hamza, 2015). According to Naoum (2007), three typical question types are used in questionnaire surveys: open ended and closed ended for types of question format, and scaled items for opinion questions which require subjective measurement. The study included scaled items for opinion questions. The final page of the questionnaire provided an option for respondents to offer any further general comments relating to the area of research.

4.2 Sample Design

The sampling technique used was convenience sampling. According to Black (2010), in convenience sampling, elements for the sample are selected for the convenience of the researcher, hence the researcher typically chooses target respondents who are readily available, nearby, or perceived as willing to participate.

4.3 Questionnaire Response

The researcher emailed survey invitations to participants requesting that they submit their views via an online survey. After initial analysis of the data, the number of usable responses amounted to 65 from small and medium enterprises (SMEs) and large organisations.

4.4 Data Analysis

The collected quantitative data has been analysed with the help of statistical techniques such as descriptive analysis and the t-test. The aforementioned tests are suitable for the research because the researcher has compared the responses for SMEs and large organisations. Statistical analyses were undertaken using the Statistical Package for Social Sciences (SPSS). Descriptive statistics has been applied so as to present the results in an efficient and readable manner.

5. Findings, results and data analysis

Table 3 Key reasons for implementing smart cities initiatives

Key reasons	Overall	SMEs	Large	T_{cat}	Significant Value (p)
Due to Swiftly changing local/national policies	3.09	3.1	3.08	0.099	0.922
To meet the rising citizen's expectations of services	3.37	3.33	3.44	-0.624	.535
To deliver efficient, responsive and personalised services to citizens	3.42	3.40	3.44	-0.221	0.826
To reduce resources consumption	3.58	3.59	3.56	0.206	0.837
Digital delivery of public services	3.26	3.23	3.32	-0.454	0.651
To improve sustainability performance	3.51	3.58	3.4	1.073	0.287
To insure continuity of critical services	3.55	3.62	3.44	1.114	0.269
To enhance cities competitiveness	3.35	3.3	3.44	-0.741	0.461
For cities to remain fir for purpose	3.31	3.38	3.2	0.973	0.334
To provide real-time insights and information to make early decision in a crisis management	3.25	3.35	3.08	1.338	0.186

Bibri and Krogstie, (2017) noted that the use of big and real-time data analytics, as well as smart technologies as a set of sophisticated techniques, methods, and technologies in the prospect of smart cities can help in managing natural resources in a more efficient and sustainable way, and hence reduce natural resource consumption. Yigitcanlar et al., (2018) also highlighted that the impact of smart city projects on the natural ecosystem is evident. Mohanty et al., (2016) and Silva et al., (2018) noted that the concept of 'smart cities' is built upon a composition of multiple attributes; i.e. sustainability, urbanization, and smartness. Through the online survey, respondents were asked to indicate the extent to which they find these drivers to their organisations, on a 4-point Likert scale: "not driving" (1), "fairly driving" (2), "driving" (3), "very driving" (4). The overall result for respondents belonging from SMEs and large organisations is shown in Table 3.

It has been found from the overall results that the three major reasons for the implementation of smart city initiatives are: to reduce resource consumption (3.58), to ensure continuity of critical services (3.55), and to improve the sustainability performance (3.51). Moreover the reasons that have the least significance according to the responses obtained are: swiftly changing local/national government policy (3.09), providing real-time insights and information to make early decision in crisis management (3.25), and digital delivery of public services (3.26). Other than analysing the overall results the researcher has also analysed the results of t-test in order to compare the responses of participants of large organisations and SMEs. It has been assessed from the sig value of all the options provided to the respondents that the null hypothesis is accepted this means that the mean for the responses of participants from SMEs and mean of responses of participants from large organisation is different in terms of the reasons of implementing smart city initiatives. From the online survey and the literature review findings, it can be concluded that there are various reasons behind implementing smart cities initiatives. One of the main reasons that were identified from the findings was the extensive urbanisation and the associated problems that tend to jeopardize the environmental, economic, and social aspects of cities. Another key reason was to minimize carbon footprint, efficiently utilizing resources, and smarter waste management.

6. Discussion

Both academia and practitioners have introduced a countless of terms and definitions related to the fuzzy concept of smart cities. The various definitions reflect the different themes and approaches behind which a city is labelled as a "smart" city (Yigitcanlar, 2018; Neirotti et al., 2014; Nam and Pardo, 2011). However, the current literature revealed that all the terms and definitions are developed as answers to the same set of issues related to the global significant rapid urbanisation, and the associated challenges. The extensive urban growth raised massive technical, social, economic and organisational problems that tend to threaten the economic and environmental sustainability of cities, among those; urban mobility and traffic congestion, security, degradation, energy and food shortages, pollution, increasing social inequality and combating poverty. On the other hand, new options for urban planning, innovation incentives, economic

and social development stand out as the most popular ones (Neirotti et al., 2014). As a result, the way cities can sustainably be planned and developed has been of fundamental importance for strategic sustainable development. Consequently, as a result of the emergence of ICT in its various forms (infrastructures, applications, data analytics capabilities, and services), as well as the debate on how technology-based solutions can be used to address the growing urban challenges and the associated socio-economic concerns and to assure viability and prosperity in future cities (Nam and Pardo, 2011; Kim and Han, 2012; Bibri and Krogstie 2017). The concept of “smart cities” is being characterised as the concept where, governments and decision makers use extensive ICT in the urban areas so as to principally focus on sustaining growth and address socio-spatial inequalities of resources. While useful, technology should not be the central focus. A humane smart city addresses first of all people and their needs. Then comes technology and only in direct connection with these need (Yigitcanlar et al., 2018). In addition to the above discussion, it was also determined that there are several reasons for implementing smart cities strategically. One of the major reasons that were identified from the findings of the study was to ensure higher efficiency, environment protection and reduction of CO2 emission and to reduce the wastage of resources. According to Yigitcanlar et al., (2018) the interdisciplinary literature highlights a number of smart city drivers. These drivers include technology, community, and policy (see Figure 3 for summary) (Kunzmann, 2014). Smart city technology makes life in the city easier, more convenient, and more secure. Also, smart cities communities have beneficiary of smart city services, and also decider of which problems to be tackled. Nevertheless, policies are seen as enablers of smart city initiatives and taking measures to minimise the negative impacts of smart city disruption. Almost identical to these drivers, Nam and Pardo (2011) conceptualised the drivers of smart cities as: technology, people, and institutions. They state that given the connection between these drivers, “a city is smart when investments in human/social capital and ICT infrastructure fuel sustainable growth and enhance a quality of life, through participatory governance.” Despite of the fact that various non-profit organisations and SME’s work towards developing smart and sustainable cities; most of them are still not on track with their waste reduction strategies. Smart cities cannot be developed easily and they require the integration of resources, investments and collaboration with organisations. Another reason which was identified was sustainability. The global environmental issues are rising due to which various challenges are faced by the local people hence it is necessary that firms start helping the communities at basic level to create sustainable societies to safe scare resources. Depletion of ozone layer, melting of ice and rising sea level are some of the main environmental issues which should be worked on in order to create sustainable societies.

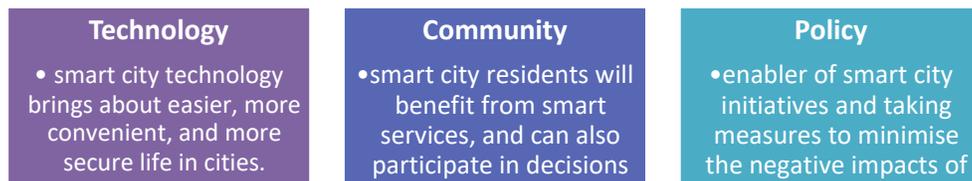


Figure 3: Smart city drivers

In accordance with the findings from Kunzmann (2014), and Nam and Pardo (2011), Angelidou (2015) noted that the technological advancements of recent years have made feasible the development of a vast array of solutions and products that seek to enable the smart city. These products use ICTs to improve urban function management in areas such as transport, energy, health care, water and waste. As a result, an increasing number of technology vendors and consultancies are looking for a niche in the smart city product market.

7. Conclusion and recommendations

Despite high-level popularity of smart cities concept and practice, there is no consensus on what a smart city is, what are the key smart city drivers and desired outcomes are, and how the smart city paradigm can be conceptualized. The concept of smart cities is a difficult concept to pin down or strictly delineate, and can still be considered a vague notion. It is often context-dependent—i.e. diverse smart city projects, initiatives, and endeavors are based on particular target objectives, available resources, financial capabilities, regulatory and policy frame-works, political structures, and so on. The study findings revealed

that apart from limited good definitions, smart cities have not been adequately conceptualised, and most of the existing work have limitations to advance our understanding on the key smart city reasons. The analysis finds that smart city reasons are not extensively covered in the literature. The analysis findings revealed a number of generic (sub) themes clustered under smart city reasons and desired outcomes. Extensive urbanisation and the associated challenges are of the key reasons to implement smart cities initiatives. The paper concludes that the key reasons to implement smart cities initiatives are; to reduce natural resource consumption, to ensure continuity of critical services, and to improve the sustainability performance. This research contributes to both theory and practice of smart cities. It contributes to the theory by intertwining smart city drivers in a novel way. This will encourage/attract smart city researchers to undertake investigations on the planning and development processes of the claimed smart cities. It contributes to the practice of smart cities by providing guiding principles for urban administrators and smart city practitioners. The study findings both from the literature review and the empirical findings show that identifying the key reasons for smart cities is very important in order to have successful smart city initiatives implementation. Therefore, more effective integration and knowledge sharing within and across smart cities initiatives and projects is required. Establishing a collaborative network with both internal and external stakeholders would be pivotal and should be addressed thoroughly. Opportunities to reflect on lessons which could benefit future projects are missed. Therefore, it is important to develop a comprehensive framework of the key predominant reasons for smart city initiative.

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A Proposed Program to audit the Sustainable Development Goals in the Kingdom of Bahrain

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Abstract

Countries are competing with certainty to achieve the expected Sustainable Development Goals, which represent an integrated package of necessary adjustments and changes in all areas of life in light of the circumstances and crises that society faced which no place and no time limit.

In the other direction, the society - at the various segments - is looking for the role played by the SAIs for the protection of public funds to achieve their role in the implementation of the SDGs.

Hence, the research aimed to build a proposed model for a program to audit the implementation of the Sustainable Development Goals (SDGs) that centered on (5) key areas (people, planet, prosperity, peace and partnership), followed by (169) a later goal covering the three aspects of development, namely: economic prosperity, social development and environmental protection. In addition to the areas of justice, peace and good governance, which the National Audit Office of the Kingdom of Bahrain is applying on the Sustainable Development Goals to audit the implementation of the basic objectives of Vision 2030 and in line with the aspirations of all in order to achieving a better life for the world population.

The research has concluded a number of conclusions and recommendations that would enrich it and draw the attention of those concerned to the anticipated role to audit the achievement of the SDGs.

Keywords: Sustainable Development, Sustainable Development Goals, National Audit Office of the Kingdom of Bahrain, Kingdom of Bahrain, Audit Program

1. Introduction

Achieving the SDGs has become a goal for everyone alike, given the comprehensive and integrated package of requirements necessary to improve the level of health care, education and social well-being of all components of society, as well as the fight against the issues of poverty, destitution and underdevelopment in light of the changes in the world.

Since the implementation of the SDGs is primarily the responsibility of all States and their governments, and the SAIs are responsible for building a sound system of performance and objective accountability for the results of the management of public funds by government agencies.

Hence, it was necessary for the SAIs to develop a mechanism that summarizes its methodology to ensure the extent to which state institutions meet the requirements of implementing the SDGs adequately and effectively to maintain public funds, which would provide an effective guarantee upon which these bodies work in this regard, while facilitating Full supervision of the implementation stages of the goals with the highest level of efficiency.

In the light of the foregoing, and to achieve this research has included six axes, the first axis addressed the methodology of research and literature review, while the second axis was devoted to the conceptual framework of the term sustainable development and the objectives underlying it, while the third section touched on the National Audit Office of the Kingdom of Bahrain. The fourth axis devoted the role of the Kingdom of Bahrain in supporting the achievement of the Sustainable Development Goals, while the fifth axis is to demonstrate the practical aspect by building a model for a proposed audit program that addresses the procedures of the external auditor (represented by the National Audit Office of the Kingdom of Bahrain) to assist in reviewing and examining the stages of the implementation of the Sustainable Development Goals by the entities covered by its control in the Kingdom, while the sixth axis presented a set of conclusions and recommendations to solve the problem of research in its various dimensions, and prove the hypotheses.

1.1 Research Methodology

It includes the problem of research, its objectives, importance and hypotheses, in addition to the research method, according to the following:

1.2 Research Problem

The research problem is the failure of the National Audit Office of the Kingdom of Bahrain to adopt a clear and specific model for an audit program that summarizes its methodology in auditing the stages of implementation of the Sustainable Development Goals set out in the Vision 2030 by the entities under its control according to specific activities, in accordance with the Government's programs of action (2015-2018) and (2019-2022) to achieve the Sustainable Development Goals, which is one of the leading and advanced countries in achieving the requirements of the Sustainable Development Goals in line with Bahrain Economic Vision 2030.

1.3 Research Objectives

The research seeks to achieve a coherent package of objectives that can be summarized as follows:

Explain the conceptual framework of the term of sustainable development and clarify the underlying objectives.

Introducing the National Audit Office of the Kingdom of Bahrain, and disclosing the functions of its work, with expressing the external audit programs and their nature.

Highlighting the role of the Kingdom of Bahrain's strategy in supporting the achievement of the Sustainable Development Goals.

Building a proposed model for a specialized program that includes the general procedures for auditing the stages of implementation of the Sustainable Development Goals according to the areas they contain.

1.4 Significance of the Research.

The significance of the research is to highlight the role of audit programs adopted by the National Audit Office of the Kingdom of Bahrain during its examination and review of the work carried out, and the need for such programs as a basis on which to verify the implementation of the Sustainable Development Goals, and to enhance the role of the Office in measuring the effectiveness of implementation at the highest Ranks of efficiency, and with the lowest costs to ensure the protection of public funds from waste and misuse. Enriching the scientific and professional library with a subject that is relatively modern and specific to be added to the research studies that have been addressed from different aspects.

1.5 Research hypotheses

The research stems from the hypothesis that:

“ The adoption of clear and specific audit programs for the implementation of the Sustainable Development Goals contributes to enhancing its role in ensuring the optimal use of available resources and improving the work performed, and adds an integrated auditing dimension to its work. ”

1.6 Research Methodology

Descriptive Approach

The data required to discuss the research problem and prove its hypotheses on the available books, researches and periodicals (Arab and foreign), as well as researches and studies published on the international network.

Analytical Approach

By constructing a proposed model for a general audit program that deals with the work procedures of the National Audit Office of the Kingdom of Bahrain in examining the activities carried out by its auditing-submitted bodies to implement the Sustainable Development Goals and the effectiveness of the implementation according to the fields included.

2. *The conceptual framework of the sustainable development and the objectives underlying it Sustainable development - a conceptual framework*

2.1 The concept of sustainable development and its importance and objectives

Achieving sustainable development has become a global demand that all look for it, especially beyond the world has going through many recently environmental, social and economic imbalances, which have become threatening not only the continuity and progress of human well-being, but also the existence and life on this planet.

Since the beginning of the eighties of the last century, the world began to wake up to the noise of many serious environmental problems that are threatening life forms on the planet, and this was natural in light of the neglect of development of the environmental aspects over the past decades, it was urgently to find a new development philosophy to help overcome this International efforts have resulted in a new concept of development known as "Sustainable Development"(Abu Zant and Ghneim, 2006: 51-52).

which refers to the fact that it is a rational developmental pattern that aims to balance economic and social development on the one hand and the requirements of environmental protection on the other (Lami and Rahman, 2012: 255).

The term has been called several names (combined development, continuous development, comprehensive development, etc.), and all have met to unify these terms in one term (sustainable development), which is defined as " a process in which resources, investment guidance, technological development and institutional change are harmonized in a manner that enhances both the potential and the aspirations of the present and the future "(Lafta, 2016: 123), as defined by the Brundtland Report of the World Commission on Development and Environment in 1987 as " development that meets the needs of the present generation without compromising the ability of future generations to meet their needs. Special ", meaning that they are continuous and mounting process to improve the quality of material and moral life and to benefit from fair results achieved for the present generation and future generations(Lafta, 2018: 275)

The contemplator of the philosophy of the term " sustainable development ", which follows the published programs and policies, can determine its importance from being based on the principle that human beings are the focus of attention, as it responds to the needs of the current generation without sacrificing and compromising the needs of future generations, or at the expense of their abilities to provide a decent livelihood.

The importance of sustainable development is also evidenced by the objectives and the benefits achieved by the following: (Al-Ghamdi, 2013: Electronic Bulletin)

- 1- It contributes to identifying options, formulating strategies, formulating goals and formulating development policies with a more balanced and fair future vision.
- 2- It progress from the importance of analyzing the economic, political, social and administrative situations with a holistic and integrative vision based on the unity of the macro-systems and the interdependence of their sub-systems and avoiding improvisation, emotion and selfishness in dealing with available resources and capacities.
- 3- Encourages the unification of efforts and synergies between the governmental, private and non-governmental sectors on the agreed goals and programs that contribute to the contribution of all current and future community groups.
- 4- Creating the intellectual, behavioral and institutional change required by the development and development of policies and programs, and implementing them efficiently and effectively, avoiding overlap, repetition, difference, scattering and opposing efforts, depleting limited resources, especially time and time, which are difficult to compensate and cannot be stored or recovered.
- 5- Within the scope of practice to achieve the goals and objectives, sustainable development provides and activates opportunities for partnership and participation in the exchange of experiences and skills, and contribute to activate education, training and awareness to stimulate creativity and search for new ways of thinking and increase the generation and use of knowledge and overlap between the fields through committees and teams, and this will Reduces conflicts and differences and strengthens loyalty and belonging and raises morale, and achieve job security and psychological reassurance, which are necessary conditions for the release, development and maintenance of human energies.

Some (Lamai and Rehman, 2012: 256) argue that many economists, politicians and intellectuals now believe that sustainable development is an effective tool for remedying any imbalances, and to avoid the negative effects of the traditional development model over the past decades. States, institutions and various actors play an active role in achieving the desired developmental sustainability requirements.

2.2 Foundations of sustainable development

Sustainable development is based on a set of foundations that help to achieve its objectives, the most important of which are as follows: (Lafta, 2016: 123)

- 1- Consider the protection of natural resources from depletion and waste as development and partnership between present and future generations.
- 2- The objective of development is to equitably distribute the proceeds of economic growth, improve the living standard of society, and build bridges between development programs and the preservation of the elements of the natural environment.
- 3- Review current investment project patterns and promote the use of “environmentally friendly” clean technology to reduce environmental imbalances and maintain the natural resource base.
- 4- It is a development that calls not only to change consumption patterns to avoid waste, but also to modify patterns of investment and cleaner production and reduce energy consumption.
- 5- The concept of dividend from development must include all that is beneficial to society so that the concept is not limited to dividend and cost based on the effects of indirect environmental impacts and the social cost that reflects deficiencies in natural resources.
- 6- The use of advanced technology for production systems that are linked to the components of the natural environment and sustainability of existing ones to avoid the collapse of the elements of future development.

2.3 Dimensions of sustainable development

They can be summarized as follows: (Al-Ghamdi, 2013:Electronic Bulletin)

- 1- Economic dimension: It is intended to improve the level of human welfare through increasing its share in essential goods and services, but this cannot be achieved in decreasing of the limited resources available to many countries unless the main elements of this dimension, namely the availability of the main elements of production, foremost of which are stability, regulation and knowledge. Increase the efficiency and effectiveness of individuals and organizations involved in the implementation of development policies and programs, as well as increase growth rates in various fields of production to increase per capita income and stimulate the relationship and feedback between inputs and outputs.
- 2- Environmental dimension: It focuses on the protection and integrity of ecosystems and the good handling of natural resources and employment for the benefit of man without disturbing the components of the environment, including land, water and air and the inherent natural resources that contribute to the survival of human, animal and plant life, and sustain and progress and prevent depletion or pollution. To achieve this, attention must be paid to several elements: (biodiversity represented by human beings, plants, forests, animals, birds, fish, etc.), which created God on earth, or under the seas or in the atmosphere of space Wealth and resources discovered and stored energy of all kinds and their various depletable and renewable sources, and pollution to the environment in all its components, especially water, air and land and all that surrounds man from outer space and audio and light stimuli, difference in balance or disturbing the health of organisms or adversely affecting the quality of life.
- 3- The social and institutional dimension: It includes the components and human coherence and individual, collective and institutional relations and their collaborative efforts, or cause problems or poses needs and demands and pressures on the economic, political and security systems, the elements of this dimension are as follows:
 - Good governance by the type of policies and rules and the extent of partnership between the main sectors of government, private sector and civil society.
 - Empowerment: It is intended to raise the awareness of individuals and groups, men and women, the majority and minority, the need to contribute to the construction and mobilization of their energies and participate in making the future they dream of for themselves and their generations.

- Integration and partnership to establish a united society in its goals and solidarity in its responsibilities within the scope of rights and freedoms calling for justice and equality without discrimination or exclusion because of considerations of sex, religion, sect, color or nationality.
- 4- The urban dimension: Urban growth in human societies is one of the dimensions of sustainable development and represents an inevitable process, whether these societies are evolving or on the way to development, challenge the quality of the environment and environment, urban governance and good local governance. In order to meet these challenges, natural resources such as water, air and fertile land for agriculture should be rationally used to ensure our food needs, land for urbanization and to meet our housing and various other urban needs and infrastructure projects, taking into account the needs of new arrivals and future generations.
 - 5- Institutional dimension: Without institutions capable of implementing the strategies of the development plan through sustainable programs implemented by qualified individuals and institutions, States and societies will not be able to pursue sustainable development, public administrations and institutions represent the executive arm of the State through which they formulate and implement their developmental, social, economic and environmental policies, therefore, achieving sustainable development and progressive development of societies, raising the level and quality of life of individuals and securing their human rights, and providing a good framework for their commitment to their duties towards society, All of them on the success of state institutions and departments in the performance of their functions and tasks. (Mahmoud, 2013: 55).

2.4 Constraints to sustainable development

Despite the global efforts and serious attempts to achieve the demand for sustainable development in all countries and societies of the world, but these attempts are still largely deficient, for several reasons, perhaps the most important of which are:

- 1- Steady increase in the world population, as statistics show that more than six billion people inhabit this land, or about (140%) during the past 50 years, and the world population is expected to reach nine billion by 2050 People, which will compound the complexities of sustainable development.
- 2- Extreme poverty is widespread in the world, statistics indicate that one fifth of the world's population is forced to live on less than \$ 1 a day.
- 3- Instability in many regions of the world resulting from the absence of peace and security.
- 4- Continued migration from villages to urban areas and the spread of slums, air pollution and waste accumulation.
- 5- Areas of the world are generally exposed to harsh climatic conditions, in particular lower rainfall than the annual average, drought and increased desertification.
- 6- Limited and abused natural resources.
- 7- Some technologies and experiments imported from developed countries are not compatible with the economic, social and environmental conditions in some developing countries.

2.5 Sustainable Development Goals - Overview

On September 25, 2015, all 193 UN Member States adopted at the United Nations Summit on Sustainable Development the Sustainable Development Goals (SDGs), which includes 17 Sustainable Global Goals (SDGs) that have been in force since the beginning of 2016 and followed by 169 goals. Later, to ensure a better life for the world's population by 2030, by eliminating poverty and inequality, improving health and education, achieving economic growth by creating decent jobs, providing clean energy, water and infrastructure, and creating sustainable cities Protecting the natural environment and biodiversity and addressing climate change in a peaceful and just environment (VARGAS, 2016: 4). Worldwide through international cooperation.

In the same vein, the SDGs are based on a set of principles: (Al-Otaibi and Al-Huwaidi, 2019: 2, 13-14):

- o Achieve better population quality by focusing on the relationships between population activities and the environment, dealing with natural systems and their content based on human life.
- o Enhance the population's awareness of environmental problems by developing their sense of responsibility towards them and urge them to actively participate in finding appropriate solutions, through their participation in the preparation, implementation, monitoring and delivery of sustainable development programs and projects.

- Respect the natural environment by focusing on the relationship between population activities and the environment, and the mechanism of dealing with natural systems.
- Achieve rational utilization and use of resources.
- Linking and employing modern technology to the goals of society.
- Make a continuous and appropriate change in the needs and priorities of the community.
- Achieving technical economic growth that preserves the natural capital that includes natural and environmental resources.
- Using the systems approach in the preparation and implementation of sustainable development plans, since the human environment is a subsystem of the overall system.
- Public participation and decentralization that enable bodies (official and community) and the population in general to participate in the preparation, implementation and follow-up of their plans.
- The principle of optimal use of economic resources
- The principle of extending the life of economic resources, and the strategic planning of these resources.
- The principle of environmental balance and biological diversity.
- The principle of reconciling the needs of present and future generations.
- The principle of viability and competitiveness.
- The principle of preserving nature's characteristics, as well as identifying and developing production, investment and consumption structures.

The following is a presentation of the SDGs in five main areas:

1. (People) Field
 - Goal 1 / eradicate poverty in all its forms and everywhere
 - Goal 2 / Eradicate hunger, provide food security and improved nutrition and promote sustainable agriculture.
 - Goal 3 / Ensure healthy lives and promote well-being for all at all ages.
 - Goal 4 / Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.
 - Goal 5 / Achieve gender equality and empower all women and girls.
2. Field (planet)
 - Goal 6 / Ensure the availability and sustainable management of water and sanitation for all.
 - Target 12: Responsible consumption and production.
 - Goal 13 / Take urgent action to address climate change and its impacts.
 - Goal 14 / Conservation and sustainable use of oceans, seas and marine resources for sustainable development.
 - Goal 15 / Protect and restore land ecosystems and promote their sustainable use, sustainably manage forests, combat desertification, halt and reverse land degradation, and halt biodiversity loss.
3. Field of Prosperity
 - Goal 7 / Ensure access to affordable, reliable and sustainable modern energy for all.
 - Goal 8 / Promote sustained, inclusive and sustainable economic growth, full and productive employment, and decent work for all.
 - Goal 9: Establish resilient infrastructure, stimulate inclusive and sustainable industrialization, and promote innovation.
 - Goal 10 / Reduce inequality within and between countries.
 - Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable.
4. Field of Peace
 - Goal 16: Peace, justice and institutions.-
5. The scope of the partnership
 - Goal 17/ Strengthen means of implementation and revitalize the global partnership for sustainable development.

Figure 1.1 depicts the five main SDG areas, as follows:



Figure 1: Five main SDG areas

In addition, achieving the SDGs requires a range of policy tools to help achieve them, including (legislative, market reform, preventive, economic, awareness raising).

3. *Supreme audit of Financial and Administrative control in the Kingdom of Bahrain and External Audit Programs*

3.1 Supreme audit of Financial and Administrative control in the Kingdom of Bahrain

Control of public finances is a useful assistance to the state in following up implementation of its plans at various stages and detect any deviation, treatment and evaluation as soon as possible in order to achieve its desired goals and reach the appropriate level in the use of its available capabilities, and the widening role played by the state in various activities and increase its intervention in many. As a consequence of the increase in the volume of public expenditure, the need for advanced financial and accounting systems to guide and guide them, in order for the state to implement these systems in an optimal manner, there was a need for effective control to help the transparency of these systems.

In view of the inability of the State to exercise its oversight functions, this function was entrusted to specialized supervisory bodies independent of the executive structures of the State in order to exercise its competence under immunity and guarantees that support its independence (Arab Organization of Supreme Audit Institutions, 2010: 32-33) and report its findings, it aims to build a sound performance appraisal system and objective accountability for the results of the management of the public finances. In promoting sound financial management and accountability.

In the Kingdom of Bahrain, the Financial Audit Bureau was established by Decree Law No. (16) of 2002 issued on July 3, 2002 in the framework of the State's endeavor to complete its constitutional institutions following its transformation into a Kingdom. An independent public legal entity called the "Bureau of Financial Supervision", belongs to the King

The Bureau began its work in an unprecedented gesture immediately after the appointment of the President of the Bureau in October 2002 to assume the task of overseeing the state funds and funds of the parties provided for in Article (4) of the Law of the Office in force, and in particular verifies the safety and legitimacy of the use of these funds and good management, Believing that public money is the backbone of the state and the pillar of its renaissance, the legislator has surrounded the public finances with the fence of the constitutional, legal and supervisory protection necessary to ensure its collection and good spending without wasteful or wasteful in support of the state and society.

The Audit Bureau is a financially and administratively independent organ and a member of the legislative and executive branches under article 116 of the constitution and article 1 of its law. The Audit Bureau issues an annual report on both the final accounts of the State and the final accounts of the audited entities (Arbossai, no year of publication, Electronic Bulletin).

3.2 External Audit Programs - Theoretical Approach

Audit program and its content

Admittedly, the external auditor cannot himself examine all financial events recorded in the books and records in detail, so he usually hires assistants who are entrusted with completing part of the transactions he deems appropriate to their scientific and practical qualifications.

In order for these assistants to do their job well, on the one hand, and to reassure the external auditor that they have done what they must on the other hand, it was necessary to have a program of auditing by assistants when performing their work, and through the audit program is determined time It is used as a means to distribute the work between the external auditor and his assistants. (Osman, 1999: 61-62)

The audit program can be defined as the "external auditor's work plan to be followed in the audit of books and records and the data contained therein. (Abdullah, 2014: 152)

The audit program represents the planning aspect of the audit process, because it is one of the main requirements to perform it efficiently and effectively, and the need to take some decisions on what to do and how to do this work and when to do this work, and these decisions are in written form and therefore represent audit instructions and information Called the "Audit Program" . (Nur, 1987: 150)

The establishment of a written and documented audit program outlining the procedures necessary for the implementation of the audit plan is the basis of the audit plan and to achieve proper control of the implementation of the work at the specified times, as well as the standards applicable when needed in the evaluation of audit matters (Accounting and Control Standards Board of the Republic of Iraq / Audit Manual No. (6), 2002: 3-4), some of them (Al-Aydi, 1990: 119-121) believe that the contents of the audit program should be developed and updated to become an effective management tool and a means to guide the audit team as a link between The work performed and the exceptions to be observed; and In order to achieve the desired results of the audit program, the planned and actual time in the report must be determined separately for each step and sub-step. This means scheduling each audit assignment separately, and allocating it to the ability, expertise and experience of each member. Audit body, this leads to increased job satisfaction (Juma, 2005: 137-138)

It can be said that the audit program is the estimated budget of the examination process, it serves as a guide and guide to the actual performance, and provides a basis for comparison with the actual performance, and the program can include a box showing the signature of the person who performed a particular operation of the program and the date of the process Therefore, the audit program not only shows the work to be done, but also shows the actual performance of the various tasks. It is therefore useful in determining the progress of the audit process. This program should be written on the typewriter and signed by the main auditor who prepared it, as well as the signature of the auditor and the official who approved it with the date of each of these signatures (Noor, *ibid.*: 151). Any part of an audit function includes all the procedures to be followed in the performance of this part, including the examination and audit of internal control systems, like every account affected by these systems (Thomas & Hankey, 1989: 272).

In addition, there are a number of considerations that the external auditor should keep in mind when designing audit programs.

- First, observance to the scope of the audit process, whether complete or partial, because each of them have certain steps to achieve them.
- Objectives to be achieved Because auditing is a means and not an end in itself, must make it possible to achieve those objectives.
- the use of audit methods that enable the auditor to obtain strong evidence in its proof.
- Follow the audit methods that suit the circumstances of each case, each institution has its own circumstances, according to which the auditor to prepare the appropriate audit program.

Objectives of audit programs: (Juma, 2005: 135) and (Noor, 1987: 150-151)

1. First: Summarize what should be done of the audit work, and limit the operations contained in the books and records.
2. Second: It represents detailed technical instructions issued by the auditor to his assistants.
3. Third: It is a tool to detect time deviations, if any, and to investigate their causes and take the necessary measures to address them.
4. Fourth: It provides the baselines for the work to be done.

5. Fifth: Encourages understanding of the organization of the project and the conditions under which it operates. Helps to monitor work and determine liability, provides automatic control of possible errors, provides records of work done and reviews the audit process itself.
6. Sixth: Helps to provide evidence of the implementation of an important standard of audit field audit which is to plan work in an appropriate manner.

Types of audit programs

It is not possible to establish a unified audit program of all kinds to be applied to different or even identical institutions because of the different circumstances of each institution that distinguishes it from others. Fixed Audit Program (pre-prepared before implementation): Fixed printed forms for all steps, and assistant external auditors are required to adhere to them and amend them at one or more points in the light of the data and information they receive from the institution (Abdullah, 2014: 153) This type of program has many advantages including:

- 1- It enables the external auditor to divide the work among his assistants according to his competence and experience.
- 2- it enables the external auditor to follow up on what has already been done and to know the time required to complete the following operations, thus coordinating the distribution of work among his assistants.
- 3- Helps to limit responsibility in the case of the discovery of errors.
- 4- Prepare the presumption that the external auditor shall perform the task in accordance with established principles and principles, and exercise the necessary professional care if the auditor is held accountable for negligence or default.
- 5- It helps to reassure the external auditor and his confidence in not to overlook some of the procedures or steps necessary for the audit process at any stage, or repeat some steps.
- 6- This program is suitable for large institutions with multiple details, as it is difficult for the assistants of the external auditor to take note of what they should do for each of them, unless there is a fixed program to clarify this.

In spite of these advantages, the audit program prepared in advance has some drawbacks, including:

- 1- Non-creativity of the external auditors and routine or performance mechanism.
- 2- The repeated use of the program from year to year leads to the lack of any adjustments resulting from the examination of the system of internal control, and therefore the lack of seriousness of some external auditors in the performance of the work if they discover operations not included in the audit program.

However, these shortcomings can be overcome through the participation of assistants in the preparation of the program and their continued opinion on its modification (Juma, 2005: 141-142).

Gradual Audit Program (Mainline Programs): This type of program is prepared during the implementation process and is limited to defining the main lines of the examination process and the objectives to be achieved. The advantage of this type of program is that it enables employees to use their expertise and know-how to follow the desired steps and to choose the appropriate methods and methods appropriate to the circumstances of the situation, which requires the auditor large practical training and extensive experience Appropriate scientific and practical training (Jarbou, 2009: 70).

4. *The role of the Kingdom of Bahrain in supporting the achievement of the Sustainable Development Goals*

- 1- National strategies and alignment with the Sustainable Development Goals: The Government of the Kingdom of Bahrain welcomed the United Nations Sustainable Development Goals initiative and directed its development strategies, plans and programs towards these goals, which will play a major role in achieving a better future for all.
- 2- Institutional Mechanisms: Decree No. (21) was issued in March 2015 on the establishment of the National Information Committee, chaired by the Minister of Cabinet Affairs and the membership of ministries and government agencies, and its amendments to follow up the post-2015 development agenda, and linking it with development programs and plans to meet the aspirations of the Kingdom in monitoring the sustainability of its progress. Council of Ministers Resolution No. 2468-07 was established to monitor progress in achieving the SDGs and their indicators in the Information and Government Authority.

- 3- Bahrain Vision 2030: Since it started in 2008, the National Economic Vision 2030 has been developed through three main principles (sustainability, fairness and competitiveness) to align the economic vision with citizens' aspirations to achieve the strategic pillars of the vision, which addresses the Sustainable Development Goals, these objectives represent a priority for the Government and are linked to the implementation of the Government's Program of Action.
- 4- The Government's Program of Action: The Sustainable Development Goals (SDGs) are among the most important foundations of the Government's programs of action, namely, the National Medium-Term Plans for the implementation of the Bahrain Vision 2030. It was found that 78% of the Sustainable Development Goals (SDGs) were included in this program, and the Council of Ministers instructed each ministry and government agency to match their respective goals, plans and policies in the government's current program of work (2019-2022) with the SDGs.
- 5- Government Program of Action (2019-2022) with the Sustainable Development Goals (SDGs): The Government's program of work (2019-2022) focuses on the achievements of the Government and its people in line with the Bahrain Economic Vision 2030 and the United Nations Sustainable Development Goals under the Kingdom's fiscal balance program. Creating a balance between government expenditures and public revenues to achieve economic growth, financial stability and sustainable development. The government's program of work has been developed in line with the main pillars, policies and initiatives to be achieved during the next four years to maintain security and stability and provide necessary services to citizens, and it will be achieved through the benefit of the current gains and avoid any additional burdens on citizens and improve the living conditions for them to promote citizen-based development.

The Government aspires to achieve the SDGs through (3) priorities in the Government's Program of Action 2019-2022:

- 1- Promote the basic constants of the state and society.
- 2- Financial sustainability and economic development.
- 3- Ensuring a supportive environment for sustainable development.

Table 1 Priorities of the Government's Program of Action (2022-2019)

Priorities for the Government's Program of Action (2022-2019)	Priorities for the Government's Program of Action (2022-2019)
Financial sustainability and economic development.	<ul style="list-style-type: none"> - Goal 1: Eradicate poverty. - Goal 2: Eliminate hunger. - Goal 4: Quality education. - Goal 8: Decent work and economic growth.- - Goal 9: Industry, innovation and infrastructure. - Goal 10: Reduce inequalities. - Goal 11: Sustainable cities and communities. - Goal 12: Responsible consumption and production. - Goal 17: Partnerships to achieve financial sustainability and economic development goals.
Ensuring a supportive environment for sustainable development.	<ul style="list-style-type: none"> -Goal 1: Eradicate poverty. - Goal 3: good health and well-being. - Goal 4: Quality education. - Goal 5: Gender equality. - Goal 6: Clean water and hygiene. - Goal 7: clean and affordable energy- - Goal 8: Decent work and economic growth - Goal 9: Industry, innovation and infrastructure - Goal 10: Reduce inequalities - - Goal 11: Sustainable cities and communities - Goal 12: Responsible consumption and production - Goal 13: Climate Action - - Goal 14: Underwater life - - Goal 15: Life on land - Goal 16: Peace, justice and strong institutions - - Goal 17: Partnerships to achieve the goals Ensure a supportive environment for sustainable development.
Promote the basic constants of the state and society	<ul style="list-style-type: none"> -Goal 1: Eradicate poverty . - Goal 2: Eliminate hunger .

Priorities for the Government's Program of Action (2022-2019)	Priorities for the Government's Program of Action (2022-2019)
	<ul style="list-style-type: none"> -Goal 5: Gender equality . -Goal 10: Reduce inequalities . - Goal 11: Sustainable cities and communities . - Goal 12: Responsible consumption and production . -Goal 13: Climate Action . - Goal 16: Peace, justice and strong institutions . - Goal 17: Partnerships to achieve goals Strengthen the basic constants of the state and society.

- 6- Outcomes of linking the SDGs to the Government's program of work (2015-2018):
- Linking methodology: As a first step to follow-up on the SDGs and linking them to the Government's program of work, all SDG 2030 targets have been reviewed and linked to the operational procedures of the current government program of work (2015-2018) to see which goals are currently government priorities.
 - Linking results: (78%) of the SDG 2030 targets are included for implementation in the current government program of work, but this does not necessarily mean achieving these goals and targets, as measurement indicators are the decisive factor in achieving them.
- 7- The awards and international guidance received by the Kingdom of Bahrain related to the Sustainable Development Goals:
- His Majesty King Hamad bin Isa Al Khalifa was awarded the United Nations Industrial Development Award (UNIDO) in 2016 in recognition of His Majesty's vision of economic empowerment of women and youth in the Kingdom of Bahrain and in honor of His Majesty's development strategy and achievements.
 - His Royal Highness Prince Khalifa bin Salman Al Khalifa was honored by the World Health Organization (WHO) in May 2019 as a global leader with great contributions to the field of health, with his vision, ideas, policies, initiatives and successes. Achievements to serve as models for all countries of the world, in recognition of his outstanding contributions to the achievement of the sustainable development goals related to the control of noncommunicable diseases, and to achieve the best standards of health and disease prevention and preserve the health of citizens and residents of the Kingdom of Bahrain.
 - HRH Prince Khalifa bin Salman Al Khalifa awarded His Highness the Sustainable Development Award 2016 to Mrs. Anna Tabjoka, former Minister of Land, Housing and Human Settlements of the Republic of Tanzania, former Under-Secretary-General of the United Nations and former Executive Director of the United Nations Human Settlements Program "In recognition of their significant contributions in supporting the sustainable development efforts of States.
 - The International Telecommunication Union (ITU) awarded His Royal Highness Prince Khalifa bin Salman Al Khalifa, Prime Minister of the Kingdom of Bahrain, the 2015 ICT Award for Sustainable Development for the Kingdom of Bahrain's progress in the telecommunications sector and harnessing ICT for sustainable development.
 - The United Nations has awarded His Royal Highness Prince (Khalifa bin Salman Al Khalifa) the Prime Minister the Millennium Development Goals Award in 2010 in recognition of His Highness' contributions to achieving the Millennium Development Goals and making them a reality.

5. Proposed program to audit the SDGs

The researchers devoted this aspect to the development of a proposed model for an audit program that addresses the work of the external auditor (represented by the Board of Financial and Administrative Control in the Kingdom of Bahrain) to assist them in reviewing and examining the stages of implementation of the Sustainable Development Goals by the entities covered by his supervision in the Kingdom through (six axes), To many reports, studies and programs issued in this issue.

The researchers used the external audit programs adopted in the audit work to prepare this framework, the proposed model is as follows:

Financial and Administrative Control Bureau Department of Audit Financial Supervisory Authority Name of Auditor:	Proposed program for the audit of the Sustainable Development Goals Prepared by: The program has been audited by: Date of commencement of audit: Prepared by:
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Program Objective

This program aims to outline the guidelines and the mechanism of work of the Financial and Administrative Control Bureau in the Kingdom of Bahrain to review and examine the stages of the implementation of the Sustainable Development Goals, in order to achieve a comprehensive coverage of the activities carried out by the bodies under the control of the Bureau with the highest levels of efficiency and quality.

Serials			Audit procedures	Time		Date		Auditors name and occupational address	Auditors signature	The worksheet number	
Main	Sub	Sub		General matters	Estimated	Actual	Start				Finish
1											
	1.1		Ensure that a long-term political, economic and social vision for the State is established as a source of medium and short-term development plans at the national, local and sectorial levels.								
	1.2		Verify the existence of a national mechanism to oversee the stages of implementation of the SDGs from all relevant ministries.								
	1.3		Ensure that there are clear work programs in accordance with timetables for the implementation mechanism.								
	1.4		Ensure that the SDGs are integrated into the five-year plans of the State and sectorial plans of the relevant ministries and development projects at the level of each ministry.								
	1.5		Verify the integrity and clarity of the procedures for delegation of authority and determine responsibilities and duties within all institutions and departments, and examine administrative orders that indicate the duties and tasks of employees within the institution to implement the objectives.								
	1.6		Review the instructions describing the detailed description of the work and how to accomplish it, and verify its adequacy.								
	1.7		Ensure that the implementation plans are consistent with the vision and strategy already set, and that the plans are coherent with the objectives of the strategy.								
	1.8		Verify the commitment of government agencies to the implementation of SDG projects in accordance with a specific timetable.								

2.			Financial matters								
	2.1		2.1 Ensure that the national program for the implementation of the Sustainable Development Goals (SDGs) is established (whether through the state budget or private sector funding, or financing roles for civil society, as well as diverse international and regional funding sources and opportunities).								
	2.2		Verify the existence of a clear and specific caliphate system to measure the cost of the activities carried out in each institution, by reviewing the annual plan of the work of the departments and divisions within the institution and verifying its effectiveness, and studying the deviations and find out their causes.								
3.			Objectives content								
	3.1		People								
		3.1.1	Identify the programs, policies and measures taken by the Ministry of Planning to ensure the social protection of the poor and verify their adequacy at the level of each year of the implementation of the goals.								
		3.1.2	Review the policy frameworks taken at all levels and ensure that they are developed on the basis of the pro-poor development strategy and the mathematical perspective to ensure poverty eradication.								
		3.1.3	Verify the accuracy and objectivity of the measures taken to ensure the safe functioning of agricultural commodity markets and that prices are not volatile.								
		3.1.4	Study the measures taken by the Ministry of Health on the elimination of epidemics and infectious diseases during the implementation stages and at the level of each year, and to ensure their adequacy and appropriateness to eliminate those diseases.								
		3.1.5	Request a statement of the number of deaths attributable to non-communicable diseases during the implementation phases and at the level of each year and compare them and verify their decline as planned.								

		3.1.6	Obtain a list of the number of individuals who receive universal health coverage, obtain all health drugs and vaccines, match the results to the scheme during the implementation process, identify the results and indicate the reasons for the deviation, if any.									
		3.1.7	Verify compliance with the who convention on tobacco control during the implementation stages of the goals.									
		3.1.8	Request a list of the number of researches and studies planned and carried out in the field of vaccines and infectious and non-communicable diseases to which the Kingdom is exposed and at the level of each year and to identify the results and study them.									
		3.1.9	Request and study the admission plan for preliminary and post-graduate studies in terms of gender equality in access to education (including persons with disabilities) and at the level of each year of implementation, and find out who is actually doing so.									
		3.1.10	Request a statement of the number of educational facilities planned to be built during the implementation phase and the percentage of their coverage for all stages of the age and at the level of each year of implementation, and find out the actual ones.									
		3.1.11	Request a statement of the number of grants available for students to enroll in higher education during the implementation and study stages of the objectives.									
		3.1.12	Request a statement of the number of teaching staff to be qualified during the implementation stages of the development goals and at the level of each year and the actual number and stand on the implementation of them.									
		3.1.13	Request a list of leadership positions held by women in institutions and check for equality with									

			men in this area and for each year of implementing the goals.									
		3.1.14	Study the automated systems used in the work during the stages of the implementation of the objectives and to determine their adequacy and keep abreast of technological developments.									
		3.1.15	Review legislation and ensure that it includes legal provisions on the promotion of gender equality at all levels.									
	3.2		The Planet									
		3.2.1	Examine the actions taken on the implementation of sanitation services during the implementation stages of the goals and each year and verify their adequacy.									
		3.2.2	Identify actions taken to improve water quality by reducing pollution and stop the dumping of hazardous wastes and chemicals and minimize their leakage during the implementation stages and ensure their adequacy.									
		3.2.3	Verify the implementation of IWRM at all levels and for each year of implementation.									
		3.2.4	Verify the support and promotion of community participation in improving water and sanitation management during the implementation stages of the goals									
		3.2.5	Ensure that all individuals have access to energy services during the implementation phases.									
		3.2.6	Study the policies implemented in support of development (such as decent work opportunities, creativity and innovation) during the stages of the implementation of the goals and to determine their objectivity and adequacy.									
		3.2.7	Study the policies adopted by the Kingdom to promote sustainable tourism, and verify its effectiveness in providing jobs, promoting culture and increasing local products during the implementation stages of the Goals.									

		3.2.8	Verify that the Kingdom has taken the necessary measures to enhance the capacity of local financial institutions to promote access to banking, insurance and financial services for all and expand their scope during the implementation stages of the goals.										
		3.2.9	Ensure that there is a comprehensive strategy for youth employment and the implementation of the ILO International charter during the implementation stages of the goals.										
		3.2.10	Request a statement of the number of deaths due to disasters during the implementation phases and at the level of each year, and ensure that the number is reduced in certain proportions.										
		3.2.11	Request a list of wastes and wastes received during the implementation stages and at the level of each year, and ensure that they are reduced by certain percentages.										
		3.2.12	Verify the implementation of sustainable management of all types of forests, halt deforestation and restoration of degraded areas, and achieve a significant increase in planting during the implementation stages and per year.										
		3.2.13	Ensure that actions are taken to combat desertification and restoration of degraded land and soil (including land affected by desertification, drought and floods) during the implementation phases and at each year of implementation.										
		3.2.14	Review the measures taken to halt the illegal hunting and trafficking of protected species of plants and animals during the implementation phases and ensure their adequacy.										
		3.2.15	Review the measures taken to reduce marine pollution of all kinds and effectively regulate fishing operations, and verify their adequacy for each year of implementation.										
	3.3		Prosperity										

		3.3.1	Verify and support income growth during the implementation phases.								
		3.3.2	Review the financial, wage and social protection policies adopted for each year of implementation, and ensure their appropriateness and fairness.								
		3.3.3	Request a list of housing projects implemented at the level of each year of implementation, to verify that all citizens have access to adequate housing and basic services.								
		3.3.4	Verify the measures taken to protect and preserve the world cultural and natural heritage for each year of implementation to ascertain their adequacy.								
	3.4		Peace								
		3.4.1	Verify the adequacy of the actions taken with respect to the following and for each year of implementation: - To reduce all forms of violence and the resulting mortality rates. - End ill-treatment, exploitation, human trafficking and all forms of violence against children and torture. - Reduce illicit flows of funds and weapons, promote the recovery and return of stolen assets and combat all types of organized crime.								
		3.4.2	Ensure public access to information and protect fundamental freedoms in accordance with national legislation and international conventions, and for each year of implementation.								
	3.5		Partnership								
			- Verify the strengthening of the company between the public and private sectors and civil society organizations by requesting a list of cooperation during the implementation stages of the goals and at the level of each year of implementation.								
4.			Management & Governance								
	4.1		Checking for the existence of legislative cover for the implementation of the Sustainable Development Goals specifying its conditions,								

			standards, controls and incentives at the national level, the level of important sectors and the different governorates.								
	4.2		Ensure the formation of a Higher Council for the implementation of the Sustainable Development Goals, subject to the highest authorities in the State, and review the action plans established according to timetables and programs for the role of the Council to implement the development goals.								
	4.3		Examination of controls and conditions of implementation, whether at the sectorial level, or at the governorate level, and verifying their objectivity and accuracy.								
5.			Conferences, seminars and workshops								
	5.1		Ensure that conferences, seminars and workshops are held in all ministries concerned with the implementation process to educate and build knowledge in this regard, and ensure that funding is provided for the establishment of these activities.								
6.			Monitoring and evaluation								
	6.1		Review and verify the objectivity of monitoring and evaluation mechanisms, feedback pathways, and powers of correction and continuous improvement approved by the implementing institutions.								
	6.2		Review all studies and plans that have already been adopted at the level of ministries and institutions and ensure that they are updated in the light of the Kingdom's vision to achieve the Sustainable Development Goals in 2030.								
	6.3		Ensure the existence of an integrated database and an electronic system of performance monitoring for all indicators of monitoring and evaluation.								
			6.4 Examination of the measurement indicators adopted in the implementation of the development goals and according to each of its fields, and to ensure that they are digital indicators to facilitate the monitoring and comparison process, while								

			verifying that they are updated periodically and commensurate with the nature of development priorities and challenges.								
	6.5		Ensure that technical reports on implementation follow-up are prepared periodically (quarterly and annually).								
	6.6		Review the objectives and programs of the national and sectorial implementation plans in the short and short term Mediation) to ensure that they are in line with the directions of the strategy.								
	6.7		Field and office review of the implementation of projects and programs included in the implementation plans by the planning and follow-up departments in government agencies.								
	6.8		Review the evolution of performance measurement indicators, with a view to monitoring progress in achieving quantitative targets.								
	6.9		Review the mechanism of cooperation and coordination between the competent bodies and ministries regarding the implementation and follow-up process.								

6. *Conclusions and recommendations*

First: Conclusions

1. There is a great harmony between the Government's program of work and the requirements of achieving the Sustainable Development Goals in the Kingdom of Bahrain.
2. The use of the proposed audit program ensures the procedures dealt with by the Financial and Administrative Control Bureau in the Kingdom of Bahrain in examining the activities carried out by its supervisory bodies.
3. The use of the proposed audit program will contribute effectively to strengthen the role of the Office of Financial and Administrative Control in the Kingdom of Bahrain to verify the optimal use of available resources and improve the work performed, and imparts an integrated control dimension of its work.
4. The Kingdom of Bahrain has made great strides in achieving the requirements of the Sustainable Development Goals.
5. The Sustainable Development Goals provide an opportunity for significant gains in development and responsibility. Timely, reliable, accessible and comprehensive budget information produced, as well as greater public participation opportunities, combined with strong and independent oversight, are important factors. These elements provide the capacity for all actors to participate clearly, while ensuring the effective use of public funds for the implementation of the sustainable development agenda.

Second: Recommendations

1. All countries should direct their development strategies, plans and programs towards the Sustainable Development Goals (as is the case in the Kingdom of Bahrain as a model) which will have a great role in achieving a better future for all.
2. The need for governments (as in the case of Bahrain as a model) to publish strategies for the implementation of comprehensive, open, accessible and timely data on revenues and expenditures related to the SDGs.
3. There are clear and widely accepted international standards for budget transparency in accordance with the requirements of the IMF, OECD and the World Bank, as outlined in UN Resolution 67/218. These standards require governments to publish eight key budget documents and provide information at all stages of the budget cycle (as is the case in the Kingdom of Bahrain as a model).
4. It is essential that the United Nations develop clear and measurable indicators on the implementation process and require States to report regularly and comprehensively on their financial revenues, investments and results.

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Section 5
BIM and Innovation in Construction

Implementing Building Information Modeling in Kuwait

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Abstract

Building Information Modeling (BIM) otherwise called Digital Construction, is a new process that is transforming the global Construction Industry. Instead of eliminating the traditional way of construction, the BIM process aims to enhance established ways of handling a project. This process leads to substantial improvements throughout the supply chain. It has been proven that this new process develops the delivery of a project, particularly regarding its environmental impact, sustainability, time, and cost. Such benefits are less evident when implementing projects the traditional way. The Kuwaiti Construction Industry is suffering from a lot of deficiencies when handling a construction project, and it's in very high demand of implementing BIM. This paper presents the benefits and techniques associated with BIM implementations in Kuwait that will show how eliminating the deficiencies will lead to satisfied clients by enhancing the quality and building performance. This paper will demonstrate how BIM implementations will increase the benefits of design by, applying virtual reality techniques that will help in minimizing errors, give precise cost estimation, and improve sustainability and energy efficiencies. And, will show how the construction process will be improved if the BIM information documents are implemented on projects.

Keywords: Building Information Modelling (BIM), BIM Information Documents, Virtual Reality (VR), Construction Industry, Publicly Funded Projects

1. Introduction

In Kuwait, as any other country around the world suffers from a lot of construction deficiencies and weaknesses in regards to over budgets and delays. The Kuwaiti Construction Industry should be in demand to implement BIM and be in the process of developing the construction traditional way which, will lead to a collaborative environment that will eliminate delays and high budgets (Almutairi, 2016). The traditional society of Kuwait has the prime role behind these deficiencies. There's no doubt that Kuwait is accelerating in developing the construction projects, but what this country lacks from, is the presence of BIM experts and the government's knowledge of BIM. Although, in recent years it has been witnessed that the governmental projects have reached the smart building levels, but the existing buildings from the 90's have very low endurance and need crucial maintenance.

As part of implementing BIM, there's the process of documentation and the process of using technology wisely. By implementing the BIM Information documents on the publicly funded projects in Kuwait it will help in getting everyone involved in the project to be aligned (Magenta, 2019). If the Kuwaiti Construction Industry will start wisely using the technological design process which includes virtual reality, it will help them by decreasing risk measures and enhance design management regarding crucial activities like, progress of design, health and safety and coordination (Virtualis, 2019). Kuwait has set a vision in 2035, there's a big possibility that BIM will be part of this vision.

2. Construction in Kuwait

The country of Kuwait is known to be a very small country, it's situated on the Arabian Gulf in the Middle East. Kuwait's area is 17,818 Km² with a population of 4,242,779 (Worldometer, 2019). Kuwait is one of the wealthiest countries amongst the Gulf countries, and it's known for its fast development. The Oil Industry in Kuwait is the number contributor to its economy.

The Kuwaiti Construction Industry is considered the second contributor to the country's economy. The Publicly Funded Projects plays a huge part in the country's development, and it's an association between the Government sector and the private sector. The construction projects in Kuwait are threatening the environmental concerns and how sustainable they are (Alsanad, 2015). The Kuwaiti Construction Industry

suffers from great financial problems that's affecting the country's economy. The Government usually hires international consulting and contracting organizations instead of local consulting and contracting companies, this might mean that the local companies lack from resources or the Government would have given these companies a chance to prove they can.

Unfortunately, the Industry is still implementing the traditional way in construction which is the Design-Bid-Build, and they nearly always employ the lowest bidder which always leads to a lot of consequences. As known, the traditional way is to select the design in regards to the lowest price for the design phase, and selects the lowest price bidder for the construction phase. The right way to start a project is to create the project documentations at the initial points but, in Kuwait it's actually much more difficult than that (Soliman, 2010).

2.1 Construction Challenges in Kuwait

All around the world, there's no doubt that most of the construction projects go through delays, and during the construction phase they suffer from budget upsurges.

In the USA, nearly four thousand construction projects were examined. It showed that the ratio of projects that go through delays and budget upsurges are greater than the projects that are delivered on schedule (P. Morris, 1988). Therefore, Kuwait is not the only country suffering from that problem, it's a problem that the construction is suffering globally.

A number of scholars came with the outcome of finding the causes of the increases in budget and time in the construction industry. A detailed analysis has been done to assess the project contributors "non-excusable time and cost increases". A fishbone diagram (*Figure 1*) has been created by a quality control expert from Japan named Dr. Kaoru Ishikawa that helps projects teams to dodge solutions that barely address the indicators of greater issues (Rouse, 2015). When the fishbone was used it's been clear what the causes of the issues happening in a construction site precisely, and formed a classification of the none excusable delays (*Figure 2*).

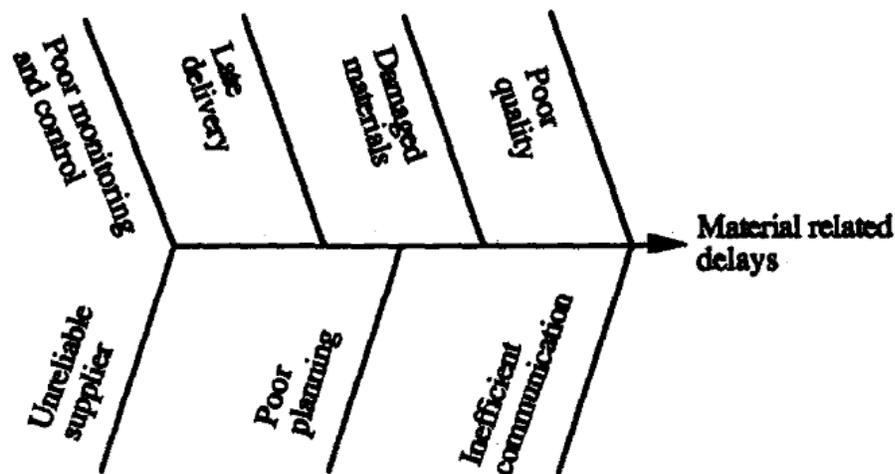


Figure 1: the fishbone diagram that helps projects teams to dodge solutions that barely address the indicators of greater issues (Rouse, 2015)

Factor	Rank
Late delivery or show mobilization	1
Damaged materials	2
Poor planning	3
Equipment breakdown	4
Improper equipment	5
Unreliable supplier/subcontractor	6
Inadequate fund allocation	7
Poor quality	8
Absenteeism	9
Lack of facilities	10
Inappropriate practices/procedures	11
Lack of experience	12
Attitude	13
Poor monitoring and control strike	14
Shortages of personnel	15
Delay payment to supplier/subcontractor	16
Inefficient communication	17
Wrong method statement	19
Unavailability of proper resources	19
Deficient contract	21
Interference with other trades	22
Too many responsibilities	23
Subcontractor bankruptcy	24
Low morale/motivation	25

Figure 2: The issues associated with the fishbone diagram showing the none excusable delays (Rouse, 2015)

Some delay causes in construction have been classified by another scholar. These causes were, financial restrictions, hard labor, tools and materials, and these causes are considered the main reasons for construction delays (Hensey, 1993). A study has been conducted in Thailand on the reasons behind construction delays and it concluded that the resources supplied are insufficient, have clueless clients and their representing consultants, and shortage of the contractor's resources (Promkuntong, 1996).

In Kuwait, the Housing Sector has set for the citizens an exceptional housing system, a husband and wife can register with the government to receive a house, there are two systems, it's either they choose a house built by the government or, they choose to get a land and a mortgage to build a house. Of course, most of the problems arise when the couple choose the house built by the government system. Here, the government has the liberty to select the contractor to build these houses, after that the terror begins. The housing Sector in Kuwait is the weakest sector when it comes to construction projects. The major problems regarding these projects are the delays that lead to over-budgets leaving the client very disappointed (Hafez, 2001). The issue here is that these issues were never examined and improved.

There's huge pressure on the construction industry to reduce construction budgets, deliver quality and eliminate delays. It might seem that these goals are manageable, but the reality is that there are huge bulks of waste that's the outcome of weak project planning, and to solve this problem recycling waste materials is not even thought about. This leads to occupying excessive landfill areas that will eventually lead to budget increases (Kartam, 2004).

The examples mentioned are all big challenges especially for a little country like Kuwait. A condition like this has a huge impact on the country's population and its economy. BIM is the new normal in construction. With its management system and technology, it's developing the traditional way in construction. The next challenge for Kuwait is to start adopting the process of BIM on its construction projects. If the process of BIM is understood thoroughly it won't always be a challenge, it's just that the government needs to be on board on adopting BIM to start planning ahead on how it can be implemented on the publicly funded projects.

3. Building Information Modelling

BIM is the shortcut of BIM, it's the process of producing and organizing the information of an asset throughout its life cycle (NBS, 2014). The main issue in construction is the lack of communication between all the disciplines that leads to lack of information in a design, that will actually lead to a lot of deficiencies when constructing the asset like, delays, budget increases, and low quality asset (Crotty, 2012). The process of BIM has the principle of solutions, it just depends on human's behaviors and how they implement the process for generating problem solutions. The implementation of BIM leads to a promising economic impact into developing the construction industry. Implementing BIM will give effective asset designs with the ability to apply virtual reality to help in detecting problems by walking through the aspects of the design ahead of construction. The BIM process has proven that it develops standardization and analysis of a model. By having a digitally generated model will ease the upcoming phases of a project all through to the operation of the asset (C. Eastman, 2011).

3.1 BIM information Documents

When representing the information in a clear form before even starting the design phase it's a very crucial part to ease the design and construction phases. Anything related to the project, from large information to the tiniest information should be documented (Karen M. Kensek, 2014). If the information captured is with high value it will lead to lowering the budget, this information needs to be accurate, explicit and comprehensive. These documented information systems need to be alive documents throughout the project lifecycle, and they need to be adaptable to last minute changes (A. X. Sanchez, 2016).

There are specific BIM Information documents that presents the client with information that guarantees the alignment of the project team. These documents clarifies to the team how the flow and management of information is developed and shared along the lifecycle of the project. A systematic documentation process leads to extra effective outcomes, it all comes to relying on strong and brief document sets developed at the initial point of a project (Magenta, 2019). These BIM Information Documents will be mentioned and explained below.

The EIR (Employer's Information Requirements)

The best way to implement BIM is by creating the EIR document before the start of a project. Without having a solid EIR, every participating person in the design and construction phase will be implementing BIM in their own way without following any guidelines that an EIR would provide. Developing the EIR should be at the initial phase of a project. This document provides the guidelines of implementing BIM for every project to provide the right idea to every participating person in the project to understand all the important information regarding the project. The client is the main beneficiary if an EIR is created for their project because, it gives the client a chance to express the information wanted clearly during the project, and most importantly what's needed at the late phases of a project to help in managing the facility management of the asset (BIMsense, 2019).

The BEP (BIM Execution Plan)

Before starting the construction phase in a project it's crucial to create the BEP to demonstrate it and implement it through all the project phases. This document is very thorough and it helps the project team on recognizing and implementing the process of BIM through all the tasks of construction management.

If the BEP has been built with a strong structure it will help the project team on highlighting the important information, which will lead to completing the tasks without wasting time. (Kelly, 2016)

The MIDP (Master Information Delivery Plan)

The MIDP is considered the main plan because it's used for managing and delivering information throughout the project's lifecycle. The person that's responsible of creating this document is the project delivery manager associated with the task managers to be used into assisting that the project information is delivered throughout the project (BIMPortal, 2019).

The TIDP (Task Information Delivery Plan)

The TIDP is a document stating out the responsibilities of each team member related to the information deliverables and, it's used to direct information delivery. Each deliverable is produced by separate task managers (DBW, 2019). Every task should coincide with a milestone that's aligning with the general programs of the design and construction, considering any sequenced specifications to produce information. Every task has to be detailed with the responsibilities' information assigned to every supplier and state how these responsibilities should be prepared to produce the information documents and how they shall be exchanged between the project teams. (SFT, 2019)

The Supplier Information Modeling Assessment Form

This Document provides meaningful tactics in assessing the competence, knowledge and maturity of each participating member in a project in regards to BIM. This form should be sent to all participating companies that are assigned to the project's supply chain. (SFT, 2019)

The Supplier Information Technology Assessment Form

This assessment form should be filled by all the companies in the project's supply chain, it leads to enabling the companies to validate their capabilities with information exchange and their maturity with technology. (SFT, 2019)

Supply Chain Capability Assessment form

This form is a way of assessing the supply chain organizations to demonstrate the tactics on how to get the approval on a collaborative working environment that leads to generating the necessary information related to the project and how to operate the asset after it's been delivered.

COBie (Construction Operation Building Information Exchange)

This document is a spreadsheet information format that holds information digitally regarding an asset in a comprehensive and valuable possible way (Hamil, 2018). The COBie is a popular way of use in information production from the design, during the construction until the handover and operation of the asset. The owner of the project has the responsibility of specifying the required information that's needed at handover of the asset. When having a solid COBie input in a project it will lead to a collaborative environment. (Kristian, 2016)

3.2 Virtual Reality (VR)

The concept virtual reality (*Shown in Figure 3*) emerges from imitating the reality of a false world, by copying its attributes from sensors to achieve movements in a virtual area subjugating physical limits. In the virtual reality senses, the addition and subtraction of information is done electronically. Then a computer rebuilds this information and it becomes more numerous till it tricks the senses and generates feelings of being absorbed in an innovative virtual condition. The adsorbed reality is considered the progression of virtual reality, and it can be expressed by wearing VR headsets that gives the illusion of this absorbed new reality.



Figure 3: Shows an illustration of how the experience of VR might seem (Sampaio, 2018)

In the methodology of BIM, VR produces perfect 3D models of a project. The method of virtual reality has a deep connection with BIM. In BIM the 3D attributes have already been defined which makes it easier to implement a virtual reality situation on it. A BIM model already has sequences of geometry, spatial dimensions on materials, and so on (Newsroom, 2017). The VR technology integrated with the BIM process is a business that needs to have the spotlight shed on it.

There are a lot of VR devices in the market that gives the user the demonstration of the virtual world and leads to the interactions with virtual areas and attributes. The attention is focused on how these VR devices can adapt to establishing connections demonstrating the information exported from the BIM 3D model. And these days, there's a lot of developed BIM software tools that supports the integration of the VR technology and the BIM process (Sampaio, 2018). The limitless extension of using the information of BIM integrates with the BIM based software tool with other innovative technologies. These innovative technologies connects the digital entities with the physical entities, and it's already been researched and investigated that combining BIM with other technologies is possible. (Lijuan Chen, 2014)

3.2.1 Capacity of the VR and BIM integration

The technology of VR gives an outcome of great communication skills for a project's team members based on great model visualization, and contribution to great interpretation of the project (Yi Jiao, 2012). It's very crucial for team members to understand the different types of information that can be linked to a group of parameters to identify each parametric element, based on the process of the BIM model. This allows the team members to evaluate issues to review substitute solutions. Having a developed collaborative work environment will lead to better interactions with the BIM 3D model leading to visualizing the geometry of components and consulting the parametric information (*Figure 4*).



Figure 4: showing a BIM 3D model tour of virtual reality in support of a collaborative meeting (Sampaio, 2018)

In recent years, the integration of the BIM process with the VR technology has been accepted in construction. The VR gives the user the authorization to completely engage on a scale of one-to-one with the manipulated BIM 3D model, giving an accurate immersing sense of existence in a space that's still not built (Benjamin Poussard, 2014). The AEC management (Architectural, Engineering, and Construction Management) experts understand that the applications of VR eases the design visualization for the client prior to construction, it will lead to exact needed materials that lowers the project's budget, and gives the exact number of labor needed for the project. For example, a VR journey can be implemented on a BIM 3D model to scan the schedule of maintenance or review the simulation of the model, to support making decisions.

4. Implementing BIM in Kuwait

After thorough research and demonstrating some of the benefits of the BIM process, it's been made very clear that implementing the process of having a solid BIM information documentations system and having to implement the VR technology will have very promising advantages to the Kuwaiti construction industry. Some of the essential points will be discussed further.

4.1 BIM Information Documents

The UK government has set standards supporting the use of BIM that led the country's construction industry to have advanced innovative systems that can be implemented on the publicly funded projects. In 2007 a British Standard BS1192:2007 has been issued stating that all organizations working on publicly funded projects should work in a collaborative environment to result in high standards of value mostly prominent to the processes of drawings and production of documents should be automated (BSI, 2007). Associated with this British Standard, Publicly Available Specifications PAS1192-2 have been issued in 2013 with developed guidelines by sponsored organizations to meet the standards set in BS1192:2007. In PAS1192-2, the information documents have been mentioned as a way of storing information digitally to be implemented on publicly funded projects (Buildings, 2019). Most of the information documents mentioned in section 3.1 are stated in PAS1192-2, stating that they have to be issued and electronically archived in a Common Data Environment (Limited, 2013).

As a third world country, Kuwait needs to follow the footsteps of a developed country like the United Kingdom. The benefits that are associated with the implementation of the BIM Information Documents are remarkable. If Kuwait's government decides to put a plan ahead in the vision 2035 and revise the British standards and rely on them to create standards and codes of practice to support the implementation of the BIM process and its associated information documentation system, the vision set will be met eventually. If the information documents are implemented on the publicly funded projects in Kuwait a lot of deficiencies will be eliminated. The production of the EIR will give the client the vision on the proposed designs, how they operate and how they will construct it. This will lead to making better decisions by the stakeholders leaving them understanding the incurred budget, and understanding each construction stage and how much effort it needs. The EIR is a document that benefits the project team members more than the client because, it gives them a clear vision on the required scope of work to complete a project (Notable, 2019). The necessity of having a BEP will create competitive benefits to Kuwait's construction industry, some of these benefits include accurate quantity takeoffs, having a 3D BIM model that has thorough information that can maintain the asset after delivery, will eliminate design duplicates, construction risks will be identified prior to construction, and many more benefits (DeCandia, 2017).

All the information documents mentioned in section 3.1 will have advanced benefits serving the Kuwaiti construction industry and the public sector. Especially, that the construction industry in Kuwait suffers from a lot of deficiencies like project delays and over budgets, having the government signing on having BIM standards and codes of practice will solve a lot of these problems.

4.2 Virtual Reality

When it comes to VR the ball is in the construction industry's court. If an organization has been assigned to a publicly funded project and this organization already implements the VR technology on its projects, they will definitely win more contracts in the future. How can the implementation of the VR on publicly funded projects in Kuwait lead to advanced benefits?

VR will help the project teams to perform better by having insight of the asset before it's even built. Objects layouts can be defined through VR that leads to better design and rendering. VR improves collaboration between the members of the project like the client and stakeholders, they can visualize the execution of their project which eases the connections with the project team members. The most crucial benefit behind the VR is providing improved maintenance for after delivering the asset, it will give insight on the location of objects in spaces that are very hard to reach, and much more (Kaushal Diwan, 2017).

Because of the problems occurring on the publicly funded projects in Kuwait, implementing the VR on these projects will solve a lot of projects issues, and the most crucial issues that are delays and over budgets. VR can solve these problems and most of these benefits have been stated.

5. Conclusion

To conclude, when the UK government have put standards supporting BIM, it led to proven efficient implementations of BIM. Although the UK is leading the BIM game, but they are still facing challenges and barriers by implementing it. The PAS1192-2 have stated the necessity of producing the information documents that will lead to having positive impacts on the publicly funded projects.

Virtual Reality has proven that it's a very effective BIM tool that has many benefits on projects whether it's during the project is in action, during the development of design or during the operation of the asset. VR has proven that it's more than an innovative technology, it's actually an essential tool that develops the activities of a project by adding value, improves the engagement of stakeholders, improves communication, solves the challenges of a project, and improves the predictability and outcomes of a project.

The construction projects in Kuwait are managed poorly and it's causing construction delays high cost budgets. This study has showed that the relevant BIM strategies will suit the requirements needed to save the publicly funded projects in Kuwait. If Kuwait follows the positive footsteps of the UK government with standardizing BIM, the publicly funded projects will witness massive positive changes. And the problems occurring in construction projects can be solved by utilizing the VR technology, as it has proven that it can solve these problems.

Finally, Kuwait is a developing country, adopting BIM is seen to be happening anytime soon, because some people are aware of this process and they're trying their best to implement it on the publicly funded projects. And in time, Kuwait will thrive with remarkable assets that are delivered with value.

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Innovative Changes in Quantity Surveying Practice through BIM, Big Data, Artificial Intelligence and Machine Learning

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Abstract

Like many construction industry professions, quantity surveying (QS) has been around for many years and has undergone many changes to reflect developments within the wider industry and society. The proliferation of computers into the design process starting from the 1980's leading up to the rise of Building Information Modelling has particularly led to significant changes in the design and construction landscape. In the UK for instance, the proliferation of BIM and possible demise of traditional Bill of Quantities, with the concurrent rise of smart buildings/cities with exploitation of Big Data (BD), artificial intelligence (AI) and Machine Learning (ML). It implies that QS practices need to reflect on emerging products and services that can promote construction quality and productivity as well as their own professional development. With the decline of traditional QS roles and increased focus on speed of construction, there may be opportunities for different roles for quantity surveyors when dealing with data-driven needs of advanced clients such as BIM managers and Project managers. Additionally, there is need to improve the market value for traditional QS practices when dealing with less innovative clients with less time constraints, which inadvertently contributes to a skills gap which will allow practices to charge more for the traditional services. This study is an exploratory research based on secondary data, which is aim at understanding BIM adoption and related technical advancements that represent innovative and emerging roles for QS professionals to meet the growing demands in the industry. The findings will ignite and support the need for changes in practice, professional education as well as attitudinal behaviour required toward the UK's Construction 2025 goals.

Keywords: Quantity Surveying, Building Information Model, Innovation, Productivities, Construction.

1. Introduction

The innovation brought about by Building information modelling (BIM) adoption & compliance affects Quantity Surveying (QS) practices nowadays (BIM Ireland, 2016), and the future of the profession is at an important crossroad. Innovation in UK construction industry is nothing new, but the UK seems to lag behind advances by the rest of European in terms of BIM (Bimplus, 2019). However, with the UK government mandating BIM for all their projects (GOV.UK, 2019) it is plausible that this could lead the way for others clients to do the same. This is because BIM is demonstrating the capacity to change not only contemporary QS work practices but potentially the entire UK construction industry (Fung et al, 2014).

UK construction is a crucial part of the economy and is still incredibly busy despite a lack in growth. "Wider construction accounts for nearly 7% of UK's value added, of which construction related products and services account for about 1% each and contracting accounts for about 4.7%. Some 3 million jobs are based in construction, 10% of total UK's Employment" (HMGOV.UK, 2013). There is also a large supply chain within the construction industry, which tends to remain within the UK, it is around £124 billion of the consumption (HMGOV.UK, 2013) and directly linked to the country's GDP. Given the capital intensive nature of construction projects and the impact they have on a country's economy; it is not far-fetched to argue that cost estimators are an essential part of the construction industry. Consequently, advances in the industry such as in BIM adoption will affect the role of the quantity surveyor perhaps in more ways than previously understood. One reason being that the low profit margins typical of construction projects, for example as reported by The Construction Index (2017) the top 100 contractors in the UK earned a pre-tax profit of around 1.5% in 2017. Given such low profits for large contractors, it is plausible to imagine that Small and Medium Scale (SME) organisations, which form the bulk of the supply chain, are operating at even lower profit margins. Consequently, opportunities to extract value and profitability from capital investments will rely on the professional astuteness and the ability to exploit new technologies for value realisation by professionals such as QS whose role is primarily costing.

The quantity surveying role within the construction industry has been around for many years and like most professions had to change with the times, most noticeably in 1980s with the introduction of computers and the possible demise of Bill of Materials (Cartlidge, 2013) and as a result, QS practices started to develop different services (Cartlidge, 2013) to provide new opportunities for young quantity surveyors with the introductions of technologies which will put quantity surveyors at the forefront once again (Sawhney, 2016). With the decline of traditional QS roles and more focus on speed of construction (Cartlidge, 2013) it is vital that the profession evolves as there may be emerging opportunities for different roles for quantity surveyors when dealing with experienced clients such as; BIM managers and Project managers with a quantity surveying background (Sawhney, 2016). This may create a new market for the traditional QS practices when dealing with less innovative clients with less time constraints and higher cost pressures according to Keelagher, (2017), leading to a skills gap which may permit practices to demand a higher fee structure or band for more traditional services. This study is therefore an exploration into how BIM and related digital technologies such as Big Data (BD), Artificial Intelligence (AI) and Machine Learning (ML) are going to affect traditional QS responsibilities and how they might going change the QS practice as a whole.

2. Literature Review

2.1 Building Information Modelling Adoption in UK.

Building information modelling (BIM), is a 3D model-based process (Autodesk, 2019), that provides professionals information and tools to efficiently plan, design, construct and manage buildings and structures. It allows design clashes to be detected and cost scheduling correction before construction, saving both time and money in the process (Kunz and Gilligan, 2007; Azhar, 2011). It is an intelligent model-based system, that gives architecture, engineering and construction (AEC) professionals the insight and tools to more efficiently plan, design, construct, and manage buildings and infrastructure (Autodesk, 2019). In addition, as an IT enabled approach it involves applying and maintaining an integral digital representation of all building information for different phases of the project life cycle in the form of a data repository (Gu & London, 2010). These definitions put all the emphasis on the technology and do not recognise the collaborative working that is required for BIM projects.

There is some argument over actual definition of BIM and the abbreviation should be Building information management (RIBA, 2012). This indicates alternative views that BIM is not all about technological innovations as the management is crucial (Pittard & Sell, 2017). This implies a technological focus, where the focus should be on the collaborative working that BIM creates. In other words, BIM "essentially, combines technology with new working practices to improve the quality of the delivered product and also improve the reliability, timeliness and consistency of the process to create, control and amend the information" (Pittard and Sell, 2017). This means the right processes and management need to be in place alongside the technology for successful BIM working.

BIM Levels are measured in terms of maturity, relating to the progressively moving construction to full collaborative working within the range of Levels 0 to 3 (BIM Industry Working Group. (2011), with basic 2D CAD mostly considered as Level 0 as pre-BIM status. Level 1 refers to the migration from 2D to 3D and object-based modelling and documentation, Level 2 progresses from modelling to collaboration and interoperability whilst Level 3 is the transition from collaboration to integration (Fig 1). It reflects the real underlying BIM philosophy including business intelligence, lean construction principles, green policies and whole lifecycle costing (Khosrowshahi & Arayici, 2012); and studies (RIBA, 2012 and Dakhill, et al, 2019) have considered Stage 3 as the "Holy Grail" for a digitally built Britain.

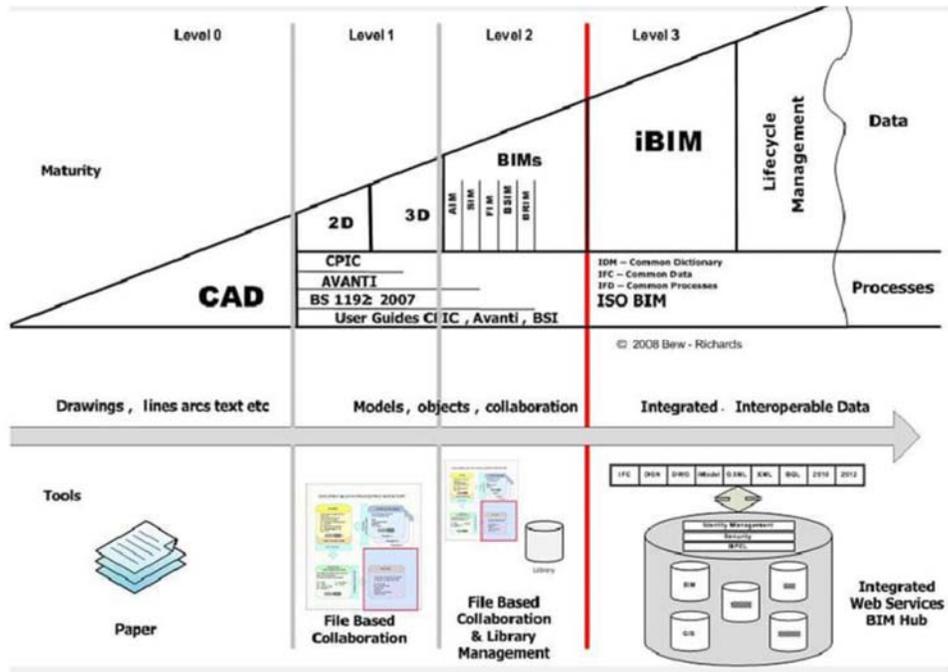


Figure 1: BIM maturity model (BIM Industry Working Group, 2011).

In simple terms, BIM represents a paperless process (Jiang, 2011), a revolutionary step that affects all aspects of the design team and more CAD and architectural software developers are moving towards BIM based products. Estimating tools such as: Solibri Model Checker 8, Autodesk QTO 2012, CostX 3.5 and CATO's BIM Measure 16.4 are already available to quantity surveyors, (Cartlidge, 2013), to accelerate labour intensive ways of working for the QS (Wu et al, 2014). However, the exclusive skills needed to support the quantity surveyor e.g. following New Rules of Measurement (NRM) adopted in the UK, only BIM Measure 16.4 supports this UK-based approach to measurement automatically and additional work is needed to improve other tools (Wu et al., 2014).

BIM Adoption in the UK is a big part of construction 2025 strategy (HMGOV.UK, 2013). Government construction projects as been mandated to use BIM Level 2 from 2016 there on, from 2025 the government is expecting to move towards level 3. A key driver for this is the collaboration project with the ministry of justice, which as demonstrated an 18% saving by using collaborative working processes (HMGOV.UK, 2013). The importance of Building information modelling has begun to manifest increasingly in recent years (Mayouf et al, 2019). This has put more pressure on quantity surveyors currently in the industry to be better trained, educated and have a better understanding of BIM based products and processes. BIM adoption is heavily reliant on both existing surveyors and new graduates acquiring the skills and training to be able to implement BIM, constituting an added burden for employers and academic institutions (Mayouf et al, 2019) making some construction firms reluctant to implement it, due to cost and time implications.

BIM has been around for several years but has not be utilized to its full potential (Eadie, et al 2013), most of the use was discovered at the earlier stages of design with lesser use in the construction stage. This is expected to increase once BIM has a wider adoption within the industry. The benefits as backed by a survey undertaken by (Eadie et al 2013) resulted in 82.61% of people considered that BIM would be beneficial to the project against approximately 17% who thought otherwise. In summary, it can be argue that BIM seemingly has a bright and important future for the construction industry as a whole and the QS profession in particular.

2.2 Innovations associated with related digital technologies and challenges facing Quantity Surveying practice.

The quantity surveying profession like many others in the built environment has evolve over the years (Cartlidge, 2013). Many of the traditional services are not as vital as they once were. The development of information technology has been an integral part of this shift. Within the traditional technical role of the

quantity surveyor, the main activities were limited to a narrow scope whereas within its contemporary role, QS would undertake a spectrum of work ranging from providing investment appraisals to construction project management (Thayaparan et al., 2011). As part of this reinvention and evolution, the QS has often become the clients lead consultants, thus moving up the ladder in terms of responsibility and in terms of importance within the project team (Ashworth, Hogg & Higgs, 2013). Additional services provided by contemporary QS extends to roles in project management, lifecycle costing, value engineering and management (Smyth and Pryke, 2009). The advice given to clients has also developed, providing better detailed analysis (Davies, 2006) and as a result of past innovations, quantity surveyors have evolved into professional experts in the contractual and financial aspects of the construction management industry (Ballesty, 2007).

It has been strongly argued that innovation within the construction industry is habitually sluggish towards innovative practices (Olatunji, 2010). Challenges like wastage and costs overruns have reflected poorly on the industry and solutions to these issues are still being sought. This has supported the lack of consideration around technology in the construction industry (Sexton and Barrett, 2004). It can be claimed that computers and the development of email mode of communication has had the biggest influence on QS practices and the construction industry over the past decade. The requirement to wait for printed drawing packages and the use of scale rulers has been largely removed from the process, being replaced by emailed drawings and measurement tools for on screen take-offs. This has made the information more accessible and increased the speed of estimates and schedules, increasing clients demand. Consequently, reducing timescales for design teams to produce documents and drawings.

2.2.1 Building Information Modelling (BIM) and the QS

The full impact of BIM on quantity surveying is yet to be appraised (Cartlidge, 2013) but it will certainly not be the end of the quantity surveying roles. Although challenges of BIM implementation exist, the use of automatic measurement provided by current BIM software does not negate the requirement to have a professionally trained QS to verify the work as expected from a competent professional surveyor. In this regard, the Royal Institution of Chartered Surveyor (RICS) views BIM adoption as an opportunity for surveyors rather than a danger (Withers, 2019). If surveyors do not incorporate and encourage change within their respected firms, the future BIM could result in a loss of relevance of the traditional QS (Cartilage, 2013).

It has also been noted that smaller firms may be able to gain from not adopting BIM and retaining the traditional services (Cartilage, 2013). Many clients in developing countries will still benefit from more traditional QS service, if they are less concerned with speed of delivery and more concerned with detailed measurement and value for money. It has been pointed out that the term 'quantity surveyor' was almost redundant over a decade ago, with some QS organisations focusing instead on the proactive management of broad range of issues that affect costs and hence rebranding themselves as "cost managers" (White, 2015). Similarly, BIM Managers and BIM Coordinators are new roles in the structure of BIM which also provide new opportunities for experienced quantity surveyors. Once the UK has reached BIM Level 3 maturity, the BIM manager and coordinator roles would probably be more common due to lack of expertise within the industry but there is no indication to suggest that QS cannot play both roles, which are in fact, an opportunity for experienced quantity surveyors or commercial managers of the future.

There are some challenges when using common BIM tools in the industry in general and in spite of their great capabilities for costing and estimating, BIM tools do not eradicate the requirement for an actual estimating format (Eos Group, 2008). From such BIM tools, the quantifying data can be extracted to an MS excel spreadsheet (Eastman, 2011), and following this the QS will need to put it into their own estimating format. Furthermore, BIM models and documents do not currently have the capability to capture the 'intangibles' (site conditions, general requirements and indirect costs), or method statements (means and methods of construction) as observed by Eastman, (2011). Consequently, Sawhney, (2016) have emphasised that the QS must analyse the BIM model for accuracy and completeness, as cost estimates are only as accurate as the detailed information or data handed to the QS, which if incorrect, can lead to inaccurate information (Stanley, R and Thurnell, D, 2013). Moreover, the accuracy and quality of BIM estimates is reliant on the material specified by designers (McCuan, 2009). Other challenges that the UK construction is facing with BIM adoption is the barriers within the industry itself preventing the holistic implementation. The high cost of application, lack of national standards and lack of skilled personnel (Liu et al., 2015) are among the primary barriers. Many small companies will not want to spend more for improved ICT systems and training as they currently feel it would not be worth it (Steve. R, 2014).

There are three key issues highlighted (Fig. 2) for successful BIM adoption in the UK (Khosrowshahi & Arayici, 2012). Changes in organisation culture will be needed to make the transition to BIM Level 3 maturity.

Changes in company and clerical procedures will bring improved competences. These will include alterations to technology and ICT systems including new hardware and software, changes to company structures including development of new roles for coordination, clash detection and BIM management roles are inevitable. Over time, technology will enable quantity surveyors to put together accurate estimates through BIM and other new forms of digital technology to deliver their projects. (Khosrowshahi and Arayici, 2012). Consequently, upskilling is a crucial part of the successful application of digital technology. Current staff skill levels need to improve continued professional development is important to the practices.

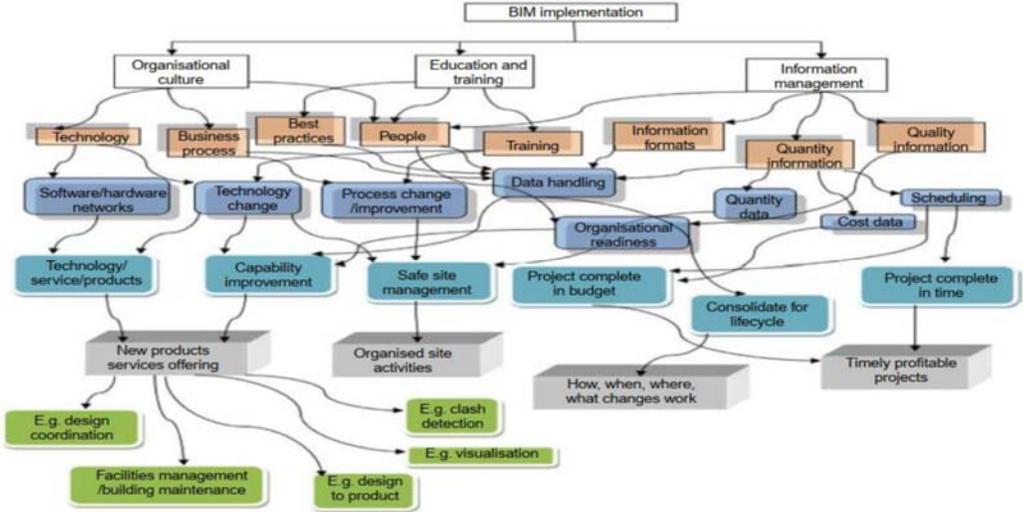


Figure 2: BIM implementation concept map (Khosrowshahi and Arayici, 2012).

The main aim of BIM is to enhance project performance and produce better outcomes (Kjartansdottir et al., 2015) and in this regard, better performance can be attained by improving the productivity of the overall industry. Quantity surveyors and estimators are becoming more and more mindful of the improvements in quantity measurement tools used in BIM processes. Yet, it is instructive that typical digital technology-led estimating tools do not have the capabilities to compile an estimate without participation from the quantity surveyor. BIM-compliant QS tools are therefore part of a transformative process for the industry (Eastman, 2011) capable of improving the efficiency of measuring quantities and replacing the use of scale ruler to on-screen take-off. It is important, therefore, for quantity surveyors to embrace this transformation and seize the full potential of digital technology. In the current climate, there is already a lack of quantity surveyors culminating in a skills shortage. One way to elevate this is to reduce the workload of the existing quantity surveyors. With measurement becoming automatic through software, this will enable quantity surveyors to improve their services to their clients. It will negate the need to spend valuable time measuring basic construction items and increase the time quantity surveyors spend supplying advice based on detailed cost analysis, thus helping clients achieve value more efficiently.

2.2.2 Big data and the QS

The Most Economic Advantageous Tender (MEAT) are always considered during the tender stage of construction projects. However, there is opportunity to evaluate any tender against historical data using algorithms, which can compare and contrast large volumes of construction data and documentation. In this regard, tender evaluation can easily be enhanced with the used of Big Data (Zhang et al, 2015), with full use of previous project cost data, piloting data mining examination and providing a position for tender analysis of new or existing construction projects. The advent of BD is therefore making construction project cost data more realistic. The project cost data is similar to BD with the following characteristic: bulky, evolving swiftly, multi-sourced and mixed (Kart, 2012), and together, these provide the necessary ingredients for modern technology-driven construction cost management. Although with the presence of BCIS cost database or other form of cost data, it is uncommon to see the introduction of applicable storage and analytical technology of BD being applied on traditional databases like BCIS for guiding cost control during tender stage in construction cost management (Dean, 2008). This gap represents an important opportunity for both QS and BIM technology providers. In summary, BD technologies can support the integration of essential and wide ranging cost data needed by stakeholders for generating accurate cost

estimates and social benefits, leading to higher value in the end. Other industries use big for their own value realisation and the unique value management possibilities (Bryant et al, 2008), hence the QS profession can learn from them. The technology for BD includes series of algorithms and artificial intelligence techniques, such as: Genetic algorithms, neural networks, data mining, regression analysis, clustering analysis and association rule learning, classification analysis, data integration and fusion, as well as machine learning etc. (Zhang et al, 2015). These represent some of the skills and capabilities that future QS professionals would have to acquire.

2.2.3 Artificial intelligence and the QS

Construction cost estimating is very important for any construction related project; it has significant effect on related activities such as: planning, design, bidding, cost and construction management (Cheng et al, 2008). Hence cost estimating is a form of cost control measure adopted by a QS in the absence of quality information during the pre-tender stage. The Quantity Surveyors would rely on historic data, past experience and knowledge in preparing an initial cost estimate. However, this reliance on human experience and knowledge has its limits (due to large numbers of variable that are inter-related with each other) and to address this challenge and improved the accuracy of construction cost estimating the potential use of computerised algorithms for estimating by QS is probably inevitable.

The use of Artificial Intelligence (AI) in the form neural networks and regression models that improved estimating accuracy can have significant impact on decision-making in areas such as: decision on an alternative design, materials selection and cost estimating, which are all essential mainly in pre-design analysis stage (Mohamed and Celik, 1998). During the preliminary design stage, AI has been used to estimate the construction project duration and costs (Yau and Yang, 1998), including estimating highway construction cost overrun (Wilmot and Mei, 2005), and to predict variation in the construction cost index (Williams, 1994). However, for typical projects, factors, which can work against the accuracy of cost estimates, must be identify at various stages of RIBA plan of work due to the role played by the preliminary estimate prepared by the QS in helping the client to make important decision related to the success of the project (Liu and Zhu, 2007). It has been shown that the accuracy of construction cost at the feasibility stage is typically within 25% and as the project details emerge and the design evolves, this accuracy changes to 15% at the design stage with estimators input (Cheng et al, 2008). An accurate construction costs estimate will certainly help make designs decision more realistic and projects more effective by improving project management processes. With the use of AI, such reliable construction cost estimate can be provided at the preliminary stage of the project to assist with completion even with limited amount of specific project data available to the QS.

2.2.4 Machine Learning and the QS

Machine Learning (ML) is a branch of AI and is a method that can be used to study and mine useful cost information data, including knowledge discovery, clustering, classification, prediction, and regression (Hussain et al, 2018). Once big data has been analysed and found useful, machine learning techniques are employed for clustering, prediction, and classification tasks. Since the construction industry has different types of clients that are concerned with possible causes of time and cost overrun, therefore, any existing cost data and Knowledge Discovery in Databases (KDD) technique (Kim et al, 2008), can be used to extract the possible causes of cost or time overrun in an ongoing project (Soibelman and Kim, 2002). Minimising or avoiding cost and time overruns is crucial because while the client wants value for money on their projects, contractors are looking towards profit maximisation. Using ML methods, useful solutions for inaccurate cost estimation and time overrun can be found. This is plausible because the industry as a whole is in a good position of generating huge data through the various parties involved in the construction process, which can collectively be used for ML. It is arguably the lack of awareness about BD, AI and ML techniques, which prevents the construction industry from moving at a speed comparable to other industries. Although a lot of research is ongoing in this area to demonstrate the applications of BD and ML techniques for solving various problems (Hussain et al, 2018), it is still limited but this can be expected to change with the introduction of technology and digital tools, which need to be adopted by all stakeholders involved in construction activities.

3. Methodology

The purpose of this study is to provide a better understanding of current trajectory of BIM and digital technologies such as BD, AI and ML and their potential impact on the quantity surveying profession. It is an exploratory study aimed at providing context, overview and future direction of the QS profession. The

study relied solely on secondary research data compiled through literature review and findings learned from the sources. The study uses inductive reasoning (Creswell and Clark 2017) to create new knowledge as lot of the issues been investigated are hinged upon what is to transpire in the future. To use deductive resonating in this case would have proved difficult as the literature review contained many generalizations surrounding the prospect of the industry, due to its uncertainty.

4. Results and Analysis.

The research relied on studies primarily available on Google Scholar and Science Direct to discover what has been published on the issues surrounding the adoption/implementation of digital technologies (BD, AI and ML) in QS practices. The table below provides a summary of relevant research work on the subject matter. The table below shows that studies have been done on using BD, AI, and ML algorithms (typically in the context of BIM) to optimize resource planning, waste management, Tender price evaluation, Dispute and claims management, Cost estimating of building projects (pre and post), Risk management, Cost and time overrun etc.

Table 1 Studies on use of advanced technologies (BD, AI and ML) for QS related tasks

Research Title	QS profession related focus of the research	Technology used	Sources (2009 – 2019)
Benchmarking construction waste management performance using big data	Waste management	BD	Lu, et al (2015)
A system for tender price evaluation of construction project based on big data	Tender price evaluation	BD	Zhang, et al. (2015)
Use of big data in project evaluations.	Evaluation of construction projects	BD	Olsson and Bull-Berg (2015)
Prediction of outcome of construction dispute claims using multilayer perceptron neural network model	Dispute and claims management	AI	Chaphalkar, et al. (2015)
Hybrid use of AI techniques in developing construction management tools.	Development of tools	AI	Ko and Cheng (2003).
Comparison of construction cost estimating models based on regression analysis, neural networks, and case-based reasoning	Cost estimating models	AI	Kim, et al (2004)
Web-based conceptual cost estimates for construction projects using Evolutionary Fuzzy Neural Inference Model.	Cost estimating	AI	Cheng, et al (2009)
Modelling optimal risk allocation in PPP projects using artificial neural networks.	Risk management in PPP projects	AI	Jin and Zhang (2011)
Conceptual cost estimates using evolutionary fuzzy hybrid neural network for projects in construction industry	Conceptual cost estimating	AI	Cheng, et al (2010)
Use of artificial intelligence to predict the accuracy of pre-tender building cost estimate.	Pre-tender cost estimating	AI	Aibinu, et al. (2011)
An artificial neural network approach to structural cost estimation of building projects in the Philippines.		AI	Roxas, et al. (2014)
Cost premium prediction of certified green buildings: A neural network approach.	Cost premium of green buildings	AI	Tatari and Kucukvar (2011)

Smart optimization for mega construction projects using artificial intelligence.	Project optimisation	AI	Aziz, et al. (2014)
Potential of big visual data and building information modeling for construction performance analytics: An exploratory study.	Construction performance analysis	BD	Han and Golparvar-Fard (2017)
Bankruptcy prediction of construction businesses: towards a big data analytics approach.	Predicting bankruptcy of construction businesses	BD	Hafiz, et al. (2015)
Big data architecture for construction waste analytics (CWA): A conceptual framework.	Construction waste analysis	BD	Bilal, et al. (2016)
Estimation of earthworks execution time cost by means of artificial neural networks.	Estimating earthwork execution time	AI	Hola and Schabowicz (2010)
Optimized artificial intelligence models for predicting project award price.	Predicting project award price	AI	Chou, et al. (2015)
Predicting construction cost overruns using text mining, numerical data and ensemble classifiers.	Prediction cost overruns	ML	Williams and Gong (2014)
Predicting construction cost and schedule success using artificial neural networks ensemble and support vector machines classification models.	Construction cost prediction	ML	Wang, et al. (2012)
BD = Big data; AI = Artificial Intelligence; ML = Machine Learning;			

5. Discussions and Findings

The findings show there are clear and considerable benefits of BIM and other digital technologies such as BD, AI and ML on the QS profession. BIM and these digital technologies face challenges in terms of adoption, tools & software available as well as education. Although BIM is viewed as primarily about collaborative working not about the technology, the role of technology is indispensable to the process and as shown by the studies, technology can be used to perform advanced costing and estimating functions that are outside the capabilities of a human (QS). The data/evidence shows that, over the years the quantity surveying role has changed and will continue to adapt, demonstrating that it is a multipurpose and versatile profession. Although the impact of BIM, BD, AI and ML will require the QS profession to keep evolving, it has done so in the past and will continue to grow with the potential to create new roles and even retain traditional roles for the less established clientele who require it. There are improvements required, both in terms of education & training and in terms of development of technology-driven estimating tools before they are universally accepted.

With issues surrounding cost overrun, the need for improved construction cost data has increased, and the use of big data in determining the tender price, will make this more accurate. It will have huge impact on construction cost management process with cost data mining (Zhang et al, 2015). The tender decision using technology will be reasonable and dynamic but there is need to refine and revise the algorithms to improve the result accuracy and the degree of automation of data mining process, which will help the clients or tenderers to analyse the tender price conveniently. The use of artificial intelligence in preparing construction cost estimate during the preliminary stage of a project will enable the stakeholder to make an accurate decision with their respective projects (Cheng et al, 2008).

6. Conclusion

A review of some of the BIM software shows that there will be some challenges quantity surveyors have to confront when using the current estimating tools. It is important that the correct one is chosen as the autonomous measuring tools to elevate the need for a quantity surveyor. The real impact of BIM on the UK market is unclear yet, but the government seem determined to implement it in their projects and advancements in digital technology tools will only speed up this process.

The potential impact of other technologies which are supplemental to BIM (e.g. big data, artificial intelligence and machine learning), will require the QS profession to adapt. However, historical evidence shows that the role has comfortably evolved from provision of traditional services to contractual and financial expertise. As it has proven so in the past, the role will continue to adapt with the potential to create new roles and even retain roles for less established clienteles, thus proving it is a versatile multipurpose profession. In terms of BIM-compliant technologies starting with the innovation in measurement tools, and inclusive of emergent tools that rely on BD, AI and ML, quantity surveyors should become more productive as they will have more time to improve services.

In conclusion, there is little doubt that digital technologies would change the role of the quantity surveyor in the future. As technology progresses and advances there is a risk, quantity surveying practices will lag behind other professions if they do not continue to evolve and take a leading role in the direction of emergent technologies. BIM and digital technology based processes and tools will allow the quantity surveyor to investigate deeper into complex aspects of cost management procedures much further than they would have been able to with paper-based processes and drawings. The digital transformation taking place in the industry is an important opportunity for quantity surveyors and it is their responsibility to make sure they embrace collaborative working through BIM as well as the insights, power and control made possible by other technological applications. There is hope however for those unwilling to embrace the future - traditional roles of the quantity surveying may present new opportunities for the less advanced clients who are not open to (or capable of) exploiting digital technology adoption.

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Automated Health and Safety Documentation in Construction Using Image Processing

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Abstract

One of the computerized technologies for advanced automation is the usage of digital image processing. Digital image processing methods have been developed for progress monitoring for the past few years. Automation in safety can be reliably computed through the use of digital image processing methods. Since the steel structures construction continues to be one of the most hazard jobs in the construction industry. Therefore, an automated processor that can recognize the existence of specific site activities needs to be developed. The objective of this paper, which is part of my Ph.D. is to presents the development of a system that can detect site activities and generate the risk assessment forms for them automatically, the system can determine whether this activity exist in a given digital image by processing digital color information. For the development of the image processor, color image processing is employed, instead of grayscale image processing commonly used in previous researches. Keywords: up to five keywords, separated by commas.

Keywords: Automation, digital, health and safety, risk assessment, construction, image processing.

1. Introduction

It is a common mistake to conduct the Health and Safety exercise in order to comply with the related laws and regulations. This approach is wrong and unethical especially in the construction industry. Although this industry accounts for 5% of the general working force, it results in 22% of the fatal injuries and 10% of major injuries which are substantially bigger than its share indicating its dangerous nature.

Falling objects, moving vehicles, collapse s, and electrical shocks were the major causes of fatalities; while slips, trips, falls, and mishandling were the causes for major injuries.

The role of Health and Safety in construction sites should not be limited to the protection of workers but should be extended to cover the general public directly or indirectly in contact with these sites. An important objective of this role is the strict enforcement of the relevant laws and regulations. A significant reduction in fatalities and major injuries is being witnessed over the last years due to the improved adherence to guidelines and regulations as reported in the UK's Health and Safety Executive statistics and publications.

2. Context

2.1 Health and Safety Principles

Health and safety should be regarded as one of the key targeted objectives in any business and particularly in the hazardous construction industry. However following and abiding by the various rules, regulations, and guidance associated with its implementation can prove to be a relatively complicated task for construction management teams. In order to simplify the understanding and implementation of the relevant H&S rules it might be conducive to consider the underlying principles behind them (Arsalan and Kivrak, 2013).

These principles fall under the following titles:

- i. Health and Safety Management System:
A system should be in place which includes designations, policies, and work procedures. This system should clearly define accidents preventive measures and designate a person or persons whose job is to enforce compliance with H&S rules and deal with any possible legal obligations.

The system should also set out clear steps for planning, monitoring, and controlling these measures.

ii. Hazards identification and risk assessment:

The process of risk assessment associated with the works' identified risks should be carried out in logical steps leading to the establishment of an approved system which helps to address these issues. These steps can be as follows:

- The identification and documentation of any activity which has the potential of causing harm to the workers or the general public.
- The estimation based on previous records of the probability of causing harm by the identified activity and level of severity of such harm.
- The establishment and enforcement of an adequate measures response protocol to the identified risks which should be updated and maintained using the relevant bench marks set out in the applicable Health and Safety Laws and Regulations.

iii. Informing and training workers to understand and apply these measures

2.2 Working Together

The implementation of Health & Safety guidance, regulations, and recommendations related to any specific type of work is a joint responsibility. The first step in this coordinated effort is between the work force and its safety designated staff. It is the Health and Safety departments' responsibility to establish a sense of commitment to safety practices in all members of the working force. However it is not enough to restrict the Health and Safety education and coordination to the immediate work site. Customers, clients, contractors, suppliers, and other related groups should also be involved in this effort. Furthermore the implementation of Health and Safety regulations and recommendations should not be in response to accidents. It should be a proactive exercise which prevents accidents rather than respond to them (Arsalan and Kivrak, 2013).

2.3 Hazards associated with Steel Structure Construction

i. Design stage hazards:

Failure to incorporate safety principles during the design phase can result in unsafe site conditions and possible instability during construction while lifting, transporting, or handling of construction materials. Other considerations to be taken into account are safeguarding against progressive collapse and possible abnormal loads. The following figure shows possible construction hazards together with their control and management (Brilakis and Soibelman, 2005).

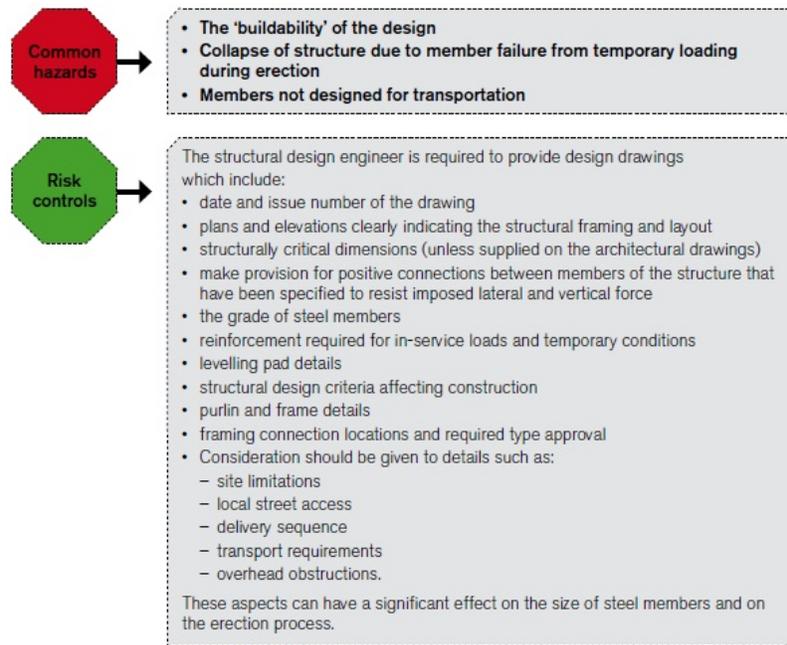


Figure 1: The Risks and Hazards during the design Stage

- ii. Fabrication stage hazards:
 The task of insuring the perfect fit of members in a steel structure is the responsibility of the fabricator. The following figure indicates the hazards and their management associated with the fabricator's work (Brilakis and Soibelman, 2005).

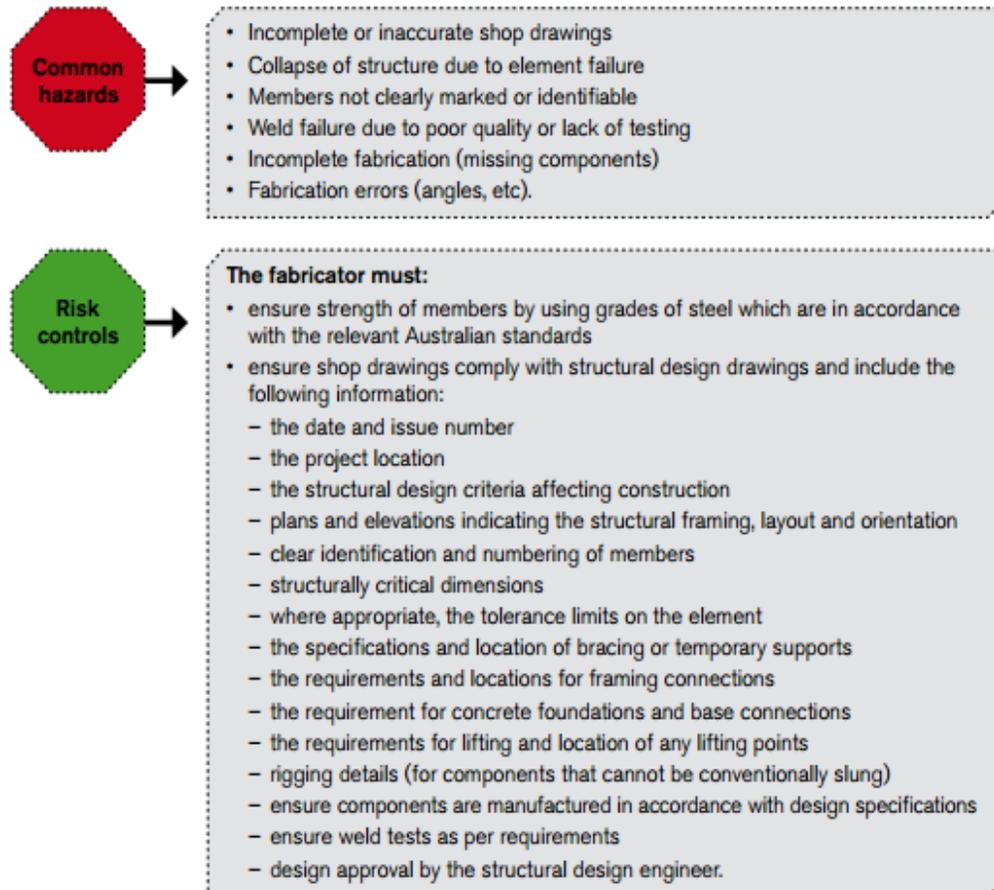


Figure 2: The Risks and Hazards during the fabrication Stage

- iii. Transportation stage hazards:
 The transporter should plan the routes which he intends to use beforehand and obtain the necessary authorization and permits for wide or heavy loads, restricted routes, etc. Figure 3 states these hazards and their control (Brilakis and Soibelman, 2005).

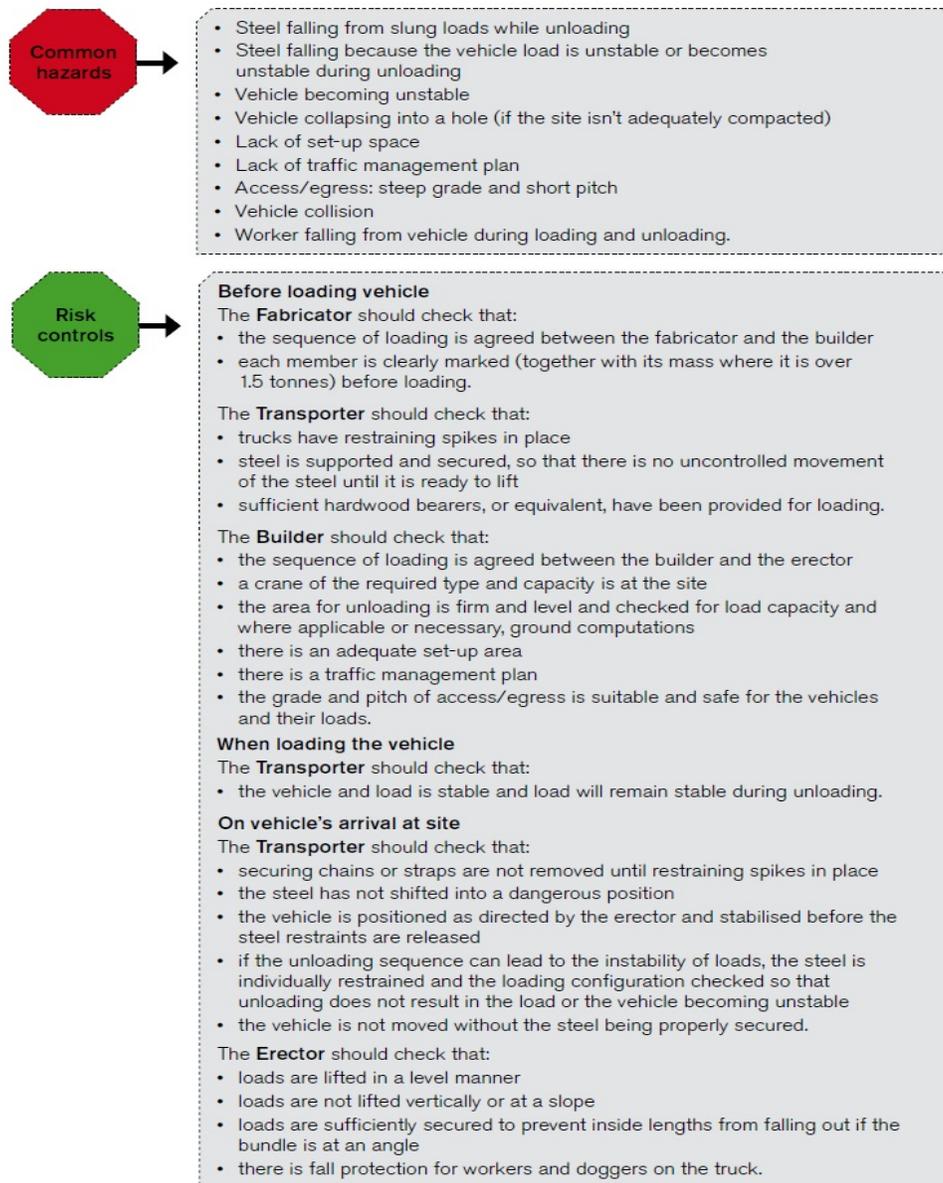


Figure 3: The Risks and Hazards during the Transportation Stage.

- iv. Erection stage:
 During the erecting stage, the strength and stability of both temporary and permanent structures should be insured. The erection engineer must provide erection procedures and guidance on structures' stability at each stage of the construction process. A Safe Work Method Statement (SWMS) similar to the one below should also be provided (Brilakis and Soibelman, 2005).

Table 1 Erector tasks [2]

Safe Work Method Statement – Structural steel erection (sample)		
What are the tasks involved?	What are the hazards and risks?	How will hazards and risks be controlled? (describe the control measures and how they will be used)
Erecting stage (continued)	• Unstable structure	<ul style="list-style-type: none"> • Builder or builder's representative and erection supervisor to inspect the frame to ensure it meets the erection engineer's specifications • Check that bolts have been tensioned to specified torques.
End of shift	• Unsecured site	<ul style="list-style-type: none"> • Secure all plant and equipment • Inspect site and clean up area.
Please ensure you have completed this SWMS correctly by checking the following.		
<input checked="" type="checkbox"/> I have completed the form with the following information:		
<input type="checkbox"/> I have discussed with relevant employees, contractors and HSRs – what work will be high risk, the tasks involved, and associated hazards, risks and controls.		
<input type="checkbox"/> I have listed, in the first column 'What are the tasks involved?' – the main stages for the tasks involved.		
<input type="checkbox"/> I have listed, in the second column 'What are the hazards and risks?' – the hazards and risks for each work task under the relevant stage of construction.		
<input type="checkbox"/> I have listed, in the third column 'How will the hazards and risks be controlled?' – control measures for the hazards and risks, based on the hierarchy of control levels 1 to 4 (listed below). I have chosen a control measure (and how it is to be used) that is as close to level 1 as is reasonably practicable.		
Control levels 1 to 4:		
1. Eliminate risk to health or safety associated with construction work.		
2. Reduce risk to health or safety by any one or any combination of the following:		
<ul style="list-style-type: none"> • substituting a new activity, procedure, plant, process or substance • isolating people from the hazard, such as barricading, fencing or guardrailing, or • using engineering controls, such as mechanical or electrical devices. 		
3. Use administrative controls , such as changing the way the work is done.		
4. Provide appropriate personal protective equipment (PPE).		
<input type="checkbox"/> The crew has been inducted to this SWMS, and briefed to stop work immediately if the SWMS is not being followed.		
<input type="checkbox"/> I will monitor the work and, if controls are not adequate, I will stop the work, review the SWMS, adjust it as required and re-brief the team.		
<input type="checkbox"/> I will retain this SWMS, and its amended form if applicable, for the duration of the project.		

3. Methodology

The research methodology covers the reasoning and the philosophical suppositions that highlight the particular study, Dainty (2008). The choice of research strategy significantly effects the requirements of the research methods that are used for examining a problem and establish the structure for collecting, interpreting, and analysing data. An essential requirement for the development of computer integrated solution to any given problem is that the development should follow a proven and established process. Such a process brings predictability and discipline to the development. Any such process consists of consecutive stages which must be covered. An effective series by which an effective research methodology can be designed was presented by Sanders et.al. (2007).

The objective of this paper is to develop an automated documentation system incorporating site health and safety concerns based on obtained visual data. This objective was achieved by:

Reviewing previous research addressing the issues regarding safety in construction.

Developing a computerized model which incorporates real time work progress imaging together with the applicable of site safety standards, codes, and requirements.

Develop or adapt existing suitable and specialized computer software to perform the image recognition activity.

A suitable platform is designed to input the provided digital photo data and the input data is then enhanced by a data preparation method. Selected activities are detected within a chosen image and the relevant reports and videos are outputted. In order to develop the conceptual model, it is required to specify its function, Miles and Hamilton (2006). The performed function is illustrated in figure (4)

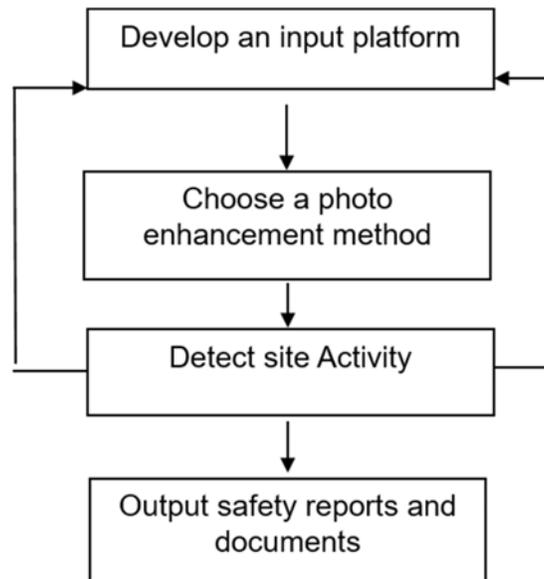


Figure 4: Conceptual model case view

4. Findings, Analysis and discussion

The construction site safety hazards and accidents in this industry have a significant financial impact on projects which can jeopardize their economic viability. Estimated project's cost can be better controlled when risk and hazards are reduced or eliminated. Costs overrun will result in diminishing the profit margin of the contract and renders it not attractive hence a dedicated commitment by all parties involved in any project will significantly impact its profitability Emmons

The purpose of the verification process is to ensure correct implementation of the conceptual model into its computer representation. This is achieved by ensuring that the logical structure and input parameters of the model are correctly represented. The process involves identifying and removing possible errors using various comparison methods with known numeric or experimental data. The validation on the other hand, is concerned with developing the right computer model that accurately represents the system of interest being simulated. The right model is subjective and the measure of its validity is based on how accurately its outputs correspond with those obtained from reality Giannanasi et. al. (2001).

5. Conclusions

Construction site health and safety is a very wide subject involving several parties, activities, and approaches. It is therefore imperative to identify a special area of interest and a specific target to be achieved within this area. As the time and resources available for this research project are finite, the work done reviewed this wide subject in order to focus on an activity of high importance and recognize a tool which can impact improvement in its safety approach.

A method has been presented that finds existence of site activities in images and allows generating the Risk Assessment Forms automatically. Its performance has been demonstrated on a range of real site images. The method simultaneously considers activities over all site location, scales and orientations, and was shown to reliably detect the site activities among complex backgrounds, and handle multiple occurrences of activities in a single image.

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Smart Modern Construction Businesses: The Transforming Business Models in Industry 4.0

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Abstract

Mass connectivity brought about by the internet and large computational capacities are disrupting traditional jobs, businesses and industries in a manner that would have been unimaginable two decades ago. The largest accommodation provider, Airbnb, has not laid a single brick, and the most popular media owner, Facebook, creates no content. Even the construction sector is currently living in a period of unprecedented change driven by rapid advances in technology and processing power. This pace of change is accelerating businesses to identify the right strategic moves and develop new business models that anticipate future disruptions. This paper explores the concept of 'Smart' and 'Modern' construction businesses and establishes that globalisation, digitalisation and industrialisation are adversely impacting all construction businesses as Industry 4.0 invades and businesses will face a daunting challenge of embracing these emerging trends that might lead to vulnerable cracks in their business models. As these trends externally impact the business, there is a need to explore the internal attributes of the business that will aid in its survival and growth. The research then develops a 'Construction Business Model Transformation Canvas' that aids in mapping the transformation of construction businesses in terms of their value propositions, key partners, activities, client relationships, potential competitors, cost structures and revenue streams. The outputs of this study provide the foundation for developing a maturity model for Smart Modern Construction Businesses for further detailed empirical research.

Keywords: Smart Construction, Modern Construction, Construction Business Model Transformation, Disruptions in Construction Industry, Offsite Construction, Industry 4.0

1. Introduction

The 'Future of Construction' initiative by the World Economic Forum in association with Boston Consulting Group developed distinct scenarios covering a range of megatrends in the construction industry where factories run the world and the industry uses intelligent systems, robots, prefabrication and modularisation (offsite construction) to create cost-efficient structures (World Economic Forum, 2018). Under the broad title of Industry 4.0, many physical and digital technologies are combining through analytics, artificial intelligence, cognitive technologies, and the Internet of Things (IoT) to create digital enterprises that are both interconnected and capable of more informed decision making (Deloitte Review, 2018). A survey conducted in 2018 among 1,500 C-suite executives across 19 countries showed that only 14% of the respondents were highly confident that their organisations are ready to fully harness the changes associated with Industry 4.0; they saw new business or delivery models as the biggest threat to their organisations. They were using Industry 4.0 technologies as a tool to make existing operations more efficient and cost effective and that left untapped opportunities to pursue innovative business models that may not only drive value for direct and indirect stakeholders but also better protect them from disruption (Deloitte Review, 2018). A similar survey conducted in 2019 stated that although leaders appeared empowered in exploring the possibilities of Industry 4.0, they remained challenged to translate the possibility into tangible business strategies (Deloitte Insights, 2019). Thus, businesses need a better understanding of Industry 4.0 business scenarios to strategize and thrive in the market.

This paper is organised as following. A review of relevant literature that aids in understanding the Industry 4.0 trends in the construction industry as illustrated in Figure 1. followed by a discussion on the business model canvas and how it can be used to identify the transforming business models in construction. The succeeding sections describe the nine blocks of construction business model transformation and the rationale for considering the same leading up to a concluding discussion on further scope of research.

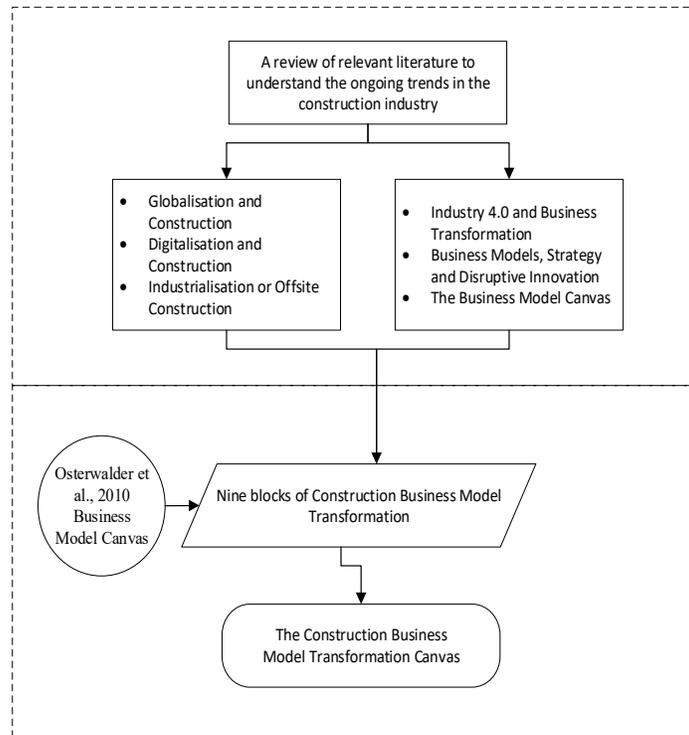


Figure 1: Flow of the paper

2. Globalisation, Ecosystem and Offsite Construction

2.1 Globalisation and Construction

One of the most significant changes in the world economy over the past two decades has been a growing globalisation of markets and industries. A global industry is one in which domestic markets are integrated across national boundaries, where competition among firms takes place on a worldwide basis, and where a firm's competitive position in one country is affected by its position in other countries (Porter, 1985, Porter, 1986). Numerous forces have contributed to rising globalisation, including reductions in multilateral and regional trade barriers (Krueger, 1995), reduced costs of international transport and communications (Hummels, 1990), and reform and greater global integration of capital markets (Sachs and Warner, 1995). Key elements indicating an industry's evolution toward becoming more global include standardisation of products and services and the development of global scale economies in manufacturing (e.g., automotive) and in research and development (R&D) (e.g., pharmaceutical). Standardisation of products across markets permits uniform branding and advertising that can result in marketing and product-based economies of scale (Johansson and Yip, 1994, Levitt, 1983). The consequences of globalisation include widespread industry rationalisation and heightened competition at national, regional, and global levels as evidenced by significantly higher levels of foreign competition (Organization for Economic Co-Operation and Development, 2003). Markets also become increasingly linked by supply-side production relationships, with production processes evolving into vertical chains of activities that extend over many countries, with different countries specializing in a particular stage of the production sequence (Hummels et al., 1999).

In the context of globalisation and the open market, the construction industry and construction activities have inevitably been affected by external factors over the past decades (Liu and Zhu, 2016). Globalisation in the construction industry has been a focal point of research for over 25 years, with much of that focus centralized on assessing past performance (Zilke and Taylor, 2014). Bon (1992) suggested that the revenue trend in the construction industry for a given country follows a curve shaped like an inverted "U"; construction activity is initially low for less-developed countries (LDCs), it increases to a peak as newly industrialised countries (NICs) build infrastructure and industrial facilities, and it finally declines as the status of an advanced industrialized country (AIC) is reached. This work sets the stage for globalisation research because it highlights the need for a country's construction operations to expand abroad if continued

growth rather than decline is to be achieved. Bon later published additional work based on the results of surveys conducted from 1992 to 1999. He surveyed academics and business leaders in the construction industry to gauge their outlook on construction markets five years into the future. Although this study used a qualitative method for predicting the future, the predictions proved true; it predicted that the U.S. and Asian markets would be areas of rapid growth in the early 2000s (Bon and Crosthwaite, 2001). The booming markets in the early 2000s influenced many companies to expand internationally in order to capitalize on market growth. The increase in the number of players in specific markets increased competition, but many foreign companies entered new markets by means of purchasing a wholly owned subsidiary, thus increasing market concentration (Gunhan, 2009). Although increased competition and increased market concentration seem like opposing results, a study by Boone indicates otherwise. Boone found that an increase in market concentration forces leaders to innovate in order to maintain market share and expand, which in turn increases competition (Boone, 2001).

2.2 The Construction Technology Ecosystem

The construction sector is one of the largest in the world economy, with about \$10 trillion spent on construction-related goods and services every year; however, the industry's productivity has trailed that of other sectors for decades, and there is a \$1.6 trillion opportunity to close the gap (McKinsey, 2017). The acceleration of the wider digital revolution combined with a shrinking traditional construction workforce are two issues critical to the future fortunes of the construction industry; one could argue that the 'stars are aligning' and the industry is ripe for disruption to offset the risks of continued reliance on labour intensive techniques (Farmer, 2018b). One of the key characteristics of digital information is that individual datasets held by many agencies and collected for a particular purpose can be brought together and readily combined to support planning and decision making in other subject areas (Commonwealth of Australia, 2016). Digital twins of physical assets are helping organisations to make better-informed decisions, leading to improved outcomes and enabling better use, operation, maintenance, planning and delivery of assets, systems and services (Bolton et al., 2018). Technology innovations that are and will continue to change the landscape of the construction industry include building information modelling (BIM), internet of things (IoT), deep learning and artificial intelligence, collaborative robotics and drones, wearable technology, 3D printing, augmented and virtual reality, cloud computing, big data and blockchain (ARUP, 2019, Commonwealth of Australia, 2016, Department of Industry, 2018, Farmer, 2018a, McKinsey, 2017, PricewaterhouseCoopers, 2017). And at the heart of these disruptive innovations is 'data'. More the information, better the understanding; therefore, data is crucial. Data can improve how the industry designs, builds, manages and eventually decommissions a built asset and greater data sharing could release significant economic benefits across the AEC sectors (Bolton et al., 2018, National Infrastructure Commission, 2017).

There has been a significant increase in the amount of money invested in construction with \$1.05B invested in construction technology startups in the first half of 2018 (Anagnost, 2019). In the Australian context, 8.9% of total venture capital investment in Australia has gone to construction technology companies since the start of 2016 (Gruszka, 2017). These statistics, coupled with many acquisitions and venture funding within the industry like Softbank's consecutive investments into Katterra, a Silicon Valley industry disruptor, demonstrate how this trend will only continue as the industry delves further into its digital transformation (Global Construction Review, 2019). These trends are clear evidences to the fact that the industry is rapidly changing at this point of time and the greatest danger in times of turbulence is not the turbulence itself, but to act with yesterday's logic (Drucker, 1980). An imperative for digital innovation and engagement has emerged across industries and businesses have already realised that they must use digital channels to engage with their key stakeholders to maintain relevance and drive the conversation; however, the challenge for businesses is the pace and transformational implications of this change, in particular, increased competition (Ernst & Young, 2011). The turmoil of business competition has often been likened to a stormy sea and "gales of creative destruction", periodically sweep through industries, sinking weak and outdated companies (Schumpeter, 2003).

2.3 Offsite Construction – An evolving strategy

In 'Refabricating Architecture', Kieran and Timberlake (2004) talk about a shift from looking at a building as a constructed object to an assembly of a highly sophisticated system with multiple subsystems. Modern Methods of Construction (MMC) or offsite construction is one of the means sought to improve and change the construction industry practices through emphasising the manufacturing concept (Akintoye et al., 2012).

MMC is closely intertwined with the concept of industrialising the construction industry (Gibb, 2001, Morton, 2002, O'Brien et al., 1995, Tatum et al., 1986, Warszawski, 1999). Industrialisation includes more standardisation of materials and processes, more of prefabrication and offsite production, platform-based approaches, and moving the value-adding activities upstream in the supply chain (Barlow et al., 2003, Pan et al., 2005, Thuesen and Hvam, 2011). Hence, industrialisation aims to improve business efficiency, quality of product, customer satisfaction, environmental performance, sustainability, and predictability of timescales (Jonsson and Rudberg, 2014). Intrinsically, industrialisation is seen as a business strategy that transforms the traditional construction process into a manufacturing and assembly process by engaging people, embracing (new) technologies and translating clients' needs into building requirements (Nadim, 2009).

Blismas and Wakefield (2009) argued that even though offsite manufacture (OSM) in construction is recognised as a key vehicle for driving process and efficiency improvements within developed construction industries and is intuitively appealing, the use of OSM definitely hasn't been widespread. But, currently the industry is sitting on a ticking 'time bomb'; As the industries existing workforce age and levels of new entrant attraction reduce, it is likely to see a 20 – 25% decline in labour within a decade (Farmer, 2018b). A combination of acute housing demand and market failures in terms of cost, quantity and quality, are forcing the industry and government to look at MMC as a solution (Davis, 2016). This impacts our society through an increasing rate of homelessness, reduced living standards and the inefficient use of our limited resources. In their Industrial Strategy, the UK Government has mandated modular construction methodology for the transport, justice and education departments by 2019 (2018). It is expected to tackle long standing strategic priorities of the industry such as the need to deliver affordable housing quickly, meet carbon reduction targets, tackle fuel poverty, and unlock stalled, difficult to develop or currently unviable sites (Gavron, 2017). Similar approach from the Australian Government would be a huge step forward; helping to bring the Australian construction sector into the future while reducing public sector construction costs and improving efficiency (Oakes, 2018).

3. Industry 4.0 and Business Models

3.1 Industry 4.0 and Business Transformation

The Fourth Industrial Revolution is characterised by a range of new technologies that are fusing the physical, digital and biological worlds, impacting all disciplines, economies and industries, and even challenging ideas about what it means to be human (Schwab, 2016). The fourth industrial revolution, says Schwab, is more significant, and its ramifications more profound, than in any prior period of human history. In the dawn of Industry 4.0, digitalisation coupled with globalisation are enabling companies to use more complex, worldwide supply chains and data networks in their operations and physical connectivity is being replaced with an increasing number of digital links — many of which are stored in the cloud (Wilkins, 2017). Industry 4.0 refers to a further developmental stage in organisation and management with characteristics such as smart production systems, global value creation networks and acceleration through exponential technologies (Deloitte, 2015). Moore's law which states that computing power doubles every eighteen months, representing exponential growth, is also applicable to other technological developments (Kurzweil, 2001); thus as Industry 4.0 matures, technologies such as 3D printing, sensors, artificial intelligence, robotics, drones etc. shall exponentially change businesses. The widespread adoption of information and communication technology is increasingly blurring the boundaries between the real world and the virtual world in what are known as cyber-physical systems (Davis, 2016). Monizza et al. (2018) defined cyber-physical systems as computers with networks of small sensors and actuators that are installed as embedded systems in materials, equipment and machine parts connected via the internet. The main roles of CPS are to fulfil the agile and dynamic requirements of production, and to improve the effectiveness and efficiency of the entire industry (Ahmadi et al., 2018).

It is evident that construction businesses are constantly being challenged by forces of globalisation, industrialisation and digitalisation as Industry 4.0 invades and when the actual state of an organisation is constantly challenged, it creates the necessity to follow new approaches to increase its effectiveness throughout its business (Cowan-Sahadath, 2010). Facing a transformation, a company has to consider high-order systematic organisational aspects such as business models but the majority of change efforts fail right in the beginning due to insufficient preparation within the business (Gudergan et al., 2015). Traditional management methods take into account the "*nominal*" factors that include the use of resources over time but such effectiveness measures do not take into account the drifts over time in terms of incremental changes in value proposition that are required to ensure competitive advantage and potential source of

progress for an organisation lies in identifying, formalising and assimilating the experiences over time: not what is done but how it is done and the timespan, in other words the transformation process (Corsi and Neau, 2015). Business transformation is not binary, and there is no one-size-fits-all process maturity level but several levels or step changes.

3.2 Business Models, Strategy and Disruptive Innovation

Companies evolve over a period of time; expanding, diversifying and contracting, depending on circumstances and there is a need to periodically re-evaluate the business, not just because there is a problem, but because the business world is always changing and the company needs to position itself to take full advantage of opportunities that might arise (March, 2009). Zhao et al. (2018) defines a Business Model (BM) as a mediating construct between technological artefacts and the fulfilment of business goals including the creation of economic value and argues that BM innovation can unlock the latent value of technology and overcome challenges in the market penetration process. However, BM innovations are rare within well-established companies (Johnson et al., 2008). It was reported that no more than 10% of innovation investment at global companies is focussed on developing new business models; new set of competencies, cannibalisation of existing resources and loss of revenue making management reluctant (American Management Association, 2010; 2016). Over the years there hasn't been much of a difference with slightly better numbers for the consumer goods sector (Bruun-Jensen and Porter, 2015). Johnson et al. (2010) mentions that BM innovation is required when significant changes are needed to all four elements of the existing model namely 'Customer Value Proposition (CVP)', 'Profit Formulae', 'Key resources' and 'Key Processes'. Business model innovations are suspected to yield higher returns than product or process innovations (Chesbrough, 2003, Lindgardt et al., 2009).

A good BM remains essential to every successful organisation, whether it is a new venture or an established player but a BM doesn't factor in one critical dimension of performance: competition; that is where 'Strategy' comes in (Magretta, 2002). Every organisation faces competition and dealing with that to establish a competitive advantage is strategy's job. (March, 2009) in the book 'Business Organisation for Construction' says depending on the size of the company, there are three levels of strategic development – corporate, business and functional and that it is business strategy that considers the amount and level of competition. The key to competitive advantage is to create a market position that is both unique and valuable and increasingly organisations have begun to identify the importance of innovation as the critical component of creating that advantage (Magretta, 2002). In the context of competition, Bower and Christensen (1995) introduced the 'Theory of Disruption' which envisaged that smaller companies with fewer resources might end up being a direct threat to the competitive advantage of established incumbent businesses through 'Disruption' to the extent of rendering the incumbent obsolete. In a further work, Christensen and Raynor (2003) broadly within the field of disruptive innovation theory (DIT), discuss that disruptive technologies do not bring better products to established customers in existing markets: they tend to disrupt and redefine current trajectories by offering products that are not as good as those on offer, but may be more convenient or less expensive and which appeal to new or less-demanding customers. Thus, businesses that reconfigure the nature of competition can be called as 'Disruptive Innovators' and the phenomenon as 'Disruptive Innovation'. However, because disruptive technologies are so hard to predict and by nature occur infrequently, they are difficult to identify or foresee, particularly where performative consensus-based techniques, such as participatory road-mapping and backcasting are used to identify future transition pathways (National Research Council, 2010). There is a need therefore to develop hybrid methodologies which can also identify more unpredictable innovations (Dixon et al., 2014). There have been a number of attempts to identify the key drivers of long-term change in UK construction and at the heart of these drivers, and at the heart of many of the technological and business model changes, are disruptive technologies (Dixon et al., 2018).

3.3 The Construction Business Model Transformation Canvas

Osterwalder et al. (2010) describes the Business Model Canvas as 'a shared language for describing, visualising, assessing; and changing business models and states that a business model can be best described through nine basic building blocks that show the logic of how company intends to make money; the nine building blocks are Customer Segments, Value Propositions, Channels, Customer Relationships, Revenue Streams, Key Resources, Key Activities, Key Partnerships and Cost Structure. Osterwalder et al. (2010) concludes that the nine blocks cover the four main areas of a business: customers, offers, infrastructure, and financial viability. In this paper each of the nine blocks of the Business Model Canvas

have been suitably modified wherever required based on the detailed literature review of the Industry 4.0 trends to best represent tenets of business transformation in construction. Table 1 summarises the nine blocks of construction business model transformation, throws light on the rationale for such modifications and mentions what each block intends to capture.

Table 1 Nine Blocks of the Construction Business Model Transformation Canvas

Sl. No.	Nine Blocks (Osterwalder et al., 2010)	Description (Osterwalder et al., 2010)	Nine Blocks as modified in the paper	Rationale for each block and what it intends to capture
1	Customer Segments	The different groups of people or organisations an enterprise aims to reach and serve	Potential Competition	One of the significant scenarios for construction businesses in Industry 4.0 is heightened global competition and competition from non-obvious stakeholders. Thus, even though it is an extrinsic element of a business it was deemed necessary to map the potential competitors instead of the customer segments with remains somewhat unchanged as the industry moves into Industry 4.0.
2	Value Propositions	The bundle of products and services that create value for a specific Customer Segment	Value Propositions	Remains unchanged. Intends to capture how companies are redefining their value propositions and what new products and services are being offered
3	Channels	The way in which a company communicates with and reaches its Customer Segments to deliver a Value Proposition	Supply Chain	For a construction business, mapping the transformation in the interconnected hierarchy of supply contracts including traceability of products and services, logistics is more significant than the traditional communication channels that the original canvas entails
4	Customer Relationships	The types of relationships a company establishes with specific Customer Segments	Client Relationships	In construction contracts often the client is prominently positioned between the contractor and end user, thus it was deemed suitable to change 'customer' to 'client'. Intends to capture if the relationship between client and contractor are changing and if there are newer expectations from clients
5	Revenue Streams	The cash a company generates from each Customer Segment	Revenue Streams	Remains unchanged. Intends to capture if revenue streams are changing with the shift from onsite to offsite construction and if newer revenue streams are emerging
6	Key Resources	The most important assets required to make a business model work	Key Resources	Remains unchanged. Intends to capture the change in key resources required in relevance to labour, material and plant
7	Key Activities	The most important things a company must do to make its business model work	Key Activities	Remains unchanged. Intends to capture the onsite to offsite shift, what new activities are being introduced due to this shift
8	Key Partnerships	The network of suppliers and partners that make the business model work	Key Partnerships	Remains unchanged. Intends to capture how the key partners are changing, the key resources being acquired by these new partners and the key activities being performed by them
9	Cost Structure	All costs incurred to operate a business model	Cost Structure	Remains unchanged. Intends to capture how the cost structure is like to be altered with the shift from onsite to offsite and the resources and activities that will be critical in terms of managing the cashflows

The primary output of this paper is the Construction Business Model Transformation Canvas as represented in Figure 2 and the nine blocks of this transformation are Potential Competition, Value Propositions, Supply Chain, Client Relationships, Revenue Streams, Key Resources, Key Activities, Key Partnerships and Cost Structure. As the construction industry embraces Industry 4.0, construction businesses need to better prepare for survival and growth. Categorised historically as slow to move and fragmented, it is a daunting task unless a clear change in culture and mindset is achieved. This research makes a non-traditionalist attempt to approach construction businesses and the transformation that they are undergoing due to Industry 4.0 scenarios of globalisation, industrialisation and digitalisation and proposes the usage of the construction business model transformation canvas for mapping the same. The canvas is expected to capture and take into account the 'drifts over time' and potential use case for this canvas for an organisation would be in identifying, formalising and assimilating the experiences over time and for forecasting future business scenarios.

<p><i>Key Partners</i></p> <p>Network of suppliers and partners that bring in external resources</p> <p><i>How are key partners changing? How are key suppliers changing? Which Key Resources are being acquired from these new suppliers? Which Key Activities are these partners performing?</i></p>	<p><i>Key Activities</i></p> <p>Activities = The Onsite / Offsite mix</p> <p><i>How are key activities changing? What new activities are being introduced?</i></p>	<p><i>Value Proposition</i></p> <p>Bundle of products and services that create value for a client</p> <p><i>How are companies redefining their value proposition? What new products and services are being offered?</i></p>	<p><i>Client Relationships</i></p> <p>How clients are acquired and retained</p> <p><i>Is the relationship with client changing? Are there newer expectations from clients?</i></p>	<p><i>Potential Competition</i></p> <p>Groups of people / organisation in an advantageous position to create value in similar space in a bigger way</p> <p><i>Are there newer markets / competitors coming up?</i></p>
	<p><i>Key Resources</i></p> <p>Resources = Labour + Materials + Plants</p> <p><i>How are the Key Resources changing? List if there are newer resources being required</i></p>		<p><i>Supply Chain</i></p> <p>Interconnected hierarchy of supply contracts including traceability of products and services, logistics etc.</p> <p><i>How are the supply chain distribution channels transforming? Are there any new deliverables?</i></p>	
<p><i>Cost Structure</i></p> <p>With the shift from onsite to offsite the cost structure is likely to alter</p> <p><i>What are the most important costs inherent in the new business model? Which Key Resources are most expensive? Which Key Activities are most expensive?</i></p>			<p><i>Revenue Streams</i></p> <p>With the shift from onsite to offsite the revenue distribution is likely to change</p> <p><i>Are there newer revenue streams for construction companies now?</i></p>	

Figure 2: The Construction Business Model Transformation Canvas as adapted from (Osterwalder et al., 2010)

4. Conclusion

This paper explores the concept of 'Smart' and 'Modern' construction businesses and establishes that globalisation, digitalisation and industrialisation are adversely impacting all construction businesses as Industry 4.0 invades and businesses face a daunting challenge of embracing these emerging trends that might lead to vulnerable cracks in their businesses. As these trends externally impact the business, there is a need to explore the internal attributes of the business that will aid in its survival and growth. Hence, businesses need a tool for strategic planning and to map the change and transformation so that they can get a grip on future scenarios. This research presents 'The Construction Business Model Transformation Canvas' suitably modified from Osterwalder's Business Model Canvas for capturing business transformation in the form of Potential Competition, Value Propositions, Supply Chain, Client Relationships, Revenue Streams, Key Resources, Key Activities, Key Partnerships and Cost Structure. It provides the foundation for empirical research to be conducted in terms of developing a capability maturity model for transforming construction businesses by using the canvas in multiple case studies and expert forums.

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Agile BIM Framework for a New Management Approach

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Abstract

Construction industry management approach is facing problems with the reaction to changes during project period. Researchers over the time develop a new management system to start adopting changes and providing proper reactions to it. Agile project management left a positive and effective print in software and manufacturing industries. In this research Agile will be considered as management method to be applied in construction industry. Moreover, over the technology revelation, construction industry started to apply and develop better method of 3D and 4D modelling called BIM "Building Information Modelling". It is not only a program but also a method that adopts changes and provides a faster result to the management and construction team during project period. In this research Agile application and BIM will be discussed in construction industry. This paper will focus on "How to enhance agile application in construction project using building information modelling." Actually, in this thesis Agile and BIM will merge to identify the project with maximum value in processes that aim to eliminate wastes, minimize errors, adopts changes, innovations through human, market analysis, more liability, more integrity, minimizing rework, involving customer and relay on agility methods.

Keywords: Agile Project Management, Building Information Modelling, Project Management, Agility, BIM, Scrum, Agile BIM

1. Introduction

Agile project management is a time cost approach that is not limited to software. While traditional management methods are a waterfall plan driven approach. Waterfall method is an application of command and control approach in project management which is not working any more. Waterfall method is slow moving to adopt changes in organization in order to develop a product. For example, the main impact of applying waterfall method is failure of Nokia. Nokia could not adopt the market changes and developing a new product. Naegel and Preiss (1994) define agility as "a comprehensive response to the business challenges of profiting from rapidly changing, continually fragmenting, and global markets for high quality, high- performance, customer-configured goods and services" (Nir, 2014).

BIM stands for Building Information Modelling. It is a development in AEC Architecture, engineering and construction. BIM is defined as an exact simulated model of a building that provides a better support to the design process throughout its stages. Also, it helps to better understand the construction analysis process of a building. BIM generate Models to help the construction process, fabrication of the elements, procurement activities, maintenance activities, operation and facility management needs. BIM support the new design and construction process. Moreover, it increases the quality of a building construction process and it reduces the cost and duration of the project throughout an integrated design and construction work. BIM provides advantages to new business process by adding more value for the project that satisfy customer and market demands.

Eastman et al. (2011) states "BIM is not a thing or a type of software but a human activity that ultimately involves broad process changes in construction." Also states, "BIM will contribute to higher degree of prefabrication, greater flexibility and variety in building methods and types, fewer claims, and fewer budget, less waste, and higher productivity." Moreover states, "The big picture is that BIM facilitates early integration of project design and construction teams, making closer collaboration possible. This will help to make overall construction process faster, less costly, more reliable, and less prone to errors and risk" (Eastman et al., 2011).

Agile BIM is a sharing and combination subject between two methods that deliver a product or a project. This chapter will discuss the way to combine agile project management and Building Information Modelling. In this research a study of agile project management enhancement to Building Information Modelling will be conducted. Recently this subject has not been discussed and covered in a wide area in

the industry of construction or manufacturing. This chapter will cover this combination and will discuss the new methodology of management and technology.

2. Agile Enhancement to BIM

Building information modelling developed advantages to the coordination between design teams and stakeholders involve in the project. But unfortunately, because of miss communication and interaction between these teams pitfalls created during the use of Building information modelling. Improper management for the use of BIM causes inefficiencies in the delivery of activities during project lifecycle. In this research Agile Project Management is chosen to be the management method to be used to enhance Building Information Modelling communication and interaction to guarantee a proper delivery of activities throughout the project life cycle.

One of the techniques agile project management has is to develop a style of communication between team members and stakeholders in regular basis to identify the goals of the next phase, and to discuss issues related to the project, activities, and to coordinate customer concerns. Agile applications to BIM will provide a reduction of rework caused by miscommunication. These applications will help to display a framework and sequence of work to BIM team and designers (Kumar and McArthur, 2015).

Building information modelling is involved in the operation phase of the project. BIM combine all data required for the design from all stakeholders involved in the project during the construction and operation phases. These stakeholders are the asset management, health and safety, sustainability, maintenance, facility management, space planning and authorities. This wide of information gathering and coordination of building information modelling needs a professional management system to collect, coordinate, distribute, review, highlight and follow up the actions during project lifecycle.

Building information modelling adaptation in construction industry and design stage of the project did not identify the processes as step by step for the project designing and operation. Accordingly agile project management approach, methods and techniques will modify these steps to adopt an improvement of using Building Information Modelling. These improvements will help to identify the processes to maximize coordination of documentation and collaboration throughout project life cycle for the data management and information distribution to customer and stakeholder's to get their feedback.

Building information modelling is primary used for design as software. BIM widely adopted especially in sustainability improvement for the buildings. BIM is used also in providing geometric and non-geometric information data to stakeholders, facility management, contractor, and sub-contractors, suppliers and management team. Agile project management approach and teams enable more interaction with architectural design to provide visualization for customer projects. Agile support BIM by providing clarity, simplicity, and beneficial communication, regular feedback from customer, changes adoption and high responds to customer needs (Kumar and McArthur, 2015).

Building design faces difficulties in rework. Agile project management supported Building Information Modelling by providing a short and fast iteration of work, improving coordination and communication, eliminating unnecessary activities, developing more beneficial engineering analysis and improving activities sequence. Agility supported BIM by increasing customer satisfaction and improving risk management for BIM.

3. BIM Agile Development

Agile BIM is developing proper communication and transferring of information with the client for the design intent and project progress. This will allow the client to have better understating of the project priorities and directions.

BIM is based on collaboration, coordination and communication between stakeholder invovled in project life cycle. Traditinal porject management way of communciaiton as shows in Figure No. is not working sufficiently with BIM appraoch of communiaciotn. Figure No. shows that direct communiaciton and invovlement between all stakeholdes is not suffiecent and long information supply chain is not helpful in BIM appraoch (Dossick and Neff, 2009).

Agile project management should take an action regarding submittals process. Shop drawings, samples and project data that sent to consultant for approvals usually takes time and could causes delays. BIM generates drawings any time required and material is specified within data inputs. Agile team has to support submittals process to manage approval and timing to avoid any delay (Pestana, Alves and Barbosa, 2013).

Agile project management approach and way of communication through daily involvement and stand up meetings is mandatory to improve communication, collaboration and coordination over project life cycle.

Figure 1 shows traditional project management approach of communication is isolating design engineering team from construction team and MEP coordination team. This will cause a lack of collaboration and coordination. Moreover, rare communication between architecture and design team with subcontractor construction team.

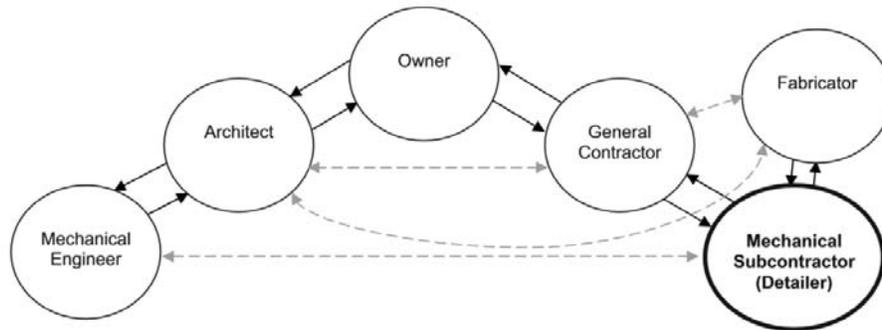


Figure 1: Traditional Project

Source: Management Communication (Dossick and Nef, 2009)

4. Agile & BIM Integration of Principles and Functionalities

Building information modelling needs proper management system to ensure work deliverables and collaboration. Agile project management is proven a successful management method for the past years in manufacturing and software industry. BIM functionalities and agile principles are studied and analysed with 32 interactions (Sacks et al., 2010).

Managers, developers, construction executives, designers and management teams of construction industry will be benefits from the adaptation of Agile BIM development strategy. A framework will be analysed to ensure BIM and Agile fits and interact together.

Agile Methodology is based on 12 principles: (Nir, 2014)

- 1- Satisfy customer and continues delivery of valuable product.
- 2- Accepting changing in requirements at any time.
- 3- Deliver working product as soon as possible for the costumer benefits.
- 4- Agile team and developer to work continuously and collaboratively during project duration.
- 5- Motivate individuals and provide them a good work environment for better support and trust.
- 6- Converting methods into face to face interaction for more effective communication.
- 7- Working product or software is a major progress to evaluate the product via deliverables.
- 8- Maintaining sustainable development.
- 9- Maintaining a good design and technical excellence.
- 10- Simplicity and maximizing the amount of work that no needs to be done.
- 11- Self-organizing team.
- 12- Provide more effective behavior throughout project lifecycle for better improvement and effectiveness.

These principles Nir listed are acceptable in the construction industry and can be applied. All these principles are effectives and describing good behaviour of the management system. Project management team and construction team are using many of these principles such as sustainability, self-organizing, good design and technical excellence, etc. Agile project management principles as described by Nir are an improvement to the traditional project management methods and teams' behaviour and skills. It is not correct to consider agile project management as totally a new approach to management. But it is an improvement and a combination between old principles and improved principles for more valuable productivity.

BIM helps in design process throughout multiple procedures such as: (Eastman et al., 2011)

- 1- It provides client more overview of the design at earlier stage. The 3D model software will provides the client and team any view at any time for any stage.
- 2- Ability to accept changes at any time of the process or any corrections needed.

- 3- It provides 2D drawings at any time for any view of elevations. This helps in a reduction of errors during generating of drawings for all activities, also it helps to generate drawings as soon as changes to design is made and entered.
- 4- It helps in the collaboration of multiple design works. Moreover, it provides more control over all the process of design which will lead to better improvement on design and implementation of value engineering and cost efficiency.
- 5- It provides an accurate cost estimation and bill of quantity in earlier stages of design. It helps to provide a clear image for all parties involved for the cost estimation during design stage which will help to take accurate and easier decisions for cost reduction and reorganization.
- 6- It helps to improve the energy efficiency and sustainability of the product earlier in the design stage.

BIM most efficient procedure is appear in changing the design where all parties involved in the designing process will have a better visualization of the change to share better understanding without any paper transaction and time consuming.

BIM will helps in the reduction of design errors and mistakes of misunderstanding of information or ideas explanations. BIM will helps a better coordination between contractor, designer and client to reduce the errors and speeding up the process to avoid any legal disputes and to provide smoother process during the project duration (Eastman et al., 2011).

BIM technology is providing a 4D CAD modelling that helps is planning system of the construction process. It provides a simulation of building construction that enable parties involved in the project to know building process day by day and what time each stage will take. This will provides a clear image for the contractor to provide an accurate number of labours, equipment's and material needed to avoid any delay for the construction process. This simulation is not available in documentation or traditional methods of construction.

BIM technology providing better support during post construction phases such as: (Eastman et al., 2011)

- 1- It helps in Handing over the project to the client or their facility management. Also, BIM provides full information for maintenance about all material information used in the project.
- 2- It provides a better support to the management and project operation. It provides for the operation team a full information about machinery equipment's, control systems and if all of these systems are working properly. Moreover, BIM provides an accurate as built drawings for maintenance and managing the project.

Table 1 shows a matrix between 12 agile principles and 13 BIM functions. Observation of this integration is BIM functionalities are not providing a way to motivate individual. Agile principle for motivation of individual is a support to BIM team and adding value to the integration and Table 2 is a description of some of the integrations between agile principles and BIM functionalities.

Table 1 Agile Principles vs. BIM Functionalities

Agile Principles/BIM Functionalities	Visualization	Rapid Generation of Multiple design alternatives	Reuse of model data for predictive analysis	Automated cost estimation	Maintain of information and design model integrity	Automated generation of drawings and documents	Collaboration in design and construction	Rapid generation of construction plan	Construction process simulation	4D visualization of construction schedule	Online communication of product process	Computer controlled fabrication	Integration with project partners
Satisfy customer			24						12	15			
Welcome changes						14	8	10	13	16		22	29
Frequent Deliverables		3										23	
Working together							9				19		30
Motivate Individuals													
Face to Face Conversation											20		31
Priority for working product	1							11					
Sustainable Development					6		17					25	
Technical Excellence			4			7						26	
Simplicity				5						18		27	
Self-Organizing Teams											21		32
More effective Iterations		2										28	

Table 2 Agile Principles vs. BIM Functionalities Discussion

Point	Discussion/Description	References
1	Agile methodology aim to provide the client a fast deliverable of the project throughout fast iteration. BIM process of design provides a 3D view of the structure for the project which helps the client to visualize the project and have better understanding of the concept and vision.	(Sacks et al., 2010) - (Nir, 2014) - (Opelt et al., 2013) - (Eastman et al., 2011) - (Hardin, 2009)
2	BIM provides a rapid generation of designs during project life cycle. This allows agile project management team to re-evaluate the errors, emissions and deletion of non-adding value items. This integration between BIM and agile project management methods will provide more effective iterations during design and construction stages.	(Sacks et al., 2010) - (Nir, 2014) - (Opelt et al., 2013) - (Eastman et al., 2011) - (Hardin, 2009)
3	BIM rapid generation of designs will provide high satisfaction for customer and show frequent deliverables of the product or design. Moreover, agile project management approach is supporting short and continues deliverable throughout iterations.	(Sacks et al., 2010) - (Nir, 2014) - (Opelt et al., 2013) - (Eastman et al., 2011) - (Hardin, 2009)
4	BIM analysis for project design and the reuse of project data to analysis the project will increase technical excellence of the project deliverables. BIM support Agile to minimize the rework. Also, predictive analysis will provide cost and time estimation to plan the work. This is technical excellence.	(Sacks et al., 2010) - (Nir, 2014) - (Opelt et al., 2013) - (Eastman et al., 2011) - (Hardin, 2009)
5	BIM throughout analysis of data input based on customer requirements will provide cost estimation of the product. BIM cost estimation provides the project simplicity rather than fully pricing of each item and time consuming.	(Sacks et al., 2010) - (Nir, 2014) - (Opelt et al., 2013) - (Eastman et al., 2011) - (Hardin, 2009)
6	BIM application of standards and polices of government throughout the design process, information and integrity will allow agile project management to deliver sustainable development projects.	(Sacks et al., 2010) - (Nir, 2014) - (Opelt et al., 2013) - (Eastman et al., 2011) - (Hardin, 2009)
7	BIM is providing automated generation of designs and drawings allows agile project management team to support construction teams and manufactures to get any required documents needed during project life cycle. This integration is improving technical excellence during fabrication and construction process.	(Sacks et al., 2010) - (Nir, 2014) - (Opelt et al., 2013) - (Eastman et al., 2011) - (Hardin, 2009)
8	BIM capabilities of collaboration between design of the project and construction stage allows agile project management method to implement changes required from customer during construction process. This integration is increasing customer satisfaction and project value.	(Sacks et al., 2010) - (Nir, 2014) - (Opelt et al., 2013) - (Eastman et al., 2011) - (Hardin, 2009)
9	BIM collaboration of design and construction allowing agile project management team during design process to coordinate between stakeholders involved in the construction of the project to provide technical experience to designers and customer.	(Sacks et al., 2010) - (Nir, 2014) - (Opelt et al., 2013) - (Eastman et al., 2011) - (Hardin, 2009)
10	Changes affect project plan. BIM rapid generation of construction plan allows agile project management to adopt changes and satisfy customer. BIM and Agile integration helps to generate plan and analysis effect on project duration.	(Sacks et al., 2010) - (Nir, 2014) - (Opelt et al., 2013) - (Eastman et al., 2011) - (Hardin, 2009)

5. *Agile BIM Framework*

The framework identify in this research is to show a clear idea of Agile BIM and how to start a construction project within the new approach of management. It supports the application of change within iteration to show for all parties involved in which stage the project is. This framework links between management, design and construction phases. Agile BIM approach is not only about following the framework, but it is about how the teams behave within the framework. Uikey and Suman (2012) highlighted the project manager behaviour within agile approach "In traditional project management, the role of the project manager is more of a command and control type, where the project manager is the commander and team members are the followers. Any type of change in the software development environment is managed by the project manager and necessary actions are directed to the team. But in today's modern project management approach, like agile, the role of the project manager is redefined as a guide and mentor, working together with the team. As the teams in agile methodologies are self-organizing and motivating, the role of the project manager is to support and help the team to accomplish the task". (Uikey and Suman, 2012). This framework depends on team work between owner or development team, agile team, BIM team and construction team.

Agile BIM framework is design on 4 dimension integration. First dimension is agile project management in 12 principles. The second dimension is Building information modelling functionalities. The third dimension is the Project Plan of Work. Finally the 4th dimension is a procurement method. This paper will discuss the 2D Agile BIM Framework between agile principles and BIM functionalities. Table 3 shows the framework points between agile principles and BIM functionalities. In order to describe some of the details for the framework Figure 3 and 4 is provided.

Table 3 Agile BIM 2D Framework

		A	B	C	D	E	F	G	H	I	J	K	L	M
	Agile Principles/BIM Functionalities	Visualization	Rapid Generation of Multiple design alternatives	Reuse of model data for predictive analysis	Automated cost estimation	Maintain of information and design model integrity	Automated generation of drawings and documents	Collaboration in design and construction	Rapid generation of construction plan	Construction process simulation	4D visualization of construction schedule	Online communication of product process	Computer controlled fabrication	Integration with project partners
1	Satisfy customer			C1						I1	J1			
2	Welcome changes						F2	G2	H2	I2	J2		L2	M2
3	Frequent Deliverables		B3										L3	
4	Working together							G4				K4		M4
5	Motivate Individuals													
6	Face to Face Conversation											K6		M6
7	Priority for working product	A7							H7					
8	Sustainable Development					E8		G8					L8	
9	Technical Excellence			C9			F9						L9	
10	Simplicity				D11						J10		L10	
11	Self-Organizing Teams											K11		M11
12	More effective Iterations		B12										L12	

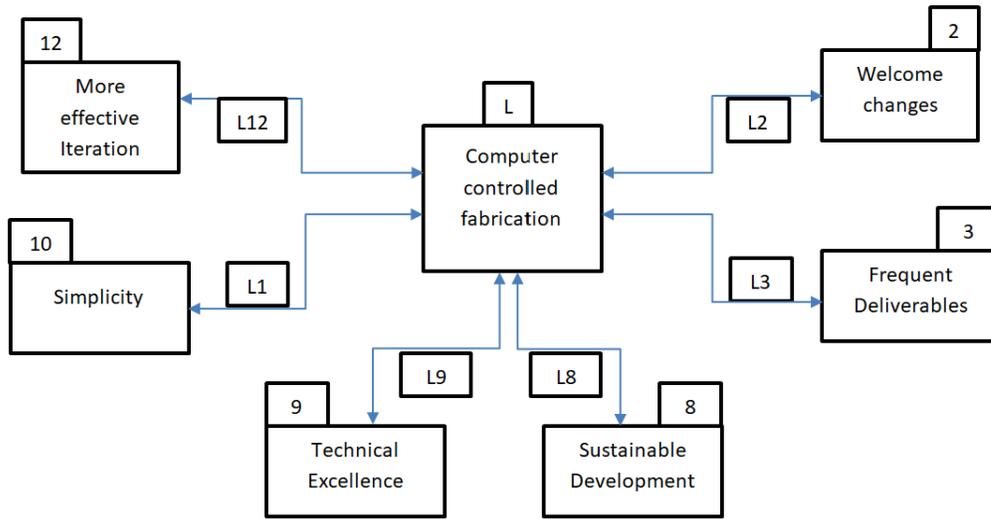


Figure 3: 2D Agile BIM Framework Detailed Process

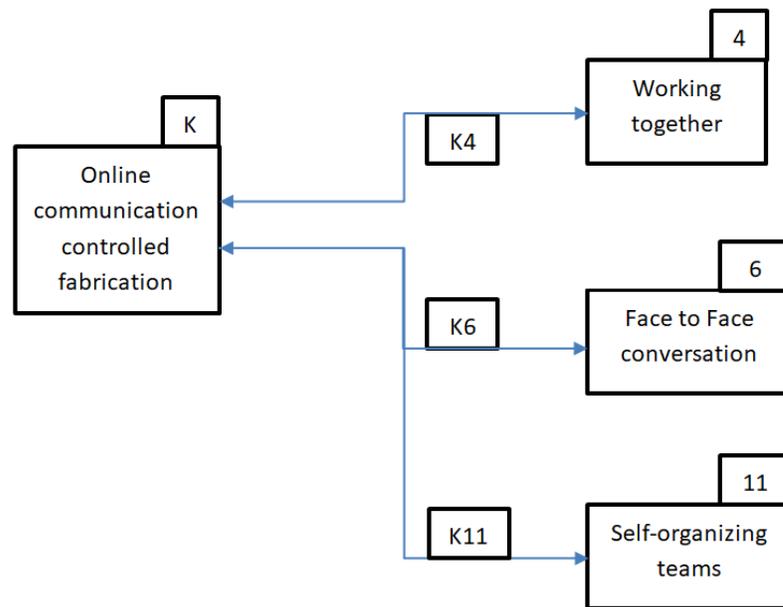


Figure 4: 2D Agile BIM Framework Detailed Process

6. Conclusion

This paper aims to draw the attention to new management approach. Agile and BIM integration is possible and under testing it may prove that this integration would provide the projects a jump in the management system. BIM supports lean construction throughout providing proper design to construction process and by removing non-adding value activities. BIM application in building design is increased lately in mechanical and electrical design coordination and implementation. BIM is used to store information, efficient communication, processing information and developing drawings. In construction project changing scope of work will impact the efficiency of work productivity and will negatively impact the labor efficiency. Project is subjected to changes. Agile project management adaptation of changes is putting the project under risks. Changes during construction process are difficult to implement but with agile method along with agile team and technology, changes can be implemented.

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Enabling a Single Source of Truth through BIM and Blockchain Integration

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Abstract

In the construction industry, where there is a complex structure and fragmented supply chain, Building Information Modelling (BIM) has played a key role in enabling integrated practice as a vital collaborative information model. However, construction supply chain (CSC) data are mostly stored in a BIM model by one actor and that could lead to dispute among CSC's stakeholders, whereas the process involves tens of sub-contractors, suppliers, and manufacturers. Thus, introducing new mechanisms to facilitate trust will enhance collaboration between the CSC's stakeholder to agree one single source of truth (SSoT). Thus, it is argued that, the integration of BIM and blockchain has the potential to respond to some of the issues discouraging the industry to use BIM as SSoT. Blockchain is a technology used in cases where stakeholders do not necessarily trust each other. This technology has the potential to reduce the "trust gap" by making data transactions independently verifiable among project stakeholders through robust cryptographic mechanisms. This paper discusses the potentials and limitations of integrating blockchain with BIM to enable a SSoT for construction projects through a structured review of previous studies. Blockchain has the potential to enhance the efficiency of compliance processes for BIM model by enabling the auditability and its transparency during CSC. Blockchain will add another dimension to what is possible when combined with BIM data for digital twin by enabling data integrity, reliability, and traceability. Compliance to regulatory requirements, and the complex system of blockchain technology to integrate with legacy enterprise system are the main barriers to motivate the CSC's stakeholders to integrate blockchain with BIM. A proposed architecture for integration of blockchain with BIM is introduced in this paper. The findings provide the foundation for developing a methodology for integrating blockchain with BIM for further detailed empirical research.

Keywords: "BIM", "Blockchain", "Single Source of Truth" "Digital Twin", "Construction Supply Chain".

1. Introduction

Building information modelling (BIM) has played a key role globally in enabling the digitisation of data workflow for the construction industry (Getuli et al. 2016; Kinnaird; & Geipel 2017; Lamb 2018; Mason 2019). Some refer to BIM as a new approach for design and documentation, or a new management and communication system, even a new technology or software application to enable construction project simulation (Doan et al. 2019; Mahamadu 2017). The National Institute of Building Science (NIBS) defines BIM as "*a digital representation of physical and functional characteristics of a facility and a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle*" (NIBS 2007, P.7). BIM is being used to enable the construction project to achieve an integrated information delivery (Perera et al. 2017) and to help project stakeholders to be well-informed of one another's activities where collaboration is adopted (Stougiannos 2018). BIM is also considered a model for legally significant data integration which could be used in case of disputes (Mason & Escott 2018). As such, BIM data integration includes but is not limited to ownership and rights, such as liabilities and intellectual property (IP) which seeks a more transparent environment (Li, Greenwood & Kassem 2019).

Pryke (2009) mentioned that the Construction Supply Chain (CSC) is still at the 'ad hoc' level, which is the lowest level, according to the 'Supply Chain Management (SCM) Maturity Model' developed by the Supply Chain Council (Lockamy III & McCormack 2004). Trust was mentioned as one of the main features for SCM to reach the 'Extended' level, which is the highest level. It is argued that trust is the basis of mutual engagement and successful collaboration for integrating the process and all the activities in a CSC (Amade et al. 2017; Jung, Chen & Jeong 2007; Talavera 2013).

Digital twin is a digital replica of a built asset throughout its lifecycle, and provides valuable information to all stakeholders to enable a single source of truth (SSoT) (Li, Greenwood & Kassem 2019). The SSoT is

defined as an authoritative source of its data, and offers data services to other entities (Pang & Szafron 2014). According to the Centre for Digital Built Britain (CDBB) (2019), the digital twin of physical assets helps organisations to make better-informed decisions, leading to improved outcomes (Bolton, Enzer & Schooling 2019). The CDBB introduced the “Gemini Principles” (Gemini: the Latin for ‘twins’), which sets out proposed pillars to guide the digital twin and the information management framework (Bolton, Enzer & Schooling 2019). The Gemini Principles report pointed out that trust is one of three principles to agree the digital twin as a SSoT (Bolton et al., 2019).

Blockchain is a distributed ledger technology (DLT) recognised mostly in connection with the cryptocurrency ‘Bitcoin’ (Turk & Klinc 2017). Blockchain goes beyond peer-to-peer financial transactions, as it enables a digital ledger without a need for authorization from a third party, which means it provides a decentralised data transaction (Coyne & Onabolu 2017) “without relying on trust” (Nakamoto 2008, P.08). The blockchain is a technology to create trust in trustless environments, thus, it increases avenues for cooperation to overcome the transparency issue in the CSC (Holland, Stjepandić & Nigischer 2018). It is argued that the integration of blockchain with BIM will overcome the transparency issue and enable a trustable value transfer to ensure the quality of compliances for the final construction products (Belle 2017; Hijazi et al. 2019; Holland, Stjepandić & Nigischer 2018; Kinnaird; & Geipel 2017; Lamb 2018; Lemes & Lemes 2019; Mathews, Robles & Bowe 2017).

2. *Problem Statement and Hypothesis*

This paper aims to review the potential and limitations of integrating blockchain with BIM to enable a SSoT for the construction industry. The industry has been recognised as having problems in its structure, specifically with fragmentation, which has resulted in its poor performance, poor value for money compared with other industries, and problematic completion due to quality issues and non-compliance with contract (Alashwal & Fong 2015; Aloini et al. 2012; Alreshidi, Mourshed & Rezgui 2018; Kim & Nguyen 2018; Pryke 2009; Vrijhoef 2011). For instance, in the case of the Opal Tower (Australia) December 2018, the final investigation report by an independent advisor to the New South Wales (NSW) Government stated that “it is evident that a number of checks for compliance were not undertaken or undertaken with insufficient rigour” (Government of NSWa 2019). As such, the Grenfell Tower (London) fire of July 2018, where the exterior cladding compliance data was not undertaken within the material workflow, from manufacturers and suppliers to production, as part of the CSC data notary and compliance (Hills 2018), led to an unprecedented losses of life (Gorse & Sturges 2017).

Information and Communications Technology (ICT) solution in the form of BIM has been introduced to enable the capability to communicate progress information within the CSC (Getuli et al. 2016), which is focused on bridging the gap of information flow between CSC’s stakeholders during the design, construction and production phases (Getuli et al. 2016; Irizarry, Karan & Jalaei 2013; Mahamadu 2017). Digital twin, as a progression of BIM model of the physical building and all facilities management data related to the building, should move along with the building as the built asset changes ownership over time (Aengenvoort & Krämer 2018; Li, Greenwood & Kassem 2019).

The relation between CSC’s stakeholders and BIM is vague, and it seeks more reliable data to overcome the fragmented nature of the sector (Getuli et al. 2016; Mahamadu 2017; Papadonikolaki, Vrijhoef & Wamelink 2015). Thus, by facilitating the automation of trust, the blockchain technology will enhance the collaboration between CSC’s stakeholders to agree a SSoT (Li, Greenwood & Kassem 2019; Penzes 2018).

Several reports and publications conducted by the Institution of Civil Engineers (ICE) (Penzes 2018), the CDBB (Bolton, Enzer & Schooling 2019; Lamb 2018), and Arup (ARUP 2019; Kinnaird; & Geipel 2017) pointed out that enabling trust for the handover model is required to ensure compliance, ownership, responsibility and overcome disputes issues as a new information dimension for the BIM model through a consensus method such as the one enabled by the Blockchain technology.

3. *Research Objectives*

Considering the above, the major objectives of this paper are: (a) to identify potential and limitations of integrating BIM and blockchain to enable a SSoT through a systematic literature review; and (b) to develop an architecture of integration of BIM and blockchain.

4. Research Methodology

A structured review of previous studies on integrating BIM and blockchain was conducted to determine the potentials and limitations of (developing) a SSoT. Scopus and Web of Science databases are used to search the publications on integration BIM and blockchain. The authors applied several searching codes. For Scopes research engine, the following search codes were applied: (TITLE-ABS-KEY (BIM) AND TITLE-ABS-KEY (Blockchain)). For Web of Science, the following search codes were applied TOPIC: (BIM) AND TOPIC: (Blockchain).

After screening through the articles, only nine research publications were found relevant and were reviewed by authors. Figure 1 shows the research framework for the paper. Most of the research publications used literature review-based methodology. Only two research publications proposed a hypothetical scenario for integration of blockchain and BIM with a significant gap of a deductive case study to support those hypotheses.

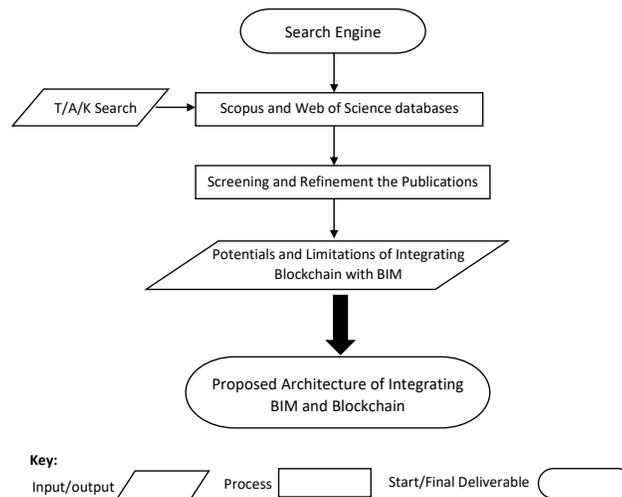


Figure 1: The Research Framework of the study

5. Research Results and Discussion

5.1 Potentials of Integrating Blockchain with BIM

The main potentials of integrating blockchain with BIM to have an SSoT are enabling BIM data reliability, ensuring compliance processes, and enabling digital twin as a progression of the BIM model. Table 1 demonstrates the main potentials.

5.1.1 Enabling BIM data reliability

Bheemaiah (2017) conceptualises blockchain cryptocurrency as a means of communication that embodies three attributes: "store of value", "unit of account" and "means of value transfer". Given this, Lemes and Lemes (2019) pointed out that integration of blockchain with BIM for value transfer includes, but is not limited to, enabling BIM data reliability and traceability. Across multiple sectors, blockchain has been introduced as a game-changer to enable trust in trustless environments (Khan et al. 2019; Lamb 2018; Li, Greenwood & Kassem 2019). Thus, it increases avenues for cooperation between the CSC's stakeholders to agree using the handover BIM model as SSoT (Holland, Stjepandić & Nigischer 2018).

5.1.2 Ensuring compliance processes

Integration of blockchain with BIM has the potential to enhance the efficiency of compliance processes for the BIM model by enabling the auditability and its transparency during CSC (Nawari & Ravindran 2019). Ensuring data ownership and transparency will enhance the efficiency in streamlining information flow,

particularly between different entities (Khan et al., 2019; Lamb, 2018; Li et al., 2019). Thus, it will help to reduce CSC 's stakeholders' reliance on other third-party and intermediary service providers and enable the idea of SSoT.

5.1.3 Enabling digital twin

Integration of blockchain with BIM has also the potential to respond to some of the issues discouraging the sector to use Level 2 BIM for CSC, such as multiparty stakeholders' aggregation, intellectual property and changing the current tracing system by enabling traceability recordkeeping without relying on trust (Amaludin & Bin Taharin 2018; Bukunova & Bukunov 2019; Li, Greenwood & Kassem 2019). As the CSC matures towards BIM Level 3 and beyond in their level of BIM adoption, collaboration within the CSC becomes a requisite and it will seek more trust to enable data exchange (Mahamadu 2017; Mason 2019; Penzes 2018). Therefore, Li, Greenwood and Kassem (2019) argue that the integration of blockchain with BIM will enable adoption of open BIM by enabling tracking of BIM components for project lifecycle strengthening CSC activities by ensuring the proof-of-ownership and rights to have an "as is" BIM model for digital twin . Blockchain-empowered digital twin, as a progression of the BIM model, enables whole lifecycle smart asset management for data management, maintenance, operation, storage and transparency (Li, Greenwood & Kassem 2019; Penzes 2018).

Table 1 Potentials of integration of blockchain with BIM

Potentials	Description of Context for SSoT	Author/S (Source)	Source Research Methodology
Data Reliability	Enabling BIM data <ul style="list-style-type: none"> Integrity Reliability 	(Lemes & Lemes 2019)	Literature review-based methodology.
	<ul style="list-style-type: none"> Overcoming issues of transparency and trust. 	(Li, Greenwood & Kassem 2019)	Literature review-based methodology.
	<ul style="list-style-type: none"> Enabling BIM data traceability. 	(Turk & Klinc 2017)	Hypothetical scenarios for integration of blockchain with BIM.
Ensuring Compliance Processes (Ownership)	<ul style="list-style-type: none"> Enabling data ownership; Automation of compliance processes in BIM; Providing more reliable data storage; Enabling using BIM work processes. 	(Nawari & Ravindran 2019)	Literature review-based methodology.
	<ul style="list-style-type: none"> Blockchain offers a secure approach to storing BIM information; Enabling using BIM data for smart asset management. 	(Parn & Edwards 2019)	Literature review-based methodology.
	Improve security and quality of BIM data.	(Zheng et al. 2019)	Hypothetical model called bcBIM was proposed (flowchart of BIM data organisation method based on blockchain).
	Improving the efficiency of the contract signing, project modification; asset management and CSC.	(Ye et al. 2018)	Literature review-based methodology.
	Improving validation and notarisation for CSC's stakeholders.	(Amaludin & Bin Taharin 2018)	Literature review-based methodology.
Enabling Digital Twin	<ul style="list-style-type: none"> Enhancing use of Level 2 BIM for collaboration and information sharing; Enabling adoption of Level 3 BIM (Integrated BIM); Enabling tracking of BIM components for facilities management; Strengthening CSC activities; Proof-of-Ownership and rights; Enabling "as is" BIM model; Digital twinning. 	(Li, Greenwood & Kassem 2019)	Literature review-based methodology (secondary data).
	<ul style="list-style-type: none"> Enable BIM as single source of truth; Data ownership. 	(Bukunova & Bukunov 2019)	Literature review-based methodology.

5.2 Limitations of integration of blockchain with BIM

Nawari and Ravindran (2019) argued that only a few studies have discussed the integration of blockchain and BIM with very limited literature, and most of them have used hypothetical cases with a significant gap of case study research approaches to support those hypotheses. In this regard, Li, Greenwood and Kassem (2019) pointed out that the construction industry is not yet sufficiently digitalised to take full advantage of blockchain technology. Consequently, the integration of blockchain with BIM is still insufficiently developed at this time (Amaludin & Bin Taharin 2018; Bukunova & Bukunov 2019; Li, Greenwood & Kassem 2019; Parn & Edwards 2019). Table 2 lists the main limitations/ barriers of integrating Blockchain with BIM identified in the literature.

Table 2 The main limitations/ barriers of integrating blockchain with BIM

Limitations/ Barriers	Description of Context for SSoT	Author/S (Source)
Readiness for adoption	<ul style="list-style-type: none"> The adoption of blockchain is still at immature level with a very limited literature and case studies. 	(Amaludin & Bin Taharin 2018)
	<ul style="list-style-type: none"> There is a significant lack of people sufficiently trained in blockchain area in the sector. Integration BIM and blockchain is still insufficiently developed. Cost of adoption / Cost and "exchange rate "volatility. 	(Li, Greenwood & Kassem 2019)
	<ul style="list-style-type: none"> The sector needs to improved understanding of motivations. Lack of proof of concept of integration blockchain with BIM. 	(Parn & Edwards 2019)
	<ul style="list-style-type: none"> No specification to regulate integration blockchain with BIM. 	(Bukunova & Bukunov 2019)
Compliance to regulatory requirements	<ul style="list-style-type: none"> Lack of legal regulations. 	(Li, Greenwood & Kassem 2019)
	<ul style="list-style-type: none"> Interoperability. 	(Li, Greenwood & Kassem 2019)
Integration with enterprise system	<ul style="list-style-type: none"> Not much interest within the major software vendors to leverage Blockchain in their BIM solutions. 	(Lemes & Lemes 2019)
	<ul style="list-style-type: none"> Storing data mechanism (Slowness); 	(Lemes & Lemes 2019)
Complexity –of technology	<ul style="list-style-type: none"> Data transmission and retrieval processes could be complicated. 	(Bukunova & Bukunov 2019)
	<ul style="list-style-type: none"> Authentication of data connectivity 	(Li, Greenwood & Kassem 2019)
	<ul style="list-style-type: none"> Coding (Building smart Contract) 	(Li, Greenwood & Kassem 2019)

In the case of integration BIM with public blockchain networks, compliance to regulatory requirements and legal frameworks will be an issue as the integration will reduce their reliance on other third-party (Bukunova & Bukunov 2019; Li, Greenwood & Kassem 2019). However, this is could be relatively easy to resolve in the case of private blockchains, where the network composition and participant design can be controlled based on known regulatory requirements (Kinnaird; & Geipel 2017; Kshetri 2018).

Parn and Edwards (2019) pointed out that the sector needs to improve their understanding of the motivation of integration blockchain with BIM by ensuring proof of concept of doing that. Complex system such as blockchain needs to be carefully considered and planned in the sector to optimise potential, and efficiency gains while protecting against or mitigating certain implied risks (Li, Greenwood & Kassem 2019). Bukunova and Bukunov (2019) argued that the sector might need to start thinking to regulate this integration in order to respond to data transmission and retrieval processes, which could be complicated.

Lemes and Lemes (2019) mentioned that there is not much interest among major software vendors to leverage blockchain in their BIM solutions, which could be an issue at a view of buy-in from CSC's participants, whereas they rely, or perhaps waiting for, startups which are more prominent in this field. Therefore, forming partnership with existing IT providers is the key strategy that companies can use when it comes to implementing their technology (Carson et al. 2018). In this regard, and as part of this research, authors have accessed and assessed the beta product from BIMCHAIN¹. BIMCHAIN uses blockchain Ethereum² platform for BIM transactions to generate and record a unique fingerprint of the data. In BIMCHAIN, BIM model files are not stored on the blockchain. Instead, metadata are signed by stakeholders

¹ <https://bimchain.io/>

² <https://www.ethereum.org/>

of the BIM model files and stored in the blockchain. BIMCHAIN proposed add-on solution is limited to Autodesk Revit application. A scenario by Turk and Klinc (2017) is "Blockchain of BIM transactions" where the transaction processor is proposed to enable data exchange (interoperability) between the blockchain and BIM and to overcome storing data mechanism slowness.

5.3 Proposed architecture of integration blockchain with BIM

In this section, the authors present a proposed architecture for integration of blockchain with BIM. Figure 2 illustrates the flowchart for the proposed architecture which provides the foundation for developing a methodology for integrating blockchain and BIM. The architecture aims to enhance the efficiency of compliance processes for BIM model by enabling the auditability and its transparency for the CSC data to agree a SSoT. The CSC data in this architecture will operate in the blockchain platform in order to be stored centrally in a BIM model to overcome compliance with regulatory requirements and enable the integration with the legacy enterprise system.

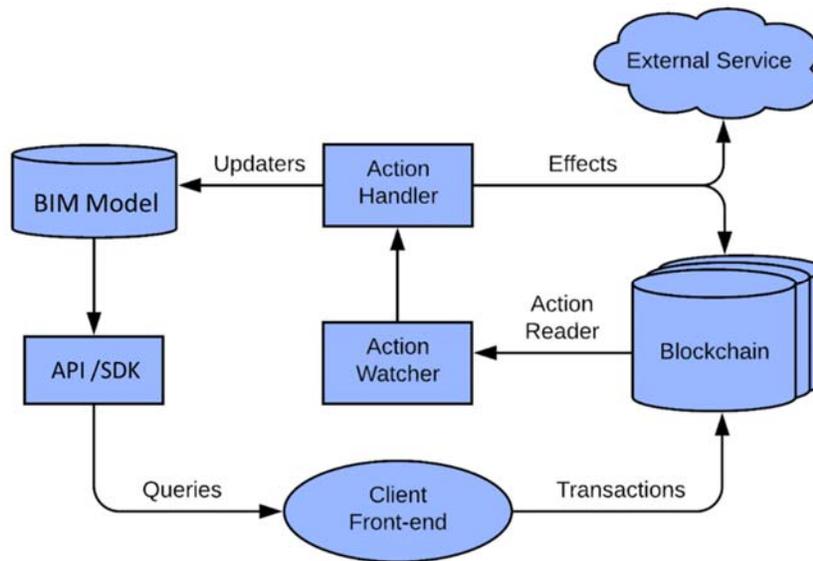


Figure 2: Proposed Architecture of Integration Blockchain and BIM

The Blockchain ecosystem or "blockchain technology stack" consists of three main layers; application, protocol, and networking (Mattila 2016). These layers are required for strengthening the understanding of what this architecture entails, how it can be integrated with the current system in order to build products and services, defining the requirement for adoption and the role that each stakeholders' plays. Swan (cited in Hoy 2017) divided the application layer into three levels; Cryptocurrencies (Blockchain Level 1.0), Smart Contract and Financial applications (Blockchain Level 2.0), and Industry applications (Blockchain Level 3.0) where this is the scope of this architecture.

At the application layer for this architecture, the motivation is to solve one specific problem; the auditability and its transparency for the CSC data to enhance compliance processes. The key stakeholders (BIM Manager, Project Owner, Contractor, and Project Quality Team) need to analyse the CSC data that is relevant to be decentralised (operating in a blockchain) in order to be integrated with the BIM handover model. Also, they need to figure out who is responsible for managing that data and how.

Blockchains can be further categorised or segmented based on their permission models into read, write, and commit (Hileman & Rauchs 2017). Read is the permission model that includes any stakeholder who can view all transactions. Write includes all participants who can create new transactions. Lastly, commit is the permission model that is characterised by the ability to change the state of the ledger. It is important to keep client Front-end in mind as another important stakeholder at the application layer for this architecture. Thus, an Application Programming Interface (API) and a Software Development Kit (SDK) are

proposed by the authors for this architecture to set an easily and clearly workflow of communication among various stakeholders. It will link the BIM model with the client Front-end and help the client (CSC's stakeholders) to send a transaction to the blockchain.

In the second layer, the protocol layer, IT developers play the main role to improve the application stack and help bringing services to life for the application layer (Mattila 2016). For instance, Ethereum protocol is used to enable smart contract applications as it involves the idea of transactions as an expression of terms (codes) in logic statements (Macrinici, Cartoceanu & Gao 2018). To access the protocol layer, the IT developers run the nodes, which are devices that run a copy of a blockchain (Mosakheil 2018) at the networking layer in order to validate transactions. As mentioned in the literature, forming partnership with existing IT providers is the key strategy that companies can use when it comes to implementing their technology at company and project levels (Carson et al. 2018). At networking layer, the Action Watcher in this architecture monitors modifications in the blockchain and notifies updates to the Action Handler in order to process actions through Updaters and Effects. The effects (Transactions History) will be stored in External (or Eternal) Server by IT providers (The Networking Layer's stakeholder).

6. Conclusion

Integration of blockchain with BIM has the potential to enhance the efficiency of compliance processes for BIM handover model. Efficiency can be achieved by enabling auditability and transparency of the CSC data to agree a SSoT. The integration will also facilitate responding to some of the issues discouraging the industry to use BIM, such as multiparty stakeholders' aggregation, data ownership, and changing the current auditing system by enabling the traceability recordkeeping without relying on trust. Blockchain technology adds another information dimension (transfer value) to what is possible when combined with BIM by enabling data integrity, reliability, and traceability. It will enable the digital twin as a progression of BIM model to function as an authoritative source of its data and offers data services to other entities.

This paper shows that only a few studies have discussed the integration of blockchain with BIM. Very limited literature and case studies alongside with a lack of proof of concept of integration blockchain with BIM. In addition, this paper discussed the main limitations/barriers of blockchain integration with BIM including lack of readiness for adoption, compliance to regulatory requirements, and the complex system of blockchain technology to integrate with legacy enterprise system. Other potential barriers include a lack of case studies to measure the performance and evaluate the efficiency of using blockchain technology in the sector, where slow-moving industry apprise.

The integration of blockchain with BIM is still in its infancy stage. There is a need to examine and validate the usability and limitations of this integration. The proposed architecture presented in this paper provides the foundation for the development of a methodology to integrate blockchain with BIM for further detailed empirical research in future.

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Development of BIM Implementation Framework for Digital Construction in Turkey

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Abstract

Building Information Modeling (BIM) is an innovative approach to integrate the process of planning, design, construction, and operation of a building in 3D and beyond. The developed countries have seen it as a strategic policy approach to transform their construction industry into a knowledge based sector from labor based sector. The Turkish construction industry is one of the largest sector and a major driver of the economic growth in Turkey. Yet, the construction practices and technologies used within the industries are the same old fashion methods and technologies affecting the productivity and efficiency negatively. Further, BIM based design and construction approach has no common use in the industry in Turkey. Thus, it is required to tackle this challenge and provide a feasible strategic roadmap to enable the industry for the BIM based practice.

The paper aims to elaborate on the core aspects including technical aspects, business considerations, training and regularity to construction market transformation. This research addresses the challenge of how BIM adoption and implementation is possible in the Turkish construction industry.

In this research, both qualitative and quantitative methods are employed. The qualitative data stems from document studies, observations and interviews while quantitative data is collected from a case study project and questionnaire based survey. Analysis of the data collected in the research so far has led to the development of BIM implementation framework in Turkey. This roadmap in its strategic implementation includes key aspects such as i) capacity buildings via events, developing BIM standards and protocols, university education system and related regulations, establishing BIM center acting as a hub for exchange of experience.

Keywords: Building Information Modelling, Turkish construction industry, BIM implementation roadmap, Digital transformation

1. Introduction

Adaptation of Building Information Modelling and Management to Turkish government, contributing to the development of a national BIM standard and BIM policy initiatives is a critical matter. Ministry of Environment and Urbanization support for BIM adoption is currently remaining at the level of encouragement, with little financial incentives offered with a lack of introduction of BIM-oriented standards and regulations. BIM standardization efforts and policy initiatives that has influence on the adoption varies significantly in Turkey. While industry is working on a variety of BIM initiatives to address specific immediate needs, a coordinated approach with industry and the government to accelerate adoption of BIM would provide productivity benefits.

This research deals with proposing an intelligent strategy and roadmaps for the development of BIM implementation framework for digital construction in Turkey. To achieve the research objectives based on the research gaps, the following research questions will be used to guide the research process;

- What are the underlying reasons for the setback of development of BIM implementation framework for digital construction in Turkey?
- What are the obstacles when using BIM in the construction phase and what barriers must be overcome to enable a further development of BIM guidelines, to make BIM more suitable for the construction phase?
- How BIM influence grows via Turkish government mandates?
- What's are global expansion and the increasing depth of BIM engagement for contractors?

2. *Building Information Modelling in the Turkish Construction Industry*

2.1 Building Information Modelling: To Be or Not To Be

In the current wake of the information technology and digital revolution, the construction AEC industry towards an effort to respond to the need of increasing productivity, efficiency, infrastructure, value, quality and sustainability and to reduce lifecycle cost (Arayici, et al., 2011) are facing a paradigm shift in the use of BIM and Integrated Design and Delivery Systems (IDDS) (Owen et al., 2009). This is a type of change that cannot be made by one group of the industry sector without involving the other. Therefore, to make these gains, there is a pressurizing need of shift in focus and process within the industry and involvement of the required stakeholders that participate in the building process, from building client, designers, builders and product manufacturers for this transition to be effective.

Subsequently, there is a non-debatable perception of BIM as a means that may enable the building industry improve its productivity by means of providing an effective collaboration and communication between all the stakeholders involved in a project from the inception of a building project to the completion of the building project (Becerik-Gerber and Rice, 2010). Evidently, to back this perception, several stories especially those that have succeeded with inherent benefits are reported by BIM researchers (Eastman et al., 2011) and there are numerous case studies that shows that the use of BIM makes the building process more efficient and effective as an evident to support the fact. Coherently, Succar, (2009), stated that BIM has now solidified its position as a promising approach towards addressing the numerous inefficiencies in the AEC industry.

Globally, adoption of BIM technology in the construction project delivery at different levels displays a significant experience in growth and hence there are some benefits of BIM technology as claimed by its proponents or users which include; the detection of clashes and cost reduction (Eastman et al., 2011), the improvement in collaboration and auto quantification, the improvement in visualization of design and coordination of the construction documents (Sacks et al, 2010), the provision for efficient data exchange and communication (Nederveen et al., 2010). Coherently, this is numerous countries including; USA, UK, Australia, Netherlands, Singapore, Hong Kong, Denmark, Norway and even Finland.

2.2 Turkish Construction Industry

In Turkey, the construction industry is identified as an area that plays an important part in contributing to the Turkish economy and contributes to approximately 6 to 7% of the Gross Domestic Product (GDP) annually. Although the Turkish construction industry plays a significant role contributing to the growth of Turkey's economy, in the era of globalization the Turkish construction industry needs to evolve and change the current construction approach, whether in terms of practice, management or technology to be globally competitive. Turkey is a major producer of basic building materials and especially strong and competitive in producing building steel, cement, ceramic and glass products.

Turkey's building regulatory system and almost AEC firms rely on the traditional approach. Turkish AEC sectors need a roadmap to implement BIM. Improving BIM awareness within the industry and beyond is a significant challenge in a BIM infant industry, which is comparatively lesser standardized than those of the developed countries. It should look for suitable adoption strategies to have the best advantage of BIM. Strategies and roadmap being identified and adopted in the developed economies with considerable levels of industry and technological maturity may not be readily adoptable in the Turkish context. On the other hand, lack of maturity is also a blessing in disguise that it allows greater flexibility in selection of options for BIM adoption since there is no significant investment in technology to go waste by the selection of any possible options. However, an investor in BIM in such a context bears greater risk of making the wrong choice. Therefore, an industry with little or no BIM maturity should carefully study all possible options and select the best in term of efficiency and effectiveness.

Once the information is kept aside; nothing is or related to BIM is practiced in the Turkish industry. A conscious effort to adopt BIM in the recent future in the local industry was not evident. However, a considerable interest on the topic of BIM is increasingly found at the discussions with professional gatherings.

Recently, as BIM has increased in importance in the construction industry, due to its benefits, many countries have accepted and supported the adoption of BIM to provide the required data exchange between stakeholders. It can clearly be seen that the level of understanding, adoption, and implementation of BIM varies from one country to another, from discipline to discipline, and from client to client as a result of many contextual factors. There is a great gap in the adoption of BIM and its uptake in the Turkish construction industry.

2.3 Research Methodology

In this research, both qualitative and quantitative methods employed. The qualitative data stems from document studies, observations, and interviews while quantitative data was collected from a case study project and questionnaire based survey. Analysis of the data collected in the research has helped to the development of BIM implementation framework for digital construction in Turkey.

Awareness and knowledge of professionals from the construction industry about BIM are required. For this purpose, an analysis of the impact of people, culture, technology, process, regularity and educational dimensions are needed. To develop a framework of BIM adoption for the Turkish construction sector, a review of literature is important and therefore was done focusing on the explanation of what BIM entails, some case studies concerning BIM in the Turkish construction industry. As a result, objectives were set out as follows:

- 1) To explore the current practice and experience in Turkish construction industry via literature review and questionnaire survey.
- 2) To explore the identified practical and theoretical barriers of BIM adoption for digital construction in Turkey via questionnaire survey.
- 3) To establish a conceptual framework for the BIM adoption barriers in the AEC firms via focus groups.
- 4) To analyze and improve the framework specifically for the Turkish construction industry focus group meetings.

3. Findings and Results: BIM Roadmap for the Turkish Construction sector

Turkish government and public sector base on the traditional construction methods, and therefore, need to arrange BIM regulations so as to improve quality of whole process of the construction. The government projects are generally inception or pilot projects of these regulations. Especially for government projects, the bidders have to produce their competitive offers in accordance with the related BIM regulations. Thereby, the authority, which must control and evaluate the projects through the regulations for approval, will be able to execute the process easily and rapidly. When Turkey decides to make a regulation about BIM, the Ministry Of Environment And Urbanization will study to improve a compatible BIM regulations can be a good support. It is possible that the clauses, which are required for Turkey's vision can be settled into the specific BIM regulation. BIM codes about drafting rules, scheduling properties, project delivery methods would be revised.

It is required that detailed drafting rules and approved annotation styles must be put into the regulations. The speed of developing standards should be accelerated. What BIM practitioners in construction urgently need is the BIM application standards to guide for the ways of using the BIM tools, developers of which are keen on the foundation standards to unify the means of information exchanging format.

BIM is becoming a global language for the infrastructure and construction sectors, enabling greater collaboration and movement of capabilities across borders. It is predicted that BIM will become the standard for delivering the world's public infrastructure projects. It is, for example, already being used on many of the metro schemes currently in construction around the world. The construction sector, including its clients, is highly fragmented in its process and learning. To a large extent, it relies on ad-hoc improvements from one project to another. Therefore, an industry-wide approach is needed to sustain long-term investment, capability and capacity development.

Government policy and public procurement methods are recommended as powerful tools to support this positive change in the sector. Without this top-down leadership, the sector is likely to continue its under-investment in information technology and to deliver low value for money and mediocre productivity levels. This is especially true for its large and diverse SME sector. The government and public sector organizations can provide leadership to encourage the sector towards the untapped opportunity of digital, and in turn provide better public services and better value for public money.

Common understanding on and consistent approaches to BIM implementations across the entire AEC industry is important for successful BIM adoption. The public sector can play the "regulator" role in BIM adoption and develop BIM guidelines to instruct and standardize BIM implementations in construction projects. Those BIM standards or guidelines could be region specific or universal. Some companies may have their own BIM standards. BIM provides a vehicle for addressing the fragmentation of the industry and a platform for greater collaboration and information sharing across the entire construction supply chain.

It will be important to ensure that technologies and processes deployed throughout the built environment supply chain are able to deliver information in an open standard format so that an owner can be assured it will remain available throughout the life of a building. Participation in international activities focused on the development of such technologies and processes will minimize the cost for Turkey to successfully accelerate the adoption of BIM across the national economy. There is an increasing incentive from industry and government in the adoption of BIM in the construction sector and the following paragraphs are areas in which this incentive can be seen to outline requirements and set targets to push the BIM implementation in Turkey.

On account of the fact that most of firms and institutions resist to use BIM in their projects, BIM utilization cannot be reached at the desired level. It is the most effective way of improving the usage of BIM that governments constitute the BIM codes. A few reasons of resistance to use BIM are related with the conservative attitudes. Unless the opinion, which advocates that construction does not need any revolution and it can be executed with existing tools and methods, is varied, BIM transition won't be able to be completed.

BIM will be used as a tool of complex projects, which consists multi systems and countless elements in addition to integration of design requirements. Management of such projects should be executed with BIM to provide accurate analysis, facilitating to understand project and preventing fatal errors. Owing to BIM, integrated project delivery, which can maintain to execute projects through a model facilitating collaboration, will be used as a construction management method. It is obvious that BIM will become a brand new management technique tool via government BIM regulations.

Four major concepts are identified for the BIM the adoption in the Turkish construction sector. These are illustrated in Figure 1, which are (1) Awareness Building, (2) Capacity Building, (3) Rules & Regularity, 4) Professionals



Figure 1: BIM Implementation Strategy Framework for Turkish Construction Industry

3.1 Awareness Building

The first stage of the transition to the national BIM system is to increase the awareness of people. Raising the public awareness is explaining BIM and disseminating knowledge to people. High AEC awareness occurs when a significant proportion of institutions agrees that importance of BIM is an issue that is of great importance to all professionals. There is self-awareness, which occurs when individuals understand how the concept of BIM implementation and process management.

BIM events in different categories are organized to increase awareness in BIM and to facilitate access to correct information. Technical and social activities will increase the importance and awareness of the use of BIM. Strong contents are created through the delivery of consistent, relevant and distinctive messaging, imagery and experiences to specific BIM implementation. The social and technical events itself allows BIM meaning to engage in a high-touch digital construction environment, where deeper connections between professionals, institutions, AEC companies and manufactures. Videos are another awareness content type

that works incredibly well on social media and platforms. People like to share videos, so video creation will increase BIM awareness considerably.

Awareness building can be via an association, working groups and platforms. They can provide BIM awareness and accelerate digital transformation for the construction industry. BIM working groups can facilitate the integration of BIM to the building industry, Higher Education and public companies easily and smoothly. Awareness Building events provide the ground for communication and cooperation for all the parties involved in a design and construction project. Help for capacity building and awareness about BIM in Turkey. Working groups will prepare regular reports on building standards and accelerate the integration of BIM into the sector. They will support construction companies to improve their competitiveness in the international arena. Technical events and workshops to build awareness towards these goals and develop critical mass in BIM and form a community of practice and academics in BIM, sharing knowledge and technology via the BIM University for example.

3.2 Capacity Building

The strategic approach to BIM adoption incorporated people, process and technology equally and led to capacity building through the improvements in process, research and development, university education & curriculum, technological infrastructure and industrial education & training of the Turkish construction sector to accelerate digital transformation. Research and Development is an important element of innovation and the value of BIM implementation in Research and Development could be seen in collaboration between the industry and academia to produce BIM value for industry use. Technological development is rapidly changing and industry cannot remain competitive unless keep up with changing of technology by committing research and development. Research and Development priorities should be based on the current issue faced by the construction industry sector. BIM technology in Turkey is really new. Therefore, there are many opportunities for universities and researchers to conduct research related to BIM and they could collaborate with the industry to identify the needs and the area for exploration.

Worldwide, academic institutions have begun teaching BIM implementation and arranged courses to integrate BIM into current programs associated with the AEC industry (Wong et al., 2011). However, educational institutions have been criticized by scholars for their lack of plans and capabilities to insert and make use of BIM on current and future programs. In the same manner, numerous academic programs are experiencing difficulties to comply with industry and students' expectations (Wu and Issa, 2013). Furthermore, most of the BIM programs given at an undergraduate level are either optional or post-graduate. Because of the extra time and cost, this may not be a choice for the majority. To overcome these issues, academia must meet the criteria of accreditation bodies and reconsider its pedagogical approach by including BIM into an undergraduate curriculum (Vlasek, 2016).

Building Information Management (BIM) education is an important part to overcome the lack of BIM knowledge and BIM skilled professionals that affect the implementation of BIM in the Architecture, Engineering, and Construction (AEC) industry. Moreover, BIM education is vital to drive the implementation and evolution of BIM in the Turkish AEC industry. Turkish BIM education difficulties are: shortage of BIM experts; lack of BIM education, as there is currently limited number of company and institutions provided only BIM training based on software; and the dissemination of BIM knowledge through educational activities and BIM communities. However, the provision of BIM education is likely to expand in the world. Most of the current training providers are eager to continue with their work and get into further areas, and there is also evidence of the first plan of inserting BIM in a university curriculum. These results infer that, for an infant country, BIM education seems to be heading in the right direction in the Turkey. The implementation of BIM is likely to increase, along with the provision and demand of BIM education in Turkey.

3.3 Rules & Regularity

The unique nature of Turkish construction projects, paper-based drawings and fragmented working relationships with different stakeholders; the Architecture, Engineering and Construction (AEC) industry suffers with problems often not encountered by other industries. The Turkish governments should push to tackle these issues led to a technical and process revolution termed 'BIM', which is being embraced by the Turkish AEC industry.

Turkish government national standardization efforts and policy initiatives should be discussed with the emphasis on pre and post policy BIM adoption. The analysis suggests that the Turkish national governance

and institutional frameworks should integrate BIM adoption. Hence, we recommend that the Turkish government should consider proliferation of national standards and compliance for a wider spread of BIM adoption.

Turkish government and public sector base on the traditional construction methods, which need to arrange BIM regulations so as to improve quality of whole process of the construction. Government projects are generally inception or pilot projects of these regulations. Especially for government projects, the bidders have to produce their competitive offers in accordance with the related BIM regulations. Thereby, the authority, which must control and evaluate the projects through the regulations for approval, will be able to execute the process easily and rapidly. When Turkey decides to make a regulation about BIM, the Republic of Turkey Ministry Of Environment And Urbanization will study to improve compatible BIM regulations that impose the BIM use in design and construction. It is possible that the clauses, which are required for Turkey's vision can be settled into the specific BIM regulation.

BIM codes will revise the drafting rules, scheduling properties, project delivery methods etc. It is required that detailed drafting rules and approved annotation styles must be put into the regulations. The speed of developing standards should be accelerated. What the practitioners of BIM in construction urgently need is the BIM application standards to guide ways of using BIM tools. The BIM tools developers are keen on the foundation standards to unify the means of information exchanging format.

Government policy and public procurement methods are recommended as powerful tools to support this positive change in the sector. Without this top-down leadership, the sector is likely to continue its under-investment in information technology and to deliver low value for money and mediocre productivity levels. This is especially true for its large and diverse sector. Governments and public sector organizations can provide leadership to encourage the construction sector towards the untapped opportunity of digital, and in turn provide better public services and better value for public money.

3.4 Professionals

Architecture, Engineering & Construction (AEC) professional workers need a specific BIM roadmap to enable integration from traditional construction methods into the BIM system. AEC working groups are needed to implement the BIM roadmap for professionals. Technical events will be organized periodically brings construction experts together to form special working groups. Sectoral knowledge is shared in these events and technical workshops are organized. It would help for the digital transformation of the construction industry and BIM integration into practice.

The committees will contribute to the digital transformation by raising awareness, sharing information, developing capacity. These committees include building professionals and scientists focused on the integration of Building Information Modelling and Management (BIM) into the Turkish construction industry and act as a hub for sharing knowledge and practice in BIM in Turkey and beyond. Committees foster education, enable strategic roadmap developments for successful BIM adoption and implementation in accordance with the required BIM standards and protocols.

Turkish BIM society will provide the ground for communication and cooperation for all the parties involved in a design and construction project. BIM committees help for capacity building and awareness about BIM in Turkey with regular reports on building standards and accelerate the integration of BIM into the sector. BIM committees will aim to support construction companies to improve their competitiveness in the international arena. BIM committees have important roles for digital transformation construction industry in Turkey.

BIM committees are formed as follows:

- BIM Education and Research Committees
- BIM Technology and Application Committee
- Design and Construction Committee
- Design and Construction Committee
- Architectural Design Committee
- Mechanical Electrical and Plumbing Committee
- Energy Committee
- BIM and Urbanization Committee
- BIM and Sustainability Committee
- Facilities Management Committee
- Government And Private Sector Engagement Committee

4. Conclusions

The construction industry, which has the most significant proportion of Turkey's gross national product, has not accomplished the digital transformation and still used conventional methods. The use of the BIM system is very limited and is known among professionals. Many parameters affect this. At the very beginning of these factors are that the State does not have an industry level BIM implementation roadmap in this regard, the university education system and not being widely used in the sector.

It is observed that the companies that are trying to integrate into the BIM system are the ones that have international business contacts. BIM application requirements exist in the specifications of the projects carried out in Gulf countries and Europe. The companies operating in the construction industry have to ensure the transformation of the BIM system to increase international competitiveness and to maintain its existence.

Turkey should prepare roadmap and standards for the Turkish Construction Industry to realize its digital transformation correctly. What will be the missions of the government? First of all, the obstacles in the transformation to the BIM should be eliminated, and solutions should be presented. The biggest obstacle is the lack of technical staff. Necessary updates should be provided in the university education curriculum.

The BIM association centers to be established should provide BIM sectoral training. Activities should be organized to increase technical and social awareness. The committees in which the knowledge can be shared should be established by forming sub-working groups composed of professionals in the centers to be established.

The most important part of integration into the BIM system is the preparation and implementation of a roadmap for the integration of the state into the BIM system. The results of the study show that serious loss of time, loss of budget and serious mistakes have been made in the Turkish construction industry. Energy efficiency is low, and carbon emission is high and unplanned structures are formed, and unlivable structures have been left to the future generations.

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The Impact of Organisation Culture on Effective Exploitation of Building Information Modelling, Big Data Analytics and Internet of Things (BBI) for Competitive Advantage in Construction Organisations

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Abstract

The purpose of this paper is to analyse the impact of organisational culture on the exploitation of three technological innovations: Building Information Modelling, Big Data Analytics and Internet of Things (BBI) considering the role of organisational culture as a determinant of organisational competitive advantage. After reviewing the literature on organisational culture and its relationship with competitiveness, this paper further analyses the critical culture constructs that impact specifically on exploitation of Building Information Modelling, Big Data Analytics and Internet of Things which leads to maximise organisational competitive advantage. Findings reveal that organisational culture can be both positively and negatively associated with aforementioned technological innovations depending on its key attributes for exploitation. Hence, culture of an organisation has the potential of fostering innovative technologies, but can also act as a barrier depending on how they are operationalised. The findings additionally show that in order to enhance innovation, neither a flexibility focus (which is rooted in collaboration and shared commonalities) nor an external focus (built upon the dynamics of competition and achieving concrete results) alone would suffice- both are equally critical in characterising organisational culture. The paper focuses on a context, where there is a lack of studies on the impact of cultural constructs that are specifically relevant to BBI, which lays the basis for the originality of this paper. Findings can guide managers' efforts in organisational culture developments which foster exploitation of these technologies towards maximising the competitive edge.

Keywords: building information modelling, big data analytics, competitive advantage, exploitation, internet of things, organisational culture.

1. Introduction

During the past several years, the information and communication technology (ICT) advances relating to the construction sector have been expeditious, offering the potential for efficiency gains and advances in business effectiveness (Construct IT 1998; Duyshart et al. 2003), and yet there has been, and continues to be a pervasive resistance to the changes that these technological advances offer (Davis and Songer 2008). The use of building information modelling (BIM) has long been argued to create an overall better product and is also very advantageous in regard to overall success of construction firms (Arayici and Egbu 2012) while Big Data Analytics (BDA) and Internet of Things (IOT) yet to improve greatly, but still the related work flows have proven to be advantageous for the construction organisations (Ming and Huaying 2007). However, despite their widespread advantage, it is increasingly accepted that the failure of construction firms in embracing these highly collaborative and integrated technologies is more than simply an issue of technology (Wainright and Waring 2004). Thus, arguably, the issue extends to the domain of "organisational culture" as a key aspect of the organisational environment within which ICT-enabled integration is supposed to occur. While the importance of culture has been widely accepted, to date the linkages between organisational culture and exploitation in particular for technological innovations have scarcely been examined in the literature. The concept of 'competitive advantage' is solely used to identify the cultural factors as to which factors highly influence the competitive advantage of construction firms. This paper makes an effort to assess the cultural attributes' impact on the exploitation of such integrated and collaborative ICT solutions. In particular it allows recognise the shared nature of the situationally contextualised "beliefs" of an organisation and its

“values”, providing the basis upon which to identify the impact of culture that lead to organisational competitive advantage

The methodology used is three fold: the study first identifies “culture” as a critical impact factor for competitive advantage generally and explores the constructs/ constituents that influence competitive advantage. Second, the study evaluates the exploitation of BIM, BDA and IOT to identify the constructs/ constituents of BBI exploitation. Finally, with the use of thorough review of literature, the study explores the impact of culture on the exploitation of BIM, BDA and IOT. In doing so, the findings reveal that organisational culture may positively and/or negatively impact on the exploitation of BBI for organisational competitive advantage. It concludes by generating hypotheses about the mechanisms by which organisational culture can enhance organisational competitive advantage when BBI are used.

2. Literature Review

2.1 Organisational Culture

Organisations are human created ‘living mechanisms’ or ‘functional systems’ that interrelates with the internal and external environment. They behave indifferently from individuals whom it is made of (Mintzberg 1979). Beijerse (2000) explicates this ideology through his well-known organisational design model that distinguishes the organisation in to elements of strategy, structure and culture. Among the three main elements, culture is the focus of this paper to investigate the impact for effective exploitation of Building Information Modelling, Big Data Analytics and Internet of Things. Culture, as defined by Mobley et al. (2005) is a set of assumptions, beliefs and values that are widely shared and strongly held by the members of an organisation. Culture has once defined to be the ‘core’ that directs an organisation for its way (Zairi and Al-Mashari 2005). Hofstede’s (1984) view on culture in terms of organisations is “the collective programming of the mind which distinguishes one group from another”. The most commonly known and the simplest definition for culture is “the way we do things around here” (Lundy 1994) which leads to many different dimensions. Schein (2004) defines culture as:

[...] a pattern of shared basic assumptions (beliefs) that was learned by a group as it solved its problems of external adoption and internal integration, that has worked well enough to be considered valid and, therefore, to be thought to new members as the correct way to perceive, think, and feel in relating to those problems (Schein, 2004, p. 17)

2.2 The Importance of Organisational Culture for the Exploitation of Innovative Technologies

Cultures that develop within an organisation can be either productive or destructive for innovation. Organisations that successfully lead innovations have a strong positive productive culture. According to Hofstede (1980) such cultures are believed to be the major influence for employees’ motivation and commitment with following key attributes;

- Shared positive values
- Heroes
- Rites and rituals
- Cultural communication networks

Hofstede (1980) divided culture into four distinctive elements: symbols, heroes, rituals and values. Symbols are said to be the most apparent element of culture that gives a meaning and resembles with gestures, objects, words or acts that signify something unique among other aspects of organisational cultures. Values form the core of the culture in the deepest level and are directly connected with moral and ethical codes. Values on the other hand are reflections of what people think, do, ‘likes’ and ‘dislikes’. Rituals are collective tasks which represents social norms. Heroes are considered to be persons who possess characteristics which are highly prized and are often labelled as ‘winners’. A hero is also a great motivator and a role model (Deal and Kennedy 1983). Hofstede (1980) further discusses about the ‘right’ type of culture that promotes innovations are always flexible in nature and emphasised towards the attitude of ‘winning’. Schein (2004) offers a different perspective to organisational culture as a “the pattern of shared basic assumptions” that a group learn as it solves its problems of external adaptation and internal integration which works well enough to be considered valid and therefore taught to new members as the ‘corrected’/ ‘lessons-learned’ way to understand, think and feel in relation to those problems.

Cameron and Quinn (2006) explain culture in four categories: adhocracy, clan, market and hierarchy using two dimensions. The two dimensions exhibit flexibility and discretion versus stability and control, and external focus versus internal focus and integration. The four categories are also explained along with six aspects of a typical organisation- dominant characteristics, organisational leadership, and management of employees, organisational glue, strategic emphases and criteria of success.

Organisational success often emerges with competitive advantage; increasingly arise from the continuous acquisition of knowledge. In order to develop continuous and sustained value creation, a firm must formulate and implement an innovation-supportive culture which enhances the capabilities required to successfully implement and maintain both now and in the future (Voelpel et al. 2005). Leonard (1995) interprets this outlook as 'unlocking' the ability to innovate, perform and improve throughout a long term period. The study conducted by Kivrak et al. (2009) revealed that benchmarking and learning have possible effects on organisational success. It is strongly perceived that effective knowledge sharing and setting a benchmark out-turn with uplifted efficiency and thereby productivity. Interacting with individuals endorsed with different cultural backgrounds and different expertise helps an organisation to embrace innovation much easier since knowledge sharing is undemanding in such environment. Moreover, it is identified that trust is a key factor in effective knowledge sharing between team members.

A synergistic approach which promotes the flexibility of respecting other's ways is considered to be the best way of successful implementation of innovations (Kivrak, et al. 2009). Admittedly, strategy development need to be drew forward. Nevertheless, there are two opposing views on changing of values within cultures in the research literature. One view sees culture as very rigid and stable within an industry and at a time when cultures change, the change occurs independently of each other (Barkema and Vermeulen 1997). The other view sees that, when different cultures contexts frequent interacts, the cultures will become more similar over time which is also known as Cultural Convergence Theory (Axelrod 1997). Therefore synergetic approach will either make couple or more cultures to be similar or smoothly change independently. Hence the ontology behind the theory is that a culture is bound to affect by outside influences and external changes. This ideology is also considered to be a driver for competitive advantage.

2.3 Competitive Advantage and Organisational Culture

Competitiveness is a concept which acts as a core to normatively oriented strategic thinking, and allows sense making to different dimensions, different levels and to different firms at different times (Barney 1986). Firm (organisation or company) is one of such levels discussed in this paper. Considering a firm's competitiveness based on economic dimension alone would be incomplete. It is essential that a firm's competitiveness need to be viewed in social dimension, achieving business success, and future growth and development (Flanagan et al. 2007). A culture is a competitive advantage for an organisation as it cannot be replicated by its competitors, for its historical legacies are embedded in cultures. Nevertheless, a culture also acts as a significant barrier for change with its anchored historical beliefs that are sunk in (Johnson et al. 2014). The mainstream construction management literature has long been recognized with organisational culture (Handy 1985; Johnson et al. 2014). Within the construction research domain, the impact of culture on organisational performance is becoming an increasingly important topic for organisations in their winning strategies. Although construction industry is predominantly identified as a loosely coupled, project based set of systems, the industry as a whole has now being investigating the possible trustworthy collaborations which also trigger the urgency of a cultural change.

With all different organisational culture types, it is well perceivable that the organisational culture is not something tangible, nor easily captured or defined. It is a complex topic that needs to be viewed in different lenses. Further, it needs to be observed with people's beliefs, values, behaviours, symbols as it plays a significant part in the day-to-day functioning of an organisation. Hence, for this study, culture is viewed through the lens in which it influence competitiveness in firms, Among Several different world views on culture that have been identified in organisational culture studies, this paper deploys the culture model coined by Cameron and Quinn (2006) the Organisational Culture Assessment Instrument OCAI. Cameron and Quinn (2006) suggested four types of culture which has predominantly considered the competing nature of employees as well as project teams/ enterprises. The OCAI include: 1) The Hierarchical culture: considered to be well coordinated, characterized by formal rules and policies. 2) The Market culture: generally perceived to be highly competitive, while winning is the motivation/passion that holds the employees and the organisation together. 3) The Clan culture: mainly refers to a friendly working environment, where the employees are treated as an extended family and the superiors are

considered as mentors; the working force is characterised by high job and organisation commitment and develop friendly relations. 4) The Adhocracy culture: aims innovating and risk taking, assured by a highly creative and agile working environment. OCAI makes an ideal suit for this study in such a way that it incorporates flexibility and discretion versus stability and control, and external focus versus internal focus and integration. The authors further claim that adhocracy culture to be the most appropriate culture that fosters innovations as it emphasizes flexibility and change and is externally orientated. An adhocracy culture promotes creativity, entrepreneurship and risk taking.

3. Methodology

This paper is presented as a part of an on-going PhD research that investigates the strategic approach of implementing and exploiting BBI as strategic tools for competitive advantage in construction organisations. As a part of the original research, the study develops a preliminary conceptual framework with the aid of comprehensive review of literature. Within this conceptual framework, the study investigates the impact of culture on BBI exploitation for competitive advantage. This paper covers the latter to develop a preliminary conceptual framework. The study is primarily based on a thorough review of relevant literature in the areas of organisational culture, exploitation prospects of Building Information Modelling, Big Data Analytics and Internet of Things and competitive advantage for construction firms from strategic perspectives. The factors presented in this paper were derived through extensive review of literature. The reviewed sources were published journal articles, conference articles, conference proceedings, monographs, report chapters, report reviews, editorial material, theses and working papers.

In the review of literature, the study first selects a cultural model to understand organizational culture in the context of which culture influence 'competitive advantage'. Among many of the well-established models, Quinn and Cameron (2006) developed the Organisational Culture Assessment Instrument (OCAI), a validated survey method to assess current and preferred organizational cultures. The OCAI is based on Quinn and Cameron's Competing Values Framework Model which was selected as the culture model for this study. The reason for the selection of this model is that the model explains how the four organisational cultures dynamically behave in four parameters includes internal focus and integration vs. external focus and differentiation, and stability and control vs. flexibility and discretion. As postulated by Porter (1985), an organisation can achieve competitive advantage over its rivals by cost advantage and differentiation advantage not only internally but also externally focused. Since the competing values framework addresses this external and internal dimensions as well as for its fit-for-purpose in related to dynamics of competition and achieving concrete results while leaders are seen as innovators or entrepreneurs, the study considered this model to be acceptable to investigate the research question 'the impact of culture on the exploitation of BBI for competitive advantage'.

Second, the academic interest around BBI in relation to its 'exploitation' is thoroughly reviewed in the literature. A systematic review was carried out to obtain a set of constructs to define 'exploitation' of the aforesaid technologies. The research question was to 'identify the exploitation constructs for BIM, BDA and IOT'. However, as a result of the thorough review of literature, the study obtained a set of common exploitation constructs in the context of ICT technological advances in general mainly because of the number of similarities observed within the domains; BIM, BDA and IOT. It was also noticed that the studies do not have a consensus in the agreement of establishing a clear boundary line between the terms 'implementation', 'exploitation' and 'diffusion'. As such, the keyword search strings did not limited to 'exploitation', instead the search strings were extended to represent 'exploitation' 'implementation' and 'diffusion' in addition to 'Building Information Modelling', 'Big Data Analytics' and 'Internet of Things'. The review took in to account all available published (journal articles, conference articles, conference proceedings, monographs, report chapters, report reviews, editorial material, theses and working papers) studies as evidences based on best quality contributions in major AEC research databases in all fields (subject, title, abstract, keywords, full text etc.), from 2007-2017. The search also expanded in to grey literature in google scholar and basic google because of the scarcity of the word 'exploitation' appearing specifically in related to BBI. The review initially retrieved a set of studies that looked in to exploitation and they were categorized separately for BIM, BDA and IOT. Some of the identified constructs include readiness to adopt, capability, maturity, value creation, continuous improvement, etc. However, many of these constructs overlap with the terms 'adoption' and 'implementation'. Therefore, the authors then further sorted these constructs with two successive steps: elimination of duplicates/ irrelevant constructs and verification. The filtered list was then subjected to classification into four distinct categories (A-primary subject, B-secondary subject, C-anecdotal, D-others) to obtain the mostly cited constructs as

primary subject. The final sample was of help to capture the mostly cited constructs for 'exploitation' of BBI- the four constructs of exploitation which are described in the analysis section.

As the third step, the identified constructs for culture and exploitation were mapped against to examine the impact of culture on the exploitation of BBI using a thorough review of literature. A set of hypotheses are established based upon literature that studied similar cultural attributes in the context of ICT technologies. In line to the selected cultural model, attributes of each culture construct were unfolded. For example, the attributes of clan culture- mentorship, teamwork, collaboration, extended family nature was explored in terms of how they generally impact on the exploitation constructs- creating new uses, extending existing capabilities etc. The findings reveal both positive and negative impacts towards exploitation of ICT technologies.

4. Analysis

4.1 Culture that influences Competitive Advantage

Having defined the Cameron and Quinn (2006) four types of culture values viewed in the lens of competitive advantage the relationship between organisational culture and the exploitation of Building Information Modelling (BIM), Big Data Analytics (BDA) and Internet of Things (IoT) is examined.

Among many models that have been used to measure organisational culture as suggested by literature, Cameron and Quinn (2006) created Organisational Culture Assessment Instrument (OCAI), based on Competing Values Framework Model (See Figure-1). The evaluation of a culture is conducted using four core values in an array of 2 x 2 competing values where each value is consisting of 4 sub values as follows:

- Clan culture- personal place, nature of an extended family, mentoring, participation
- Adhocracy culture- Dynamic, risk taking, valuing innovation, entrepreneurship
- Market Culture- result oriented, values competition, values achievement, getting the job done
- Hierarchy Culture- Favours structure and the control power, coordination, efficiency, stability

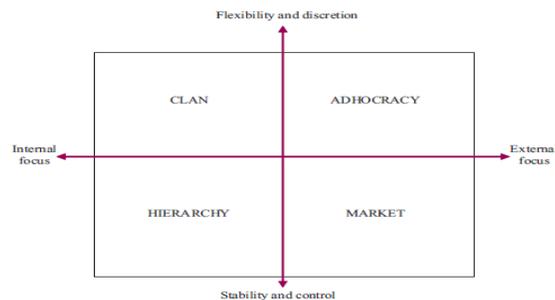


Figure 1: Quinn and Cameron's Competing Values Framework Model

Source: Cameron and Quinn (1999)

The model is a true emphasis of internal and external focus that clearly illustrates the difference between the focus for organisational improvements driven by internal factors (business processes and people caring) and external focus driven by stakeholder engagement. Stability versus flexibility distinguishes the two perspectives of organisations that are more stable and organisations that promote innovation, personal growth, continuous organisation improvement and change. These dimensions are evaluated through six dimensions: Dominant characteristics, Organisational leadership, Management of employees, Organisational glue, Strategic emphasis and Criteria of success. The six dimensions can be interpreted through four types of cultures. These main factors were used to evaluate against competitive advantage and exploitation of BBI in this paper.

4.2 Exploitation factors for BBI

Exploitation as defined by Egbu (2001) is the act of using resources and processes in order to benefit from their efforts. Technological exploitation can be viewed in different perspectives: commercial, social, environmental and political (Russom 2013). In the attempt of extracting the maximum value from the technological resources, firms increasingly combine their internal exploitation through the ultimate value

that it offers to the economy. Extracting economic value from these three resources by maximizing the benefits for shareholders is an extremely challenging task because BBI by its own terms are intangible, idiosyncratic, uncertain, predominantly tacit, and with poorly defined property rights. As postulated by Zahra and George (2002), exploitation is applying new external knowledge commercially to achieve organisational objectives, and to create new ones by incorporating acquired and transformed knowledge into its operations. Taking this operational definition as the basis of 'exploitation' speculated in this study followed by a thorough review of literature, four key constructs for exploitation were identified (see table-1).

Table 1 Constructs for exploitation of BBI

Constructs for exploitation of BBI
Refinement of existing systems
Efficiency and effectiveness of daily tasks
Extending and leveraging existing capacities of individuals who engage
Persistent creation of new products, uses, systems, processes, knowledge or organisational forms

In the era of increasingly severe commercial competition, an investment on IT related technologies is not only a short-term competitive advantage, but also for keeping the competitive advantage, and obtaining sustainable competitive advantage. Further this advantage can be obtained by improving efficiency and effectiveness of IT technologies (Cao Ming and Shu Huaying 2007).

(H1. BBI exploitation positively impact on organisational competitive advantage)

Having reached to a set of constructs for organisational culture and exploitation in common, the next step is to review the literature to generate a set of hypotheses that explores the impact of these cultural constructs on the constructs of exploitation.

4.3 The Impact of Culture on BBI Exploitation for Competitive Advantage

There is an agreement in the literature about the need for a culture which emphasises caring for employees in such a way that they feel wanted and admired is a key to learn, improve and increase efficiency of work. Trustworthiness, openness, empowerment are also considered to be important when it comes change management (of a new technology adoption and survival for exploitation). Kitchell (1995) found that organisations with flexible and open culture and emphasize long-term orientation have a greater propensity to adopt advanced manufacturing technology. Although the innovation investigated in these studies were on an outcome perspective (e.g., adoption of new technology), these empirical results lay ground for the associations between certain dimensions of organisational culture and innovation adoption. All these describe the characteristics of a clan culture which can be concluded to have a positive correlation with BBI exploitation. On the other hand no agreement has been made for clan culture to have an adverse impact on creating new uses or extending and leveraging existing capacities of individuals which are the constructs of exploitation. Although the above-mentioned studies focus on different aspects of the relationship between clan culture and innovation exploitation in general, most find a positive relationship between them. Therefore, the following hypothesis can be formulated:

(H2a. Clan culture positively impact on the exploitation of BBI)

The adhocracy culture which promotes risk-taking orientation, creativity, teamwork, collaborative working, and ambiguity tolerance, entrepreneurship, openness and change orientation is considered to be the most appropriate culture for both innovative technology exploitation as well as achieving organisational competitive advantage. Henry Mintzberg's (1979) explains adhocracy culture as basically control by the support staff. There is little formality so, direct supervision and defined processes are less important than in other organisation structures. Research and development can be a primary driver of adhocracies as typified by new technology industries. Uzokurt et al (2013), who conducted an empirical study in the bank sector in Turkey, proved that an innovation culture in an organisation facilitates the introduction, adoption and diffusion of innovations which, in turn, results in superior firm performance. Ruppel and Harrington (2001), drawing the competing values framework, concluded that a value system which emphasize flexibility and innovation is essential in development success for technological innovations. Another empirical study conducted by Brewer and Gajendran (2012) has observed that the

dynamic and risk taking culture of a construction firm influences its level and quality of ICT uptake and integration to produce improvements. Moreover, some of the patterns identified in the studies are clearly associated with the success of technology adoption within firms, whilst others are specific in nature (i.e. BIM implementation in particular). However, it is appearing that the terms used in these studies; 'adoption', 'implementation' implies to a series of activities at a given covers the exploitation constructs (i.e. refinement of existing systems to make more benefits). This is majorly because of the diversified definitions used by the authors to describe the aforementioned terms as well as the inability to establish a clear line in between the terms; adoption, implementation and exploitation. Amabile et al. (1996) critically evaluate the innovative and risk taking type of culture by disaggregating in to two types; high creativity and low creativity. Both these type of cultures challenges factors inter alia; organisational encouragement, supervisory encouragement, work group supports, freedom, sufficient resources in different levels. Even though few studies challenge the view that clan culture positively impact innovation exploitation, there is a consensus among authors for its positive impact; which leads to formulate the following hypothesis:

(H2b. Adhocracy culture has neither a uni-polar impact on the exploitation of BBI nor significant impact on the exploitation of BBI)

The external knowledge acquisition encouraged by the market culture appears to be positively impact on both BBI exploitation and competitive advantage (Brewer and Gajendran 2012). Its emphasis on goals accomplishment stimulates the long-term orientation associated to competitive advantage. The market culture also focuses on stability and control instead of on the flexibility which a necessity for compete in a highly agile environment. A positive effect of this culture on exploitation and competitive advantage can therefore be expected.

(H2c. Market culture positively impact on the exploitation of BBI)

The views reported in the literature on hierarchy culture contain both positive and negative impacts towards BBI exploitation. Kanter (1988) states that innovation is most likely to occur in organisations that have integrative structures, emphasize diversity, have multiple structural linkages inside and outside the organisation, have intersecting territories, have collective pride and faith in people's talents, and emphasize collaboration and teamwork (p. 383). This perception describes the degree of 'complexity' and stratification' of organisational structures (Mintzberg, 1979). On the other hand, some of the authors claim that the hierarchical nature of an organisational structure has highly negative effect on innovation uptake as well as its diffusion, as a result of the power barrier between individuals. This can be attributed to achievements of norms and formal procedures and control, which are considered to be the main barriers for innovative technologies adoption and survival. High-structures are said to inhibit continuous change orientation, communication and dialogue, empowerment and risk-taking. However there's no agreement on the negative impact of hierarchy culture on BBI exploitation. Because the constructs identified for exploitation in this study require a set of robust (predominantly quantitative) as well as highly structured measures to understand the dynamics of.

(H2d. Hierarchy culture bi-polar impact on the exploitation of BBI and has no significant impact on the exploitation of BBI)

5. Findings and Discussion

5.1 The conceptual framework

According to the review of literature carried out, evaluating the positive and negative impacts, the above-mentioned studies focus on different aspects of the relationship between organisational culture and exploitation of innovative technologies, under complexly different conditions. In summary, following hypotheses were concluded and a theoretical model was developed (see Figure 1).

H1. BBI exploitation positively impact on organisational competitive advantage

H2. Organisational culture will affect Exploitation of BBI. In particular:

H2a. Clan culture positively impact on the exploitation of BBI

H2b. Adhocracy culture has a bi-polar impact on the exploitation of BBI and has no significant impact on the exploitation of BBI

H2c. Market culture positively impact on the exploitation of BBI

H2d. Hierarchy culture has a bi-polar impact on the exploitation of BBI and has no significant impact on the exploitation of BBI

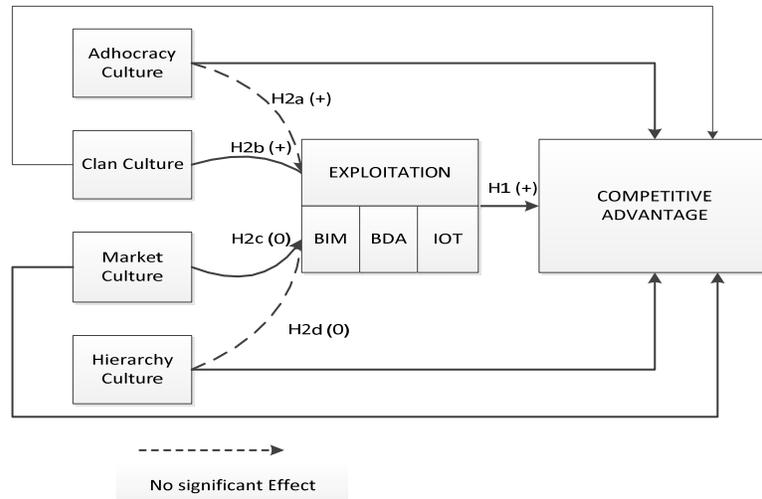


Figure 1: Conceptual Framework for the relationship between culture, exploitation and competitive advantage

Amongst the four culture dimensions, clan and market cultures found to be the two cultural dimensions, that create comparatively high influences creating new uses, extending and leveraging existing competencies, promoting efficiency gains as well as effectiveness gained by the use of BIM, BDA and IOT. To facilitate BBI exploitation within construction sector, the stakeholders are suggested to span over their departmental or organisational boundaries, so as to encourage communicate and exchange their BIM/BDA/IOT knowledge and experience with working colleagues, business partners and encourage the firms' culture to reflect an extended family with more engagement and participation by its employees. Further, encouraging the result orientatedness (goal achievement) and the ability to recognise the value of competition helps firms to enhance their competitive edge. Disaggregating each domain, the performance efficiency expected through BIM is likely more affected by the risk taking dynamism of adhocracy while the predictability for business insights expected in BDA is majorly influenced by 'Clan Culture' for its flexibility in creative thinking. Smart achievements expected through IOT is mostly a matter of the level of internal and external integration where both 'Hierarchy' and 'Adhocracy' cultures.

6. Conclusion and Recommendation

This paper focused on the relationship between organisational culture and the exploitation of BBI for organisational competitive advantage. The study design was built on appropriate theoretical modelling work, particularly in the development of appropriate interventions with 'competitive advantage'. Cameron and Quinn's (2006) Competing Values Framework Model was deployed to explore the aforesaid impact. However, 'competitive advantage' is not in-depth evaluated in this study. The study proposes both positive and negative correlations between constructs of culture and exploitation of BBI. The study provides evidence for the positive link between two organisational cultures (clan and market) and BBI exploitation while highlighting both negative and positive impact of hierarchy and adhocracy cultures. The implications of these results may help practitioners (within an organisation) who are intending to adopt, implement and exploit technological innovation to compete in the market. The paper highlights the fact that, organisational culture is a key enabler for exploiting BBI and thereby for achieving competitive advantage. Lastly, since the present study is based on literature review, further empirical studies (for quantitative studies and cross-validation) are required to validate the hypotheses proposed in this paper.

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Emerging Technologies in Construction Safety and Health Management

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Abstract

Safety on construction job sites has become a subject of primary concern across construction industries worldwide. Construction work is widely perceived to be dangerous, exposing workers to high risks of injuries and illnesses. The application of technology is considered as an effective approach to improve site worker's health and safety conditions and ensure construction safety management in general. Various types of technologies and interventions have been implemented for construction job site safety such as Virtual Reality (VR), online databases, Geographic Information Systems (GIS), Building Information Modelling (BIM), Unmanned Aerial Vehicle (UAV), 4D Computer Aided Design (4D CAD), wearable robotics, laser scanning, photogrammetry and sensor-based technologies. This study provides an overview of the various types of emerging technologies available for construction health and safety management. A comprehensive traditional literature review focusing on innovative technology applications for construction safety was conducted. This study provides an overview of the various types of advanced technologies available for construction health and safety management. Relevant publications in the areas of advanced and emerging technologies for construction health and safety management was obtained from research databases. The keywords 'technology' and 'construction site safety' were used to search the databases. Findings from the study identify research gaps and emerging future trends of technology application for construction safety.

Keywords: advanced technology, construction, health and safety, literature review, safety technology

1. Introduction

Globally, the construction industry is perceived to have one of the poorest occupational health and safety records (Donaghy, 2009); (Hinze and Teizer, 2011). Construction work is known to be executed in hazardous, clumsy environments and under poor and unhealthy working conditions (Welch, Russel, Weinstock and Betit, 2015); (Li and Ng, 2017); (Zou, Irizarry and Li, 2013); (Zhou, Ding and Chen, 2013); (Li, 2018). Despite stringent health and safety regulations, no significant decline in the number of construction accidents has been recorded (Azmy and Zain, 2016). Defective equipment, dangerous work areas and unsafe working conditions are cited as common causes of construction site injuries and fatalities (Li, 2015); (Hinze and Teizer, 2011). In light of these, various types of technologies and interventions have been developed to prevent worker's injuries, accidents and enhance construction job site safety (Welch et al., 2015); (Dodge Data and Analytics, 2017); (Zhou, Whyte and Sacks, 2011).

With the emergence of novel technologies, numerous studies have identified that the adoption of these technologies could provide a lasting solution to the problem of construction health and safety (Zhou et al., 2013); (Zhang, Cao and Zhao, 2017). Several studies have concentrated on the application of digital technologies such as Virtual Reality (VR), online databases, Geographic Information Systems (GIS), Building Information Modelling (BIM), Unmanned Aerial Vehicle (UAV), 4D Computer Aided Design (4D CAD), wearable robotics, laser scanning, photogrammetry and sensor-based technologies for accident prevention and onsite safety (Dodge Data and Analytics, 2017); (Zhou et al., 2011).

Li and Ng (2017); Li (2018) considered the application of wearable robotics and industrial robots, such as exoskeleton, robotic arms and the Assist Suit AWN-03 as a practical approach to improve site worker's health issues and safety conditions. Zhang et al. (2017) argued that sensor-based technologies including sensor-based location, vision-based sensing and wireless sensor networks are considered to provide innovative methods for the advancement of real-time construction safety. As a viable technique, the application of wireless sensor networks which is widely used for forecasting and environmental monitoring could assist in the avoidance of accidents and improve construction site safety performance

(Wang, Luo and Zhang, 2010). Teizer (2015); Kim and Cho (2010); Teizer, Caldas, and Haas (2007); Navon and Sacks (2006) argued that automation is a significant alternative that can enhance up-to-date gathering of safety data and improving the construction environment with the objective of ensuring better safety performance.

This paper aims to explore the various emerging technologies available for the management of construction health and safety. An in-depth and comprehensive review of previous literature is conducted to ascertain the innovative technology adoptions and implementations as reported in numerous studies and captures emerging future trends that have potential to impact construction safety in future.

2. Health and Safety Problems in the Construction Industry

Safety in the workplace is an important aspect, and efforts to create its awareness continue to gain momentum in the construction industry with the aim of recording zero injuries and fatalities (Hinze and Teizer, 2011). The construction industry is one of the highest risk industries, with about 50% of accidents and worker's deaths occurring on construction sites (Dupre, 2001);(Abdulkadir and Godfaurd, 2015) . The consequences of poor safety practices on construction sites are usually accidents or loss of lives (Teizer, 2015). Therefore, implementing construction site health and safety significantly reduces site risks and cost overruns resulting from site accidents (Swallow and Zulu, 2019); (Zhou, et al., 2013).

Although over the years there has been a slow improvement in the number of injuries and fatalities within the construction industry, accidents as well as worker's deaths resulting from site injuries are inexcusable (Heinz and Teizer, 2011). The occurrence of accidents and near misses on construction sites has proven that all facets of health and safety in construction require further improvement (Azmy and Zain, 2016). Swallow and Zulu (2019) stated the major reasons for the construction industry's poor safety are cultural and human behavioural factors with cost and training influencing these factors. Azmy and Zain (2016) reported causes of construction-related accidents as overexertion and strenuous movement, mode of lifting and transporting equipment and being caught-in between objects. Saurin, Formoso and Cambraia (2014); Teizer (2015) considered reasons for these incidents as poor site conditions, human error, failure on the part of the organization to provide a safe environment for workers identified negligence and lack of awareness as a major cause of jobsite accidents. Through investments in safety equipment, communication, workers training and leadership, organisations positive safety culture should be reinforced. Additionally, combining advanced digital technologies and techniques with these factors assist in solving the issues of construction health and safety (Abdulkadir and Godfaurd, 2015).

3. Digital Technologies and Trends in Construction Health and Safety Management

Digital technologies in construction have been in existence since hard hats and protective glasses. In recent times, the combination of big data, tech genius and construction has improved the safety of workers on construction sites (Azmy and Zain, 2016). With the development of new technologies, the use of technology continues to attention (Zhou, et al., 2013). A variety of tools have been developed to assist contractors achieve safety on their construction projects. Numerous studies have identified the use of digital technologies such as BIM, VR and AR, drones, GIS, automation and robotics, unmanned machinery, sensing and warning technologies, 4DCAD as effective technologies for accident, prevention and safe project delivery (Zhou, et al., 2011). These technologies are discussed in detail in the following subsections;

3.1 Robotics and Automation

Numerous studies have considered robotics and automation to have potential to solve health and safety issues in construction. Robotic technologies are presently used in the execution of dangerous and strenuous tasks. Li (2018) concluded that robotics and automation are most effectively used in activities undertaken in hostile environments and require speed and repetition. These activities put construction workers at the highest risk of overexertion illnesses and injuries (ibid).

Adopting robotic systems is a current trend for accelerating and automating construction tasks (Chu, 2013); (Pereira, Santos, Pires, 2002); (Bock, Linner and Ikeda, 2012). Several types of robotic systems have been developed to improve quality of construction projects, productivity, health issues of workers as well as other safety problems (Ruggiero, Salvo and St. Laurent, 2016). Controlled by computers on site and

dependent on advanced detection and control, robots are employed in the autonomous installation and gathering of heavy construction materials, which usually require enormous labor, and to construct structures such as skyscraper towers (Niu, Lu and Liu, 2017); (Jung, Chu and Hong, 2013) ; (Li and Leung, 2018).

Recently, numerous emerging robotic technologies such as exoskeletons, welding robots and forklift robots have been developed and can be implemented in construction (Ruggiero, et al., 2016). Wearable Robotics such as exoskeletons for reducing lower back stress, are applied when lifting and handling heavy objects, and usually benefits older workers (Balaguer and Abderrahim, 2018). The Suit AWN-03 senses workers motion and provides a support for workers back, shoulder and thigh (Kyodo, 2015). Signals are sent to the motors, which rotate the gears when there is movement, and reduce energy required at the hip and spine. The FORTIS Exoskeleton is another wearable robotics tool that enhances users strength and endurance (Li and Ng, 2015); (Frane, 2016). These exoskeletons come in power assist and unpowered forms. The power assist exoskeletons are configured to transfer energy through the skeleton of the wearer. The unpowered form provides a feeling of weightlessness redistributes weight and improves the posture of the wearer when carrying heavy objects (Dude, 2014).

Robotic arms are composed of aluminium servo brackets and have a similar look to the human arms (Yusoff, Samin and Ibrahim, 2012). Its ergonomic tool arms are made up of infrared sensors for radial distance and a USB camera, which captures angles and provides the arms with feedback on whether it can lift an object (Li and Ng, 2017). Vatsal and Hoffman (2017) study developed elbow-mounted robotic arms with a third forearm and a gripping beneath. The study explored the prospects for application of the robotic arm in construction. Robotic arms were found to be possibly used for enhance workers comfort and safety through stabilisation and bracing; reaching and transfers; and reducing effort in repetitive activities.

3.2 Online databases

Online systems have been used to improve several aspects of construction safety such as safety training and education, risk identification, safety monitoring and evaluation and safety inspections (Dodge Data and Analytics, 2017). Online databases can be utilized to detect potential site hazards and evaluate competence (Zhou, et al., 2012). Yu (2009) designed a prototype web tool to assist in the evaluation of potential designers, contractors and coordinators. The online system applies Artificial Intelligence during the evaluation process to support decision making through risk identification and assessment, and information capture and analysis (Zhou, et al., 2012).

The Construction Safety and Health System (CSHM) is a web-safety monitoring system that detects potential site risks and gives warning signals for activities that need immediate interventions (Cheung, Cheung and Suen, 2004). The system enhances prompt data search, upload, collection and documentation through remote internet access (Amzy and Zain, 2016). Safety indicators from diverse projects are understood and valuable information is obtained to improve construction health and safety management. Project performance is monitored over a specified period by analyzing scores assigned to certain parameters (Yu, 2009). Azmy and Zain (2016) identified the development of a real-time communication system for monitoring construction safety on diverse projects. A centralized database is used to store transmitted data and is analysed by site managers to inform decisions on construction sites (ibid). This system is an alternative platform for sourcing construction health and safety reports and statistics.

3.3 Building Information Modelling (BIM)

To address the issues arising because of the complex nature of construction projects, Suermann (2009) indicated that BIM could be applied to efficiently accomplish construction tasks. The BIM system is applied as a supporting technology for the planning and management of health and safety on construction sites (Zhou, et al., 2011); (Ganah and John, 2015). Implementing BIM enables visual assessment of construction site and identify potential hazards (Azhar, Behringer, Khalfan, Sattineni and Magsood, 2012); (Watson, 2010). A result of incorporating BIM in construction activities is developing safety-training videos for workers (Azhar, et al., 2012). Using the BIM model to conduct visual safety trainings enables site workers develop a better understanding of the actual site conditions (Watson, 2010). Construction workers are provided with sufficient time and information for safety planning and management before executing construction activities. With the use of sensors for data collection, the BIM

can adequately reduce the likelihood of site accidents by checking procedure of data acquisition (Druley, Musick and Trotto, 2016); (Ganah and John, 2015).

Ganah and John (2015); Kim and Ahn (2010) identified one of the major advantages of adopting BIM as its capacity to represent and manage graphics as well as automatically analyse designs, generate illustrations, reports, design schedules and manage facilities. Additionally, the BIM technology has proven to be effective not only in the design phase, but also in the operation stages particularly for simulation of the construction process (Watson, 2010); (Ku and Mills, 2010). Eastman, Teicholz, Sacks and Liston (2011) described two instances where BIM was used in construction health and safety management. To test rides in an amusement park project, envelopes were modelled to ensure that there were no activities during the testing period. Conflicts were identified within the testing period and 4D simulations were applied to resolve the issues. The second project used massing cylinders to model spaces occupied by activities in the construction of a steel frame building. Possible risks that worker might be exposed to were identified with clash detections between cylinders.

3.4 3D and 4D CAD

Health and Safety experts use 3D CAD for safety planning, accident investigation and facility maintenance safety (Rajendran and Clarke, 2011). Additionally, 4D CAD is utilized to simulate safety processes to display safety components and high-risk areas during the projects life cycle (Azhar, et al., 2012). Rwamamara, Norberg, Olofsson and Lagerqvist (2010) concluded that the use of 3D and 4D technologies in the early stages of construction projects allows the project team identify potential risks. Identifying risks at an early stage minimizes cost over-runs that occur because of design changes (Amzy and Zain, 2016).

CAD systems currently used by contractors to plan safety represent a stagnant and inaccessible design process (Lappalainen, Mäkelä, Piispanen, Rantanen and Sauni, 2007). Malassi (2016) indicated that although, with CAD systems, buildings are displayed topologically with explicit design features and attributes, they are not an appropriate tool for identifying safety risks on construction sites. Rozenfeld, Sacks and Rosenfeld (2009) developed CHASTE which is an automated tool for detailed and reliable forecasting and analysis of safety hazards in construction projects. CHASTE clearly indicates that the dangers construction workers face are frequently caused by activities executed by teams other than theirs (Tang, Lee and Wong, 1997). Mallasi (2006) applied 4D visualisation technology to detect and analyse workplace time-space congestion. Critical Space-Time Analysis (CSA) was used to analyse competition between various construction activities sharing similar execution space (Zhou, et al., 2012).

Zhou, et al. (2013) proposed the application of a 4D visualization framework for site safety management in a metro construction environment. 3D models were fabricated from architectural drawings and geographical survey plans. The study demonstrated that the 3D and 4D visualization technology is a virtual tool that effectively facilitates communication between site workers and project managers. The technology presents a novel approach to safety monitoring by providing proactive data such as safety photographs, to aid decisions concerning unstable structural components and practices to be avoided (Zhou, et al., 2013) ; (Hu, Zhang and Lu, 2010) ; (Bansal, 2011) ; (Merivirta , Ma`kela`, Ka`hko`nen , Sulankivi and Koppinen, 2011).

3.5 Smart sensors and wireless networks

The application of sensors plays a significant role in implementing construction safety through real-time monitoring of buildings or building components (Zhang, et al., 2017). Sensor based technologies have been applied to prevent accidents and prevent worker – equipment collisions by monitoring the entire environment on construction sites. Ahsan, El-Hamalawi, Bouchlaghem and Ahmad (2007) highlighted sensor-based location, vision-based sensing and wireless sensor networks as the various types of sensor technologies applied to construction safety management.

Wireless sensor networks have been found to enhance and facilitate information flow among design teams on construction sites (Ward, Thorpe, Price and Wren, 2004); (Brilakis, 2007). Complexities of the construction environment makes the circulation of a network a difficult task; however wireless networks present solutions to this problem (Ahsan, et al., 2007). Brilakis (2006) found that visual inspection methods employed to monitor bridge construction projects do not provide detailed and reliable information. New technologies such as wireless radio transmitters have been developed to monitor and inspect bridge construction projects (reference). GSM, Wireless Local Area Network (WLAN), Terrestrial Trunked Radio (TETRA) are the various types of wireless technologies that have been tested on

construction site operations (Zhang et al., 2017). Ahsan, et al. (2007) identified a wireless network known as Wi-MESH to provide remote backend access and connection to the internet on construction sites where telephone access is restricted (Brilakis, 2007).

3.6 Virtual Reality

Virtual Reality is an artificial, computer-generated experience of a real-life situation or environment (Bouchlaghem, Shang and Whyte and Ganah, 2005). It generates realistic imagery and hearing making the user feel like they are experiencing the simulated reality firsthand. In construction, virtual reality has been used by the safety team to review safety tie-off points and coordinate major crane picks over occupied facilities that cannot be disrupted, allowing for effective means to visualize and communicate the impact of major construction activities in existing facilities that could possibly be overlooked when viewing through traditional techniques (Zhang et al, 2017). Virtual Reality also creates a genuine safety work experience viable for construction safety training (Li and Leung, 2017). These benefits safety training as exercises on safety can be carried out in the absence of a qualified safety administrator by simply simulating the training environment on a personal computer (ibid).

Zhou et al. (2014) argued that traditional paper-based handouts, video tapes or slide shows hardly present electric hazards vividly to the trainees and furthermore do not provide sufficient opportunities for trainees to interact in activities. This form of participatory training brings a real life situation into the training in an "it can happen to you" scenario and allows the trainee to relate these regulations and conditions to real life situations of with life and death significance.

3.7 Augmented Reality

As opposed to virtual reality which uses computer generated imagery to simulate real life scenarios, augmented reality enhances reality through the use of technology (Bouchlaghem et al, 2005). However, the enhancements can be distinguished where such interactions are developed into applications and mobile devices (Patrucco, Bursano, Cigna and Fissore, 2010). Augmented Reality projects 3D imagery on a person's physical surroundings as they walk through construction sites with mobile devices or special helmets and using GPS and cameras to present real-time data geospatially giving updated user feedback (Bouchlaghem et al., 2005). Safety trainings may be conducted with this technology by enabling workers to wear augmented reality headsets to give virtual drills, instructions and safety scenarios at minimal training costs and downtimes (ibid).

3.8 RFID

Radio Frequency Identification (RFID) uses radio frequency waves to transmit data, retrieve data and store data to identify the status of workers and objects (Yin , Tserng, Wang and Tsai, 2009; Lo and Lin, 2013). RFID systems are composed of an RFID tag and RFID reader, with RFID tags consisting of a small microchip and antenna. Data are stored in the tag, generally as a unique serial number. RFID tags can either be active (using battery) or passive (no battery) or have a read range of 10 to 100 meter (Yin et al. 2009).

In construction safety applications, RFID technology has been used to demonstrate real-time data gathering (Lo and Lin, 2013). RFID tags have been used in simulated construction environment to track the movement of workers, equipment and materials and the resulting tag data examined to determine if a near- miss accident has occurred (Zhou et al,203). This information can further be used to prevent future occurrences be used to prevent such occurrences in the future (ibid).

Chae (2009) designed a Collision Accident Prevention Device (CAPS) that uses RFID (Radio Frequency Identification) technology to estimate the size of the working area. The device supports accident prevention involving vehicles, heavy equipment and workers using data from working area of each object. CAPS estimates and calculates the positional relation of heavy equipment and workers and once determined that a worker is in the restricted area of heavy equipment, a message warning message is send to the worker and concerned parties (ibid).

4. Conclusion

This paper has provided a comprehensive and traditional review of previous literature on technology adoptions and implementations in construction health and safety management. Numerous studies have been conducted on the application of various types of technologies in aspects of construction health and safety such as site safety education and training, safety communication and information and site monitoring and control. The adoption of various safety technologies like 3D and 4D CAD, RFID, augmented reality, virtual reality, Building Information Modelling, smart sensor and wireless technology, online databases, robotics and automation have significantly increased the effectiveness of health and safety management on construction sites. In addition, it was found that standard safety practices and policies combined with the implementation of digital health and safety tools and techniques could assist site managers, supervisors and co-ordinators ensure efficiency of their construction projects. Therefore, investing in emerging technologies enhances the safety performance on construction sites.

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Impact of Big Data from BIM and GIS on Smart Urban Futures

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Abstract

It is estimated that more than 70% of the world's population will live in urban areas by 2050. The implications and impact of such growth on natural resources, the economy, and ways of living in current cities are still being assessed as there is an urgent need to develop solutions that can support a sustainable growth. While the potential of big data on the development of solutions appears to be taken for granted, its clear application is yet to be explored in the context of cities governance and design. Urban and rural areas will be further examined, and their boundaries are inevitably to be diluted in the future providing for new ways of living, working, doing business and connecting.

This paper will investigate the use of big data in smart urban futures by exploring the potential of information in support of ecological smart urban corridors development. Through a comprehensive literature review on existing data and information systems such as BIM and GIS and their integration, the paper will analyse the current role of Big data in planning and decision-making and smart cities design.

The results will provide for a clear vision of present data use and potential application in the visualization and design of smart urban futures.

Keywords: Smart Urban Corridors, BIM, GIS, Big data.

1. Introduction

Today, across the world there are more people living in cities than in rural areas. Cities and conurbations increasingly play a major role in driving economic growth and improving the overall quality of human settlements. More job opportunities are generated, and facilities operate more efficiently than in rural regions due to agglomeration and industrialization. A large population sharing infrastructure allows more sustainable growth and concentrated governance permitting for more organized planning. However, cities are facing challenges of rapid urbanization, changing demography, deprivation, insufficient service coverage, inequality, and climate change. Parallel to this, disruptive technologies are evolving at a fast pace and play a major role in how we use and perceive our cities.

This paper intends to explore the role of Big data from GIS and BIM systems in identifying the ecological principles to develop Green and Blue infrastructures for Smart Urban Futures. Through a thorough literature review it explores the potential of smart and disruptive technologies and human and ecological interactions in creating smart networks between existing urban settlements and the rural landscape through the development of ecological urban corridors.

The overlaying patches of different rural and urban areas are increasingly complex and require different approaches and ways of thinking. The trends in city development are now established around economics, nature, the search for a new urban lifestyle and new approaches to governance that serve the multitude of variables and everyday disruptions that cities face.

Currently, analysis and visualisation of urban data, infrastructure, processes, and inhabitants present an overwhelming problem for monitoring, analysis, planning and decision-making in smart cities projects (Song et al. 2017). This problem hinders the capabilities of cities to properly respond to fast changes in world events, environmental challenges, and economic demands (Sassen, 2018). In the future, the key to accessing data for any urban feature will be to identify the specific location, things and timing of events to create plans which relate to the people who will be affected in that city (Albino et al, 2015). However, understanding existing and available data is of utmost importance for authorities, stakeholders and communities to make informed decisions for future urban growth; the necessary data visualization to support such processes and engage with all partakers has yet to be explored.

Methodology applied to develop scenarios of ecological urban corridors has greatly evolved from being based on either qualitative or quantitative combined with spatial analysis (Peng et al. 2017). Big data from GIS and BIM systems can support the identification of ecological principles to develop smart urban green and blue corridors. Their role in smart urban futures development presents a challenge given their historic

environmental and socio-economic characteristics but also an opportunity to explore an innovative multi-inter-disciplinary approach to urban planning. Supported by big data analysis, visualisation and modelling communities, decision-makers, stakeholders and academics engagement is paramount in this process but only possible if the existing data is readable by all. Visualisation and modelling of big data analytics may provide for the support required to engage in innovative approaches to urban planning and decision making in the development of smart ecological urban corridors identifying environmental, liveability and economic drivers and enablers that establish a set of principles to guide the development of existing waterways.

2. *Methodology*

This paper was developed based on a thorough literature review according to the guidelines by Gough et al. (2017) and use is made of the digital library databases: Springer, Science Direct, Google scholar, IEEE Xplore and ACM library.

Several types of documents were reviewed including articles, reviews, conference proceeding papers and book chapters. Significant research publications were obtained on Green and Blue Urban corridors historic development and methodologies, Geographic Information Systems (GIS) and Building Information Modelling (BIM) integration, Cities Information Modelling (CIM), Big Data and Big Data Analytics for a considerably large period of 20 years from (1999–2019).

3. *Smart Ecological Urban Corridors in Perspective*

The concept of ecological urban corridors first appeared in the field of biology. With the increase in human demands and the scarcity of resources, the concept has gained a prominent role in the rapid urbanization and regional integration in connectivity green corridors in the city and intercity. The urgency in which cities grow and need to take over the existing rural areas is increasing at a fast pace due to the population growth and exodus to the urban areas (Seto et al, 2013: U.N., 2018).

The rapid development of urban expansion leads to biodiversity loss and landscape fragmentation. Some argue that it is necessary to focus on urban ecological corridors at a larger-scale of urban and rural space level and its ecological social, cultural and other features began to be a widespread concern (Che, 2001; Rouget et al, 2006). The urban ecological corridor meets the needs of residents towards the recreation of an ecological green living open space. The term is usually defined through a linear or ribbon ecological landscape that provides the functions of natural habitat, green open space or human habitat isolation in the context of an artificial eco-environment of a city or urban area (Noss & Harris, 1986). With the paradigms of economic development and ecological protection with the burst of urban environmental problems and the increasing human ecological demands, the efficient construction and management of urban ecological corridors is seen as a possible way to resolve the contradictions in the process of rapid urbanization.

There are several classifications of urban ecological corridors, and these vary according to their structure or function. In terms of structural function they include river corridor (Ming et al, 2009; Peng et al, 2017); green transportation corridor (Zong et al, 2003); biodiversity conservation corridor (Li et al, 2009); heritage corridor (Kong et al, 2005); and more recently the recreation corridor which is the result of urban residents needs for green open space and recreational space (i.e. walking and cycling).

In terms of functional classification there is a continuum between ecological urban corridors and communication corridors. The first can be defined as barrier corridor, impeding the material, energy and information from flowing and by doing so protect special species from external interference thus conserving the biodiversity (Noss & Harris, 1986; Peng et al, 2017). These can cause natural habitat fragmentation, reduce landscape connectivity and increase local species extinction conversely, they can create ecological constraints of urban expansion and prevent urban sprawl such as London, Seoul and Beijing greenbelt constructions (Gant et al, 2011; Yang and Jinxiang, 2007). The second, promote the flow of important channels for the water, nutrients, energy, plants and animals thus increasing the connectivity possibilities between important patches. The two functions are not definitive and can ensue simultaneously in ecological urban corridors.

The idea behind urban development is interlinked with the way technology is shaping our present and dramatically impacting on our future. The ubiquitous infrastructure is considered an enabler of smart urban development (Anttiroiko, 2013; Kitchin, 2014; Albino et al, 2015). Technology has an impact on developing urban infrastructure, planning, water supply, public transportation and environmental protection

(Anttiroiko, 2013; Kitchin, 2014). It is not about digital cities anymore but smart urban development (Anttiroiko, 2013). Complex information systems require an innovative approach to urban development (Anttiroiko, 2013; Kitchin, 2014). But what do we do with these complex systems and the information generated by them?

Blue and green corridors are urban corridors developed around watercourses, flow paths and surface water ponding along with the green infrastructure that typically accompanies urban blue corridors (Gaston et al, 2013; Li et al, 2017). The dynamic linkages and ecological relationships of both with the urban environment create an area of multifunctional use (URS, 2011; Li et al, 2017).

The key drivers in regenerating urban corridors can be economic, connection with nature and resilience, healthier population and culture and lifestyle. These drivers are global and have different facets and relevance in different urban areas and contexts.

Currently, relevant redevelopments of river/canal sites include the Bradford-Shipley canal road corridor in the U.K. (Bradford, 2017), the Hafen City, Hamburg in Germany (Hamburg, 2014) and Cheonggyecheon stream as part of Seoul's urban regeneration plans (Cho, 2010; Lah, 2011; Lee & Anderson, 2013; Temperton et al, 2014). All projects are to be completed by 2030 with Hamburg and Seoul being on the forefront of urban regeneration awareness.

The fast pace of cities' growth with the societal and ecological challenges requires a step change. Implications on health and wellbeing, housing, future jobs and connectedness need to be addressed in a different way that includes a bottom up community engagement approach. Green and blue corridors present major challenges due to their historic and environmental role but also present opportunities to explore smart urban futures that embrace societal and environmental challenges through the application of technological solutions that promote healthier living for communities.

The integration of BIM and GIS provides for Big Data that can be analysed, visualised and modelled to support the aforementioned challenges.

4. Big Data Analytics

Big data is a considerably used expression that defines the enormous volume of data currently being collected within smart cities context to be analyzed computationally. The relevance is not on the data itself but on the correlation of significant data sets to reveal patterns, trends, and associations, especially relating to human behavior and interactions.

The defining characteristics of big data can be volume, variety and velocity (McAfee et al., 2012), in which volume signifies the quantity of records, contacts, tables or files; velocity refers to the speed of incoming data streams determines (near time, real time) and variety specifies to terms of sensory and non-sensory data sources and/or to the structured and unstructured data formats that increase variety in big data systems (ur Rehman and Batool, 2015) to uncover maximum knowledge patterns.

Gani et al (2015) added three further V's to Big data characteristics: veracity, variability, and value. Veracity refers to the reliability of big data which is represented by authenticity property of big data, data sources and correctness of data. Veracity improves the overall effectiveness of the system. Variability relates to the handling of inconsistencies in big data; and value, represented by the interest of uncovered knowledge patterns of big data. Big data value is directly affected by all V's therefore a proper balance between them signifies more value to in the big data system.

Big data is actively explored in various disciplines and sectors from biology to ecological science and business to agriculture, healthcare, cyberphysical, system, smart cities and social media analytics. The focus of this paper is on the impact off all of these on the urban planning and governance (Hao et al., 2015; Misuraca et al., 2014) of smart ecological blue and green corridors enabling innovation, competition and productivity. Its ability to couple information in innovative ways to create insights and services makes big data a crucial source of innovation; this is a key advantage over small data. Big data analytics has the ability to provide for a holistic vision of the subject matter given the sample size and correlation patterns allowed, which can be integrated in future decision-making.

Recent research indicates that Big Data Analytics has the potential to originate applications based on modeling and simulation (Tolk, 2015) with added value in numerous sectors and disciplines through data-driven decision making. This is of utmost relevance within smart cities context, which relates not only the physical structure but also and more importantly with the human and social dimension of cities. Through the application of several technologies aims to expand the performance of health, connectedness (i.e. traffic, transportations and active mobility), energy, education, and services (i.e. water) leading to higher levels of comfort for their citizens. This can only be achieved by turning information into knowledge using a combination of existing and new approaches.

Big data analytics enables the extraction of information, knowledge and expertise from big data yet this is only useful if translated into actions that are carefully defined and assessed enabling model-driven decision making (Tavana 2014; Saggi and Jain, 2018).

Tavana (2014) proposes six types of data analytic models: Data Mining, Predictive Modeling, Simulation Modeling, Optimization Modeling, Prescriptive Methods and Business Intelligence. Smart ecological green and blue corridors require different layers of data and solid and reliable identification of patterns and correlations to support effective decision making at urban planning and governance level. The different types of data analytic models can support analysis and decision making through big data visualization.

5. Impact of BIM And GIS Integration in Derive Big Data

The increased interest in GIS and BIM integration is sustained by the need for effective decision-making supported by an understanding of the environmental, geographical and infrastructure information. The numerous data generated, collected and stored in BIM and GIS can be utilized to facilitate the decision-making process through big data analytics (Schönberger and Cukier, 2013). Increase computer science and data technologies can make the fusion possible but its exploration is still at early stages and innovative applications are and will continue to be explored (Lu et al, 2017) and have the potential for co-creation and collaboration between different authorities and stakeholders which have thus far been working in silos to provide for a better built and natural environment.

GIS has been explored by urban planners at a macroscale while BIM has been advocated by architects, engineers and contractors and facility managers at a microscale (Lu et al, 2017). With the rapid urbanisation, the impact of climate change and the problematic of governance, the implementation of an effective City Information Modelling (CIM) can provide for a significant shift in the way cities are planned and developed. Big data stored in BIM at the micro level can further be integrated to CIM through GIS at an urban scale.

Some explorative studies have been conducted to integrate GIS and BIM through automatically transform the geometric and semantic information of a BIM model to a geo-referenced model for spatial planning (Rafiee et al. 2014) or use semantic web technology to ensure semantic interoperability between existing BIM and GIS tools (Karan et al. 2015). Approaches include ontology construction, semantic incorporation through interoperable data formats and standards, and querying of heterogeneous information sources (Levi et al. 1996).

Efforts have also been conducted for integrating BIM technology into GIS for developing a 3D digital city model (Xu et al. 2014) which can be used for city planning and management. The studies focus on the use of BIM and GIS static information hitherto the integration of dynamic and real-time BIM and GIS for Big data analytics for visualisation in a digital environment presents the real challenge. Both are not static but continuously enhanced with real-time incoming information incoming as the systems function. The volume, variety and velocity of the data make the systems highly dynamic. The implications of a large volume of traffic data within an urban area could bear an impact if captured in the GIS for different applications including road, traffic management but also accidents and public health. The integration of sensor networks and computing provide for real-time collection of big volumes of data that need to further be included in big data analytic systems for smart cities.

Integrating the two models and enabling technologies will have a significant impact on solving problems in the building and infrastructure sectors but also in the effective management of the natural and built environment overall. The main challenge presented is that the systems were created for different purposes therefore the ontologies and taxonomies applied in each are significantly different and not easy to integrate.

In broad terms it could be said that BIM deals with micro data flow of complex 3D through specific standards and GIS focuses on macro data flow and is based on raster and vector geometries also through specific standards. Both systems are file-based storage with specific standards. The main argument for their integration is based on establishing connectivity through web semantics and open spatial database combined with open BIM data base (Karan et al. 2015; Rafiee et al. 2014).

This integration would bear benefits in smart urban futures through sharing experiences and knowledge with individuals and other entities and continuing to obtain effective results and make appropriate decisions but more effectively on: reducing costs through higher efficiency in map creation and customer information collection, by supporting the decision to select the best location for different types of creations (i.e. institutions, enterprises, business, infrastructures etc.) thus avoiding interventions, such as constructions, in environmentally inappropriate locations and choosing the most suitable path for different infrastructures. It also has the potential to increase revenue as simulation allows the development of digital maps and provide technical consultancy in the field of natural resources and the built environment (i.e. real

estates) and potentiates the development of new products such as satellite images with projected 3D data and the development of evacuation plans for environmental disasters in the smart city.

The non-tangible benefits include providing better services to city residents through geographic information system to support decision making, as well as using the information available in the system to manage institutions and services more efficiently.

The data generated through the dynamic integration of GIS and BIM can be used in big data analytics to support planning, management and decision making in smart urban futures, yet this is not a clear-cut process. The fact remains that cities operations involve different stakeholders, disciplines and authorities whose expertise differ, and big data analytics will not on their own provide for a solution.

The design of a graphical representation through tables, images, diagrams is required to make sense of the patterns from the data analytics. According to Becker (2016) visual perception, design, data quality, missing data, end-user visual analytics are future trends of visualization which can be developed in form of charts, graphs, histogram, excel spread-sheets, heat maps and geographical maps to name a few. These aim to support interpretation of inferences drawn in a comprehensible manner.

Two main instruments are frequently used to interpret big data: visualization and modelling. These mechanisms are perceived as the most effectively to support smart ecological urban corridors as they provide for an effective way to assess big data analytics from different sources and layers allowing for overlapping of data sets which provide for a holistic view as well as more in-depth analysis if needed.

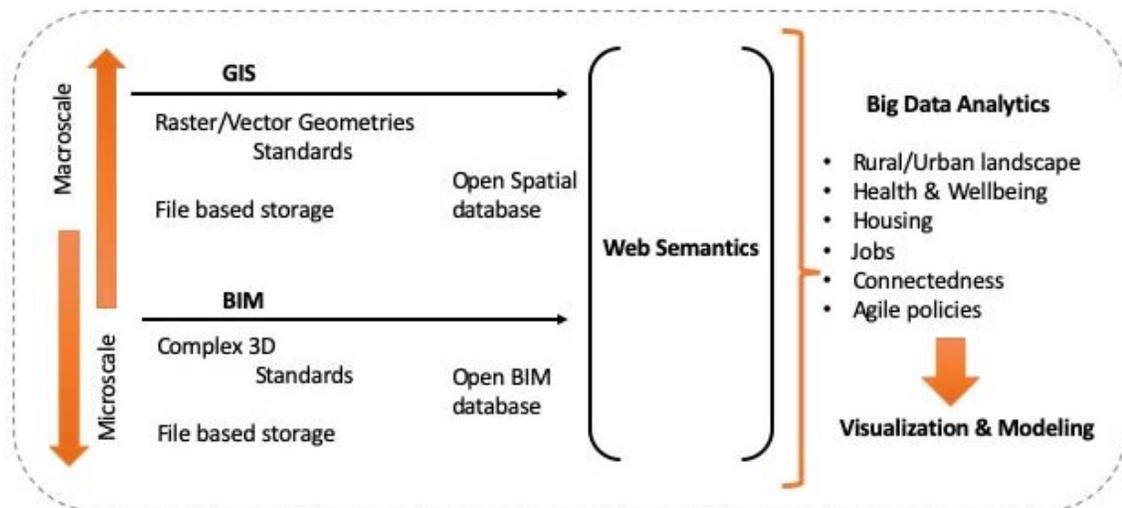


Figure 1: BIM and GIS Integration Impact in derive Big Data

6. Conclusions

Through the literature review it is possible to conclude that Big data from GIS and BIM can provide for the identification of the ecological smart urban green and blue corridors by being able identify patterns between the different data sets that can be correlated into layers, such as life expectancy, communities access to green areas and existing health infrastructures to assess the needs of existing communities for example. The potential goes beyond the mere correlation of data sets but also through the visualisation and modelling of the data.

Landscape and biodiversity data sets can be crossed with existing infrastructures data objects to provide for a thorough analysis of a potential developing area through the identification of the existing natural and build infrastructures. The data sets can be developed into visualisations and modelling to assess existing scenarios of both environments and explore the potential of new proposed ones.

The correlations and patches to be established can be infinite once the fusion works effectively. Smart urban Green and Blue corridors can be proposed based on big data analytics from the integration of both systems to support rural and urban landscape development by promoting healthier living and well-being projects, improve housing quality, identify new potential jobs in localised areas and of utmost relevance:

maintain connectivity of people and goods in fast growing cities and the challenges of climate change without further harming the environment.

Visualisation and modelling are the tools to be further explored to support community, stakeholders and authority's engagement in developing cities as living laboratories promoting sustainability through smart urban corridors development.

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Digitalisation as a Veritable Option for Construction Organisations to Achieve Competitive Advantage

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Abstract

This paper focuses on the role of digitalisation in providing a competitive advantage for construction organisations especially in developing countries like South Africa. The study sought answers in the body of existing literature in ascertaining the adoption of digitalisation, its challenges and possible measures for improving its adoption within construction organisations. It was discovered that construction organisations operate in a competitive environment. However, adopting digitalisation can serve as a strategic competitive approach to gain better client's confidence and satisfaction, through improved service delivery. The major challenges of digitalisation are the technical expertise involved in the use of digital technologies, finances, security, interoperability, and fear and resistance. Although this study is part of an on-going research geared towards improving the service delivery of construction organisations in South Africa, it has been able to bring to light the possibility of construction organisations in South Africa achieving competitive advantage through digitalisation; an aspect that has received little research attention in recent times.

Keywords: Competitive Strategy, Construction Organisations, Digitalisation, Digital Technologies, Survival Strategy.

1. Introduction

The construction industry all over the world is dynamic in nature, and its activities are not static. Reasons for this can be clients' growing demand, the complexity of construction projects, advancement in technology and the introduction of innovations. Clients' taste and demand increases by the day, and construction participants have the responsibility of meeting these demands through every available method. This situation has placed stiff competition among construction organisations, who take up the responsibility of delivering construction projects in return for a particular financial reward. For these organisations to survive this obviously competitive environment, strategic planning and adoption of innovative ideas are important. Abidin *et al.* (2014) have described the construction industry as one that constantly demands construction organisations to improve their services continually, in order to create a competitive edge.

Dimick (2014) submitted that for organisations to be competitive, they need to employ ways of carrying out their activities by working smarter, not harder. The centre focus of this lies in Innovation. Lansley (1987) submitted that for an organisation to survive a competitive environment, such an organisation must be innovative. The study submitted that companies that embrace new technologies and innovative processes during periods of the economic downturn had a significant advantage over those who stuck to their old practices. According to Welch and Byrne (2001) considering the uncertain nature of the environment in which construction organisations operates, these organisations will need some amount of contingency for survival. Adopting innovation, new technologies, and change that is faster than those of their competitors, and the external environment, is what will help these organisations survive. One of such innovation and change that has taken over almost every industry in countries around the world is digitalisation.

Digitalisation is a way of transforming information into a digital format, through the organising of information into distinct units of data that can be separately addressed (Rouse, 2017). Ochs and Riemann (2018) described it as the incorporation of digital technologies into everyday life, through digitising anything that is capable of being digitized. These digital technologies involve digitised information, recorded in the binary code of combinations called bits, and those bits represent words and images. Of recent, digitalisation has found its way into everything from personal devices to complex industrial systems (Dall'Omo, 2017) and Building Radar (2015) described it as a step towards achieving efficiency,

effectiveness and new opportunities within the construction industry. However, while most industries in countries around the world have recognised the inherent benefit in digitalisation, and has keyed into this innovation, the construction industry seems to be lagging behind (Osunsanmi *et al.*, 2018).

Considering the stiff competitive nature of most industries (construction inclusive) and the need to stay relevant by adopting innovative ideas, embracing digitalisation of activities by these organisations will serve as a truly beneficial step towards their survival (Berger, 2016; Koch and Windsperger, 2017). However, it has been noted that organisations within the construction industry are still lagging in the adoption of this obviously beneficial innovation. Herein lies the problem of this study. Therefore, this study through the review of relevant studies assessed digitalisation as a way of achieving competitive advantage for construction organisations in developing countries such as South Africa. This is done with a view to bringing to light, the different areas where digitalisation can be adopted by construction organisations, the challenges they are likely to encounter, and the different ways by which they can improve its adoption, in order to gain a competitive edge.

2. Competitive Advantage of Digitalisation

Zekiri and Nedelea (2011) opined that business strategy is all about competitive advantage as this is crucial in order to ensure that resources are allocated in the most effective way. Porter (1985) established three generic strategies for the survival of organisations. These strategies are cost leadership, differentiation, and focus. Abidin *et al.* (2014) noted that in recent times several strategies have evolved from these generic strategies and they have been adopted in several studies relating to construction organisations. For example, Warszawski (1996) after critical evaluation of Porter's generic strategies added the growth strategy to suit the activities of the construction industry. The aspect of cost leadership strategy has to do with the organisation being the low-cost producer in an industry for a given level of quality. Differentiation has to do with the organisation adopting innovative practices in order to stand out among their competitors. This aspect comes with the adoption of new technologies and technological advancement such as digitalisation in the delivery of services. Focus strategy has to do with the organisation focusing its available resources in a specific market. Lastly, the growth strategy involves the expansion of an organisation (Abidin *et al.* 2014, Abu Bakar *et al.*, 2011; Langford, 2011; Zekiri and Nedelea, 2011). While these strategies are available for organisations to survive in strict competitive environments, Porter (1985) pointed out that successfully executing each generic strategy involves different risk and requirements. It is therefore rare to see a firm suited for all the three generic strategies, hence, organisations should adopt one specific strategy that is best suited for such time.

3. Construction Industry and Digitalisation

Due to its complex nature, construction all over the world faces diverse challenges. These challenges bring about the need for advancement in the delivery of construction projects in order to avoid poor project delivery. Construction organisations in most developing countries are characterised by poor service delivery (Chilipunde, 2010; Mbamali, and Okotie, 2012). Fadhi and Tan (2001) observed that areas where significant competitive advantage can be gained to become world-class, like research and development (R&D), and technological advancement, are all found lacking in local construction organisations in Singapore. In Malawi, Chilipunde (2010) observed that in the area of technological advancement, limited skill in construction information technology affects the contractor's productivity. Construction Industry Development Board (CIDB) (2007) also observed that technology advancement is a crucial factor affecting the South African construction industry. In Nigeria, Mbamali and Okotie (2012) mentioned that an increase in the application of technological approach among construction organisations would go a long way in increasing the performance of construction organisations within the country. By adopting technological innovations, construction organisations can differentiate themselves from their peers in the way and manner their services are delivered. The adoption of digital technology in the delivery of construction projects is a form of technological advancement that can aid significant improvement in the service delivery of these organisations (Berger, 2016).

Although digitalisation proposes significant benefits to construction organisations, construction participants and the construction industry at large, its adoption within the industry is considerably low. Industries such as banking, manufacturing, and retailing have all come to understand the benefit of digitalisation and have keyed into the future by using it as a new approach for ensuring competitive gain and efficiency (Osunsanmi *et al.* 2018). The case is not the same for the construction industry, as there seems to be a consensus among researchers that the industry around the world has failed to recognize

the inherent benefit of digitalisation, thus leading to the slow adoption of this obvious beneficial concept within the industry (Castagnino *et al.*, 2016; Ibem and Laryea, 2014; Osunsanmi *et al.*, 2018). Building Radar (2015) further stressed that digitalisation has been neglected for too long in the construction industry, while its usage in other industries is evident. This neglect has significantly affected the industry, especially in developing countries, as no major transformation is evident within their construction sector (Castagnino *et al.*, 2016). Ibem and Laryea (2014) submitted that the use of digital technologies has only recently become a common idea among construction professionals due to the attention garnered over time by BIM. Thus, if construction organisations are to gain a competitive edge over their competitors, then there is the need to implement the use of digital technologies in all facets of their activities. By doing this, they can survive the obviously highly competitive environment, and at the same time provide successful service delivery within the industry.

3.1 Adoption of Digitalisation in Construction Organisations

Construction organisations can employ digitalisation processes at various stages of construction. Boston Consulting Group (BCG) (2016) observed that the full adoption of digitalisation with particular reference to BIM at the design and engineering stage of construction projects will lead to parallel and robust design and engineering as it helps architects, engineers, and project partners to merge their designs, identify interdependencies and clashes, and rapidly evaluate design iterations. It will also lead to virtual migration of physical structures, achieving a data-driven design, achieving improved visualization through simulations, enhanced through holographic technology and rapid prototyping with the use of 3D printed models. Argawal *et al.* (2016) also noted that the 5D BIM, which is a five-dimensional representation of the physical and functional characteristics of any project, could prove immensely beneficial to construction organisations. The 5D considers a project's cost and schedule in addition to the standard spatial design parameters in 3D. This implies that employing digitalisation early in the design phase can help increase the chances of accuracy in estimating the budgeted cost and schedule of a project, thereby reducing variability between budgeted cost and time, and actual cost and time (Castagnino *et al.*, 2016). The issue of variability in cost and time of construction projects is a common recurring problem (Aghimien and Awodele, 2017; Emuze and Smallwood, 2011). This issue is not unconnected to poor and inaccurate estimating methods. Thus, if construction organisations are to survive through gaining client's confidence, then the accuracy in the estimating of construction work needs to be of top notch. Digitalizing the estimating process through the 5D is bound to give an increase in the accuracy of the estimating process and thus, reduce the chances of variability in the budgeted cost and time.

Ibem and Laryea (2014) and Solanke and Fapohunda (2015) assessed e-tendering and e-procurement in South Africa and observed the low adoption of these electronic approaches. However, barring this low adoption, the adoption of digital technologies in the aspect of procurement and the tendering process comes with immense benefits such as; cost reduction in construction, the turnaround time of the tendering process, and enhanced implementation of government policies. Considering the South African construction industry where the traditional procurement system (which is in most cases time-consuming) is still being favoured in the delivery of most construction works (Thwala and Mathonsi, 2012), adopting digitalisation to hasten the procurement system is necessary. In fact, Hashim *et al.* (2013) identified the benefits of using electronic tools in the procurement of construction projects to include, among others increase in process quality, cost savings, user satisfaction, increased responsiveness and productivity, market expansion and effectiveness in project delivery. Thus, by being digital oriented, construction organisations can be sure of achieving quality construction right from inception, and this to a considerable extent will lead to the client's satisfaction and future recommendation.

BCG (2016) noted that digital designs enhance efficiency during construction. It allows for real-time data sharing, integration, and coordination among stakeholders involved in the project. It also allows data-driven construction planning and lean execution, automated and autonomous construction, new fabrication methods, and rigorous construction monitoring and surveillance. It is obvious that by employing digitalisation at this phase of the construction project, construction organisations stand the chance to increase their project delivery time and quality. Staub-Fresh and Khanzode (2017) earlier mentioned that there are less reworks and fewer change orders by adopting digitalisation on a project. These reworks are in most cases costly and occur due to countless encounter that are undiscovered until they are experienced in the construction phase.

Digitalisation at the operation phase of construction projects is possible using embedded sensors to monitor any given part of a building, checking for deterioration, enabling predictive maintenance, and

ensuring continuous updating of a central database. In addition, augmented reality can help guide maintenance crew towards areas needing maintenance attention within the facility (Castagnino *et al.*, 2016). One of the largest opportunities to reduce the total life-cycle cost of a built asset is to employ the BIM approach during the operational phase. Also monitoring the structural performance of built assets to ensure safety is one aspect of the operational phase that can be done easily with BIM (Delgado *et al.*, 2017).

3.2 Challenges of the Adoption of Digitalisation in Construction Organisations

A major challenge most construction organisations are likely to face with the adoption of new technologies is the issue of technical expertise. Embracing digital technologies comes with the training of personnel to handle these technologies. Oke *et al.* (2018) observed that there is no specific module designed towards digital training in most institutes of higher learning and this has a negative impact on the construction industry as a whole. This is because construction organisations have to train their graduates in the aspect of digital tools. To a large extent, this can serve as a source of discouragement for construction organisations who are already struggling to survive within the stiff and competitive construction environment. According to Sacks and Barak (2010), one of the major issues, affecting the utilization and appropriation of technological innovations in construction is the absence of well-trained technological staffs.

The issue of training workers on digital technologies depends on the financial capability of the organisation. In most developing countries (South Africa inclusive) where construction organisations are mostly small, medium and micro enterprises (SMMEs), training of workers in the use of new innovations might prove difficult. Rather than training, these organisations might just result in sticking to the old practices, which obviously is bound to lead to poor service delivery and poor competitive edge. In Jordan, El-Mashaleh (2007) discovered that in the construction industry main problem as regards the adoption of digitalisation could be associated financial cost implications. This cost includes the cost of acquiring, maintaining, and training of ineffective staffs. Oladapo (2007) in Nigeria made a similar observation. Dimick (2014) made a similar observation in Canada, where financial considerations were a major challenge of the adoption of digital technologies in most organisations in the country. The financial investment needed to fund the adoption of technology is considered akin to adding another salary to the payroll. Due to the cost associated with acquiring new technologies, most organisations would prefer to hire other personnel instead. This view can be said to be myopic in nature, as the accuracy, speed, and productivity associated with the use of digital technology is not being considered by these organisations.

Aside from the issue of finance, there is the issue of digitalisation having its own security issues. Redmond *et al.* (2012) mention the issue of data security and protection as being important for effective digitalisation. There is a need for assurance that information and data are only open to the right individuals and programming applications. Zeng *et al.* (2012) noted that computer security and protection procedures, borders on the security of important parts of information, resources, data, and assets that incorporates scholarly properties in this pervasive and frequently open information era. There is the need to be sure that access to information is open and accessible only to the right individuals at the right times. There is also the issue of interoperability, which is the capacity, or organisations and professions to trade, offer or incorporate data and business forms, crosswise over data frameworks or authoritative practice. When this is missing there is the tendency of failure of the diverse frameworks to connect adequately (Aranda-Mena and Wakefield, 2006; Eastman *et al.*, 2011). This practice can be overwhelming as a result of the degree of fracture, differing qualities in data prerequisites, inflexibility of data schemas (standards), requesting innovation competency necessities, and more extensive business goals, which anticipate merchants' compatibility in the improvement of programming and frameworks that interoperates (Doller and Hegedorn, 2008; Isikdag *et al.*, 2007).

Another major issue that has faced the adoption of digitalisation in most countries and industries around the world is the issue of fear and resistance. Dimick (2014) recognized these two forces as major barriers to the use of digital technologies. Some level of distrust in new technologies exists among organisations. Change is challenging for humans, and in most cases, organisations tend to fall victim to this challenge. This resistance cuts across every level of these organisations, from workers to executive decision-makers. Oladapo (2007) made a similar observation while assessing the challenges facing the implementation of digital innovations particularly among Quantity Surveyors in Nigeria.

Other factors have been observed to considerably affect the readiness towards adopting digital technology among construction organisations. These factors include; erratic power supply, high cost of

technologies, lack of management desire and appreciation of digital technologies, low return on investment, abuse of personnel, fear of technology, making professionals redundant, issues relating to the legal ramifications of electronic communications, organisational issues, and time constraint (Brewer *et al.*, 2005; Dimick, 2014; Oladapo, 2007; Oyediran and Akintola, 2011; Oyediran and Odusami, 2005; Rezugui *et al.*, 2004)

4. The Way Forward for the Adopting of Digitalisation in Construction Organisations

Dimick (2014) observed some ways through which organisations can improve their productivity and conveniently adopt digital technologies. Firstly, organisations should know their processes, and keep it simple. It is important to identify the processes involved in the organisations business and work assiduously to keep those processes as simple and straightforward as possible. By fully knowing the processes, it will be easier to assess at the outset the organisation's current and future needs in terms of digital technologies. The second step is a full commitment on the part of top management within the organisation. However, even though the total commitment throughout the organisation may be initially unachievable, the clear and visible commitment of key players from the outset is essential. Thirdly is the need to enlist the right set of people for the job. Getting project managers and workers that are digitally oriented will go a long way in promoting digital technology adoption within the firm. Next to this is having a defined end goal - a clear vision of what the adoption of digital technology will look like. Keeping this vision in mind helps in ensuring that it remains the priority of the organisation, and helps to avoid scope creep. Lastly, having clearly defined the organisation's business process, garnering management commitment, getting the right set of people and having a clear vision, it is important to plan the actual adoption process carefully and to stick to the plan (*ibid.*).

Aside from the above means of encouraging digitalisation, Becerik (2004) observed the need for intensive staff training on digital technologies. Software vendors at their training facilities with a view towards teaching users the required skills needed for these digital tools can organize these training. Management of construction organisations can, therefore, take advantage of these training to groom their staffs in the use of needed digital tools. Mutesi (2009) also submitted that the creation of soft loans from the Government for technological development could also help encourage these construction organisations in the aspect of adopting digital technology. This will reduce the financial burden associated with the acquiring, maintaining and training of staffs. Kundishora (2006) have also noted that measures such as loans from the government, adequate power supply, lowering cost of digital tools such as computers, ensuring that every department develops and manages a computerized information system, promote awareness in the use of technology, and promote local research and development, are important if the adoption of digital technology is to improve.

5. Conclusion

Based on the review of existing literature, this study concludes that whilst construction organisations operate in a stiff competitive environment and are encumbered with the task of achieving client satisfaction, there is a safe haven in digitalisation for them. Digitalisation can serve as a strategic competitive tool for these organisations to gain better clients confidence and satisfaction, through improved service delivery right from the inception to completion of construction projects. Through the adoption of digital technologies in service delivery, construction organisations can differentiate themselves from their competitors as digitalisation is believed to lead to a much better construction process, reduction of errors in design and construction which mostly lead to increase in cost and time, and better overall project delivery. However, while this strategic opportunity exists, issues surrounding technical expertise needed, finances surrounding the acquiring, maintaining and training of digital technologies, security, interoperability, and fear and resistance, play major roles in the poor digitalisation experienced in most construction organisations.

It is obvious that construction organisations stand a lot to gain by adopting digitalisation in their everyday activities. Therefore, this study recommends the adoption of digitalisation as a competitive strategy for construction organisations in developing countries like South Africa. The government can also help these organisations in the adoption of digitalisation through the provision of loans that will help lessen the financial burden of acquiring digital technologies. Although this study is part of a much larger on-going study, it has been able to contribute to the body of knowledge as it brings to light the possibility of construction organisations achieving a competitive edge through the adoption of digitalisation. It also shows the challenges that hinder digitalisation and the measures for improving its

adoption. By so doing management of construction organisations can know what to avoid and what to employ in the quest of achieving a competitive advantage within the obviously competitive construction industry.

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Embedding Industry 4.0 strategies within the UK Construction Industry

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Abstract

The construction industry is at an evolutionary period, the new generation of the construction industry - Industry 4.0 is expected to boost quality, improve productivity and efficiency. This paper explores the IOT systems introduced and how they can better future opportunities. Industry 4.0 has been introduced in the UK as a term which describes the construction industry moving onto a digital and automated environment. The main objective of this paper is to explore the practice of industry 4.0 relating technologies within the construction industry by highlighting the potential benefits that are gained in the social, environmental, technological and economical aspects. A triangular approach was adopted in this research starting with an in-depth literature review and case study research. The triangular approach works well with this research paper as it enables more than one method to be adopted to gather information, providing a more in-depth research outcome and a wider understanding of the affect of Industry 4.0 within the UK construction industry. The mixed method combines the collection of Qualitative data and results also explored through case studies. The PRESTEL framework was adopted which the different elements mentioned above are taken into consideration. Finally, the paper provides future recommendations for further research within this topic.

Keywords: Industry 4.0, IOT, Drones, BIM, Robotics, Virtual Reality, Augmented Reality.

1. Introduction

In this generation we hear a fair lot about smart cities, smart motorway, smart production and so on, these ideas all rooted from industry 4.0 following the trend that is digitalisation and increasing the use of ICT within the manufacturing environment. Industry 4.0 contains a wide range of technologies that can aid in the roll out of the digitalisation and automation of the construction industry. This new era of the digital world is expected to improve quality and decrease time while saving costs and improving performance (Marr, 2018). With all these benefits, most of the construction infrastructure sector have yet to fully manage and integrate these technologies to keep up with other sectors such as automotive and mechanical who are advanced with innovative technologies (Marr, 2018).

Industry 4.0 is still at its early stages when it comes to the construction infrastructure sector (Barrow, 2018), over the past twenty years, there have been numerous technologies such as the Building Information Model (BIM) which has been adopted by most construction companies in charge of public sector projects, BIM has given the different disciplines in organisations a different outlook on how to improve construction at all stages (Barrow, 2018). Based on a survey in 2017, 67% of UK manufactures are aware that Industry 4.0 can provide benefits and opportunities, however only 25% feel that they understand these opportunities (Maciver, 2017), judging by the results there is a need for more research to be conducted on industry 4.0, in this context, the following research questions surfaced:

- What are the current technologies linked with Industry 4.0?
- What is the current state of these technologies and is the construction industry aware of their existence?
- Which technologies have been adopted by organisations in the construction industry?
- What is the future of innovative technology for the construction industry?

2. The Current Technologies linked with Industry 4.0

The industrial production is being transformed by technologies, and these digital technologies are being currently used in manufacturing and if fully adopted by the construction sector can lead to better efficiency and enhance relationships between all disciplines in an organisation (Boston Consulting Group, 2018). There are nine main technology trends which are included in Industry 4.0 transforming our industrial production:



Figure 1: Technologies transforming industrial production

Source: Forbes (Marr, What is Industry 4.0? Here's A Super Easy Explanation For Anyone, 2018)

Big Data Analysis

In the construction industry, data is a crucial aspect as when the project is completed, asset management goes on and the more data collected in the construction stage the more the asset can be maintained in an efficient manner. With Industry 4.0, the technologies produced are equipped and with the use of a successful IoT (Internet of Things), data accumulation and analysis obtained from technologies can enhance cross-system interoperability (Loshin, 2018).

Autonomous Robots

Autonomous robots were introduced into the technologies and eventually robots will start interacting with each other and collaborate safely with humans working alongside each other. Robots would cost less as labour costs will reduce and the robots would hold a greater range of skills and abilities (Boston Consulting Group, 2018).

Simulation

With 3D modelling and BIM, simulations are being used more in the construction infrastructure sector. Creating these simulations allow real-time data to mirror the virtual model created which can also include machinery and humans. With machine simulations, operatives can test products virtually before the machinery is physically changed enabling less machine set up time and increasing quality (Boston Consulting Group, 2018). Simulations in the form of 4D sequencing is also a useful tool as site teams can visualise the planners programme and understand the scope of works.

Horizontal and vertical system integration

Implementing Industry 4.0 allows companies, departments and functions to become unified. Data integration networks then can evolve, and value chains can become fully automated.

The Industrial IoT

The concept of Industry 4.0 is based on more devices being enhanced, this will then allow field devices to link and interact with each other. This aspect will allow real-time responses and decisions to be made.

Cybersecurity

With the change to Industry 4.0, communications and sensitive information are to be stored in a database to increase connectivity. Due to all documents being in a database, security of machines and software is critical.

The Cloud

Data sharing is a necessity when it comes to the construction industry as there are different disciplines in one organisation. Sharing data through means of emails, usb's etc can be a risky one as the information shared may not be up to date or information can be lost in transition. Industry 4.0 is to improve the performance of cloud technologies and data can be shared in milliseconds and with a cloud database, unlimited storage space for information can be possible.

Additive manufacturing

Additive manufacturing such as 3D printing is only at its prime stages, companies mainly use these to create prototypes of works creating the individual items. In the future, Industry 4.0 allows additive-manufacturing to be implemented and used widely to manufacture construction products such as lightweight designs which are complex (Boston Consulting Group, 2018).

Augmented Reality

Augmented reality is an interactive experience where real life world is generated by a computer, currently, augmented reality has taken over the gaming industry and within the construction industry it is in its infancy however in the future a wider use of augmented reality will provide the construction industry with real time information and improve the decision making within planning periods (Chandler, 2018).

3. The Current State of these technologies and its perception in the the construction industry

Over the past couple of years construction companies are becoming more aware of the upcoming recession and how projects need better construction project management due to a variety of investments that have been made within the industry (Imrie, 2014). There are eight main trends in the construction industry this year which the construction industry is aware of, some of these technologies are currently at their prime however they are known within the industry.

Building Information Model

The Building Information Model takes on the most vital part of a construction project which is Collaboration. BIM includes many Maturity levels which determine the level of collaboration adopted. So far BIM has been implemented by a lot of contractors in the industry and with the Level 2 mandate the UK has started the ball rolling towards the BIM direction (Shaneel, 2017).

According to the National BIM Report 2018 74% of the respondents are aware and using BIM, 25% are just aware and 1% are unaware (NBS, 2018). Based on these results, BIM is at a good state when it comes to the construction industry as 78% of the respondents also believe that BIM is the future of project information (NBS, 2018).

Project Management Software

The potential of project management software's is being realised in the construction industry. The benefits the software provides, produce the construction industry with three main advantages: Efficiency, Transparency and Accountability. The software's available are all about providing real-time communication which is trackable and able to integrate with other different software's.

In the project management institute report back in 2016, it was noted that 95% of project data is thrown away and not collected (PMI's pulse of the Profession, 2016). Data is a key aspect within the construction industry especially during Asset management, construction managers are witnessing major benefits with project management software's and in the year 2018 we see a high usage of this (Shaneel, 2017).

VR and AR

As previously mentioned, augmented reality is an interactive real-life experience, Virtual reality was originally created to be used for video games and as it developed, its potential in other areas became increasingly clear (Bennet, 2018). In the construction industry, Virtual reality is a more common tool rather than augmented reality, Virtual Reality is mostly in cooperated with BIM, using the 3D models and 4D sequences and safety training to sell and pitch construction plans and ideas to clients. Using VR for safety training prepares workers to operate the required machinery prior to going on site through simulation enhancing collaboration and communication.

VR is becoming quite trendy in the construction industry and most, if not all, organisations are aware of its existence, it is assumed that there will be approximately a \$90B increase in the global AR market within the next two years (Shaneel, 2017).

Robotics

When it comes to the construction industry, the use of robotics is still in its infancy stage, robotics can potentially replace humans and provide a faster service with lower costs. Robotics such as self-driven machinery can enhance the construction process proving to be very innovative (Shaneel, 2017).

It is estimated that in the next four years, there will be a 1.8 x increase within the industrial robot's shipment (Shaneel, 2017).

Drones

Drones have already started changing the construction industry, from land surveying to transportation and inspections, the use of drones highlights various benefits such as eliminating a variety of dangers and safety hazards (Burger, 2018).

Currently drones are being widely used in the construction industry for advantages such as gathering data from the site and recording changes of the project which can be reported to the client. Drones accomplish this by collecting data and footage of the project and being to compare this data in between two-time frames. According to the Jdsupra, over the next 10 years, the market value of drones will see a vast increase from \$2 billion to up to \$10 billion (JDSUPRA, 2017).

Modular Construction

Modular construction is described as prefabricated elements within the construction which are made off-site and are then transported to the desired site pre-made with high quality (Shaneel, 2017). This allows for the construction to be at least 65 times faster.

Most UK construction companies use modular constructions for structural items such as modular block retaining walls in the infrastructure highways sector, with the roads still being used as they work on it, having a pre-constructed structure is a lot easier to place rather than closing the road to construct these structures on site, this moves at least 80% of the work off-site and reduces noise pollution and general disruption on site (Shaneel, 2017).

Green Construction

The construction industry has seen some major changes striving for green construction. Managers and contractors are now thinking of the future and aim to reduce waste and the use of resources for future healthier living and less damaging impact on the planet.

The current trend within the industry is for businesses to change their business model to achieve the relevant certification to be documented as green.

Improved labour

With the idea of robotics and all other technology, the idea that there will be a shortage of jobs in the construction industry has to be thought of. Many would think that if technology can do all these jobs being done by humans then where do we stand? This is not the case, with more technologies there will be openings for a lot more jobs, the construction industry will need knowledge workers and people who obtain skills to operate and maintain the technologies which have been mentioned above (Shaneel, 2017).

4. Methodology

This study comprises of a mixed method approach, identifying how the use of the Building Information Model improves collaboration and coordination in the construction industry. Case studies were observed at and semi structured interviews were also conducted.

Semi-structured interview is a qualitative method that is a combination of pre-determined set of questions which the interviewee is given the opportunity to explore a variety of responses.

Qualitative research is mainly described as an empirical research. This form of research is utilised to obtain knowledge and understanding of primary reason, opinions and motivations (Wyse, 2011). This form of research provides an awareness of the issue or assists in providing ideas for the quantitative research. Qualitative research is a method of uncovering opinions and providing a deeper insight within the problem. This method of research is obtained using unstructured or semi-structures practises which mainly include focus groups, individual interviews where the respondents are selected to fulfil a provided part (Wyse, 2011).

Interviews

An idea of an interview guide was obtained through the study of the literature. interviews were targeted at experts in the Construction Industry that have been in the industry long enough to have an idea of the current Industry 4.0 Technologies that are currently being used.

The interviews were undertaken through phone interviews and face to face depending on the location of the interviewees.

5. Results

5.1 Case Studies

Organisations throughout the UK have adopted different types of technologies, however there are a few main ones. This part of the research involves a case study on an organisation in the UK, the technologies adopted and how they are benefiting from them will be explored. The connection between these technologies and Industry 4.0 will also be expanded on.

This case study is based on a Tier 1 contractor in the UK, the organisation does a wide range of work around the UK such as building houses, infrastructure construction, Highways, rail, etc. with BIM being mandated in the UK, the company are utilising BIM, and this has also pushed them to expand on other different technologies present. This case study reflects the whole organisations business across the UK.

Table 1 Indicates the domains each case study deals with

Domain	V1	V2	V3	V4
Infrastructure	•			
Highways		•	•	
Rail				•

5.2 V1: Infrastructure Project

Interviewees: BIM Manager, BIM Coordinators, CAD Technician

Three interviews were undertaken for this project.

This project was initially appointed back in 2012, the contractors are working to create a revised and expanded works remit and construct a new nuclear power station. The works includes substantial excavation up to 5.5 million cubic meters of material, a large scale of earthworks with complex structures and creation of a road network. This project uses a range of technologies within their works to improve collaboration and provide an efficient and cost saving project.

The new process which is a breakthrough into the industry, the Building Information Model is widely used on this project. Numerous 4D sequences were produce with the programme detailing the works and sequence of works with the operational team and clients to show progress of works.

The Building Information Model and 5D project planning software were in-cooperated allowing the project's cost and potential schedule to be included within the traditional 3D model of the project site, these procedures helped to promote collaboration throughout the construction stages so far and are intended to assist within the post construction stage with all data being in BIM.

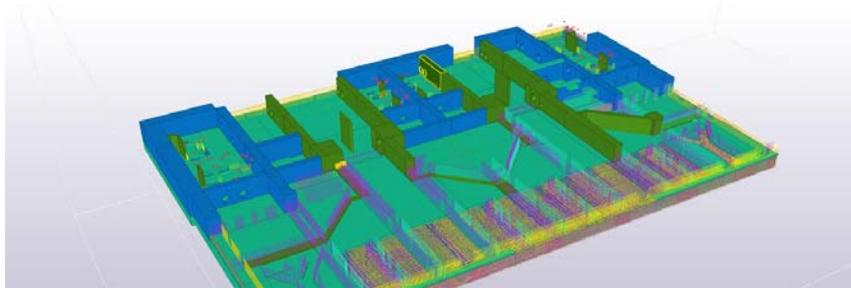


Figure 2: Designers 3D model of Proposed works

Source: Tekla, 2018

5.3 V2 – Highways Project 1

Interviewees: BIM Manager, CAD Technician, Design Manager, visual software owner PM, BIM coordinators

Five interviews were taken for this project

A smart motorway scheme located in the west midlands in the UK, construction began in March 2018 and involves a regular 3 lane motorway with a hard shoulder being converted into an all lane running motorway with technology built into it to help with congestion.

Technologies in the construction industry are mostly thought of to assist during construction and post construction in terms of data, however this Smart Motorway Project utilises the technology along with the asset post construction to run the asset.

While this project is at its construction stage, the IOT systems which have been used so far are BIM and drones. Drones were used to survey a point cloud of the whole project allowing a 3D point survey of the existing assets to be available, this was then used to overlay with the Building Information Model which was created by the designers to compare existing and proposed design.



Figure 3: Point cloud Survey with the use of Drones



Figure 4: Point Cloud Survey overlaid with proposed manhole design

Post construction, the smart motorway uses technologies such as CCTV, radar detectors, speed cameras, variable speed limits and detector loops in the ground to run the smart motorway process, these all work together to ensure the flow of traffic and improve safety.

5.4 V3 – Highways Project 2

Interviewees: BIM Coordinator, Project Director, Sub-Agent, Engineers

This project uses the Building Information Model as one of its technologies, the project also uses GPS for setting out on site. Technologies such as Trimble are used with coordinates to set out the road layout and other aspects for the operational team to construct.

On this project, Modular Block retaining walls are also used, as mentioned previously, Modular blocks are constructed off-site and then transported to the site already built to precision and ready to be put in place. The Building Information Model is used for quality inspections in the form of iPads being connected

via an App to the common data environment, this shows that technologies as simple as an iPad which are an everyday item for most people can be used in a wider range to store data and, being efficient and very useful for the construction industry.

5.5 V4 – Rail Project

Interviewees: Engineers, BIM Coordinator, CAD technician, Design manager, BIM Manager

The HS2 is a high-speed railway which is under construction in the UK, this will be the second high-speed railway in England, the high-speed railway is set to travel up to 400km/h and will connect London to the East Midlands, Leeds and Manchester.

The High-speed 2 railway is a massive project which the government have invested in, and with this being a huge investment, it is necessary to invest in technologies to ensure the project goes in the right direction. The designers of this project use photo realism, Virtual reality, augmented reality and aural representation to bring life to the route of the railway line enhancing the experience and impacting the planning and consultation process. The creation of the digital version of this so to be real railway line assisted in the decision making of the project teams as it involves major works.

In addition to all these technologies, the Building Information Model is also being utilised, similar to the previous project case studies, BIM is being used for project enhancements such as 4D planning, clash detection and visualisation.

The project has had many members of the public against it, however with the media being provided with the footage it enabled the public to get an understanding of the project and what it will look like once finished, given the opportunity to see the future enable all parties involved within the construction and design process to make better decisions at all stages of the project to date.

Table 2: Technologies used in the four case studies

Technology used	V1	V2	V3	V4
3D CAD	•	•	•	•
Cloud-based website	•	•	•	•
Drones	•	•		
Virtual Reality				•
IFC (Industry Foundation Class)		•	•	

Based on the Case study results, most of the UK construction companies have adopted a few Industry 4.0 technologies. All the construction companies that the case studies were based on have adopted the use of 3D CAD and a cloud-based website, the reasoning behind this is that the Building Information Model Level 2 was mandated by the UK government in April 2016, which involves a 3D model of the asset as well as a Common Data Environment (CDE). The technologies used within these four projects are similar with only three technologies that are not unanimous within the projects. This demonstrates that Industry 4.0 technologies are being implemented within the UK construction industry.

Technologies in the construction industry are still at their infancy's, Technologies such as BIM, GPS and Modular block are mostly common now and are being used widely in the UK especially BIM as it has been mandated in the UK as of 2016 for all public-sector projects.

Other technologies such as VR and AR and Robotics are still at their prime stages, AR and VR are trailed on some projects in the UK however they are not very much used yet. The construction industry is very aware of all these technologies and how innovation can better the industry, it is no secret that the construction industry can be slow when it comes to change, however the need for change has increased as productivity within the industry needs to be improved especially with massive investments made by the government through many different sectors of the construction industry. Organisations in the UK are under pressure to become innovative and complete projects with efficient delivery as this enables them to save costs and time during construction and enables clients to become confident in their abilities.

6. Conclusion and future recommendations

The construction industry is currently in a new era, Industry 4.0 has been introduced which relates to utilising technologies in the construction industry to improve quality, save time and cost and improve construction practices.

There are many technologies which are involved with Industry 4.0, with the statistics shown, 67% of organisations in the UK are aware of Industry 4.0 and several companies in the UK have already adopted some of the technologies. These technologies include virtual reality, augmented reality, BIM, just to name a few. Based on the findings from the research, most projects have adopted a variety of technology, mainly BIM as it has been mandated in the UK. Other technologies such as Virtual Reality is being used for benefits such as allowing companies to demonstrate the future final product to the public and improve decision making within the project teams.

Most of the technologies included in Industry 4.0 are still at their infancies and for the future would recommend more research to be carried out on these technologies, this will enable the construction industry to understand the benefits that can be gained from these technologies and with the industry being known for resisting change, demonstrating these benefits can be the start of the construction industry embracing the change.

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BIM for Facilities Management on a Blockchain Platform

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Abstract

Following the Smart City initiative, UAE announced that Blockchain (BC) is the platform that will be employed by Government departments, and all sectors have to comply. This study aims to investigate implementing Building Information Modelling (BIM) for Facilities management (FM) on (BC). The review could not identify any previous study that combined BIM, FM and BC. A mixed method approach embraced a survey of 300 individuals from the various stakeholders' categories. The questionnaire included a list of 16 challenges and 20 enablers identified from the literature asked respondents to rank the importance of the listed factors. In addition, a set of 10 planned interviews sought to verify and explain the findings of the survey. The survey attracted 143 responses and 5 interviews were conducted. The survey data analysis utilised descriptive statistics and frequency analysis; followed by factor analysis. The findings indicated lack of awareness of the concept of blockchain amongst surveyed professionals. The factor analysis extracted two components for the challenges; Technical / Security and Resistance to Changes and three components for enablers; IT systems management; Change management and Security related factors.

Keywords: BIM – FM – Blockchain – Challenges - UAE

1. Introduction

Digital transformation has recently witnessed notable developments with the emerging disruptive technologies. Facilities management (FM) comprises a cluster of multidisciplinary activities which require extensive information storage and monitoring systems. Computer Aided Facilities Management (CAFM) systems address some of these needs, yet are not fully synchronised with the prevalent building information systems. On the other hand, Building Information Modelling (BIM) is defined as an approach for sustaining and applying a digital form of the project data throughout its lifecycle (Gu & London, 2010; Shen, et al., 2010; Miettinen & Paavola, 2014; Miettinen, et al., 2018). Implementing BIM would provide the FM practices with functionalities of visualization, analysis and control that other FM information systems would not (Becerik-Gerber, et al., 2012). Most recently, the UAE, has decided to stretch the application of disruptive technologies to the construction and facilities management domain. In Dubai, it has been decided to use blockchain as the platform across all sectors including facilities management.

The review of the literature could identify a few attempts linking BIM to facilities management but not on blockchain. This study aims to investigate the challenges and enablers associated with this new initiative in Dubai; applying BIM to FM on blockchain platform.

2. Literature Review

The objectives of this study guided the review of the relevant literature and focused on two theoretical frameworks; the FM theory with emphasis on the application of BIM to FM, and the Block chain theory in an applied context.

2.1 BIM for FM

BIM is a database technology that is capable of storing the visual, dimensional and physical aspects of a building thus offers the ability to track and store the attributes of the different components within a building, to facilitate the exchange of information between the different project teams during the project lifecycle. (IFMA, 2013; Wang, et al., 2018; Eastman, et al., 2011). Most FM information systems, require entering data manually into the CAFM system after hand-over of the building. This task has proved to be laborious, time consuming and inefficient. By implementing BIM, the initial data needed would be available upon request and enhances the overall FM function through its advance visualization and analysis capabilities. BIM within construction management research has attracted the attention of researchers and

professional communities in the past decade; developing from automated cost estimation, virtual prototyping and the sharing of information to focusing on using BIM for energy analysis, sustainable development and maintainability checking. (Becerik-Gerber, et al., 2012) (Eastman, et al., 2011)

However, BIM in the architectural, engineering and construction (AEC) industry has been more extensive than in the FM industry. The reliability of the data held is a vital aspect of facility management that may cause havoc, if it is not managed diligently. BIM for FM was claimed to offer facilities managers an accurate and efficient method of storing and retrieving information (IFMA, 2013). Developing models and tools for the handover process has become an important landmark in the development of using BIM for FM. In 2014, when BIM data were created and used in the facilities services of the University of Washington, USA, researchers believed that the idea of a single central BIM was a big step and may remain unrealised for the foreseeable future (Anderson, et al., 2012). Love et al., (2014) developed a framework for assessing the benefits of implementing BIM for FM based on a resource-based theory of an organisation whereby asset owners seek value from their investment in BIM. Yet measuring the value of an IT investment remains subject to considerable debate. The cornerstone of the proposed framework were governance, performance measurement, change management and stakeholder management (Love, et al., 2014). Miettinen et al., (2018) found that almost all large contractor firms in Finland used BIM for design and construction. The FM practitioners indicated the need for the further development and integration of the FM information systems. BIM was recognised as a potential future technology, however, they found it difficult to specify how BIM could enhance current practice. Awareness and knowledge have been highlighted as one of the biggest setbacks of BIM implementation in FM (Miettinen, et al., 2018). Knowledge and knowledge management is a critical resource for any construction and FM company as the built environment is a knowledge intensive industry (Ofek & Sarvary, 2002). BIM enhances knowledge management and facilitates data sharing and retrieval among stakeholders (Motawa & Almarshad, 2013; Motawa & Almarshad, 2015; Wang, et al., 2018). The capture of visual and numerical data can benefit the FM teams during the operations and maintenance stage. BIM can create customised parameters of data, thus enabling users to add and share knowledge related to specific building objects, and guides the FM team on operations and maintenance activities (Wang, et al., 2018). Previous studies extolled customised parameters within a BIM model whereby reliability, reduced redundancy of data, improved knowledge management, easier knowledge retrieval and more efficient knowledge sharing were highlighted as key advantages of using BIM. (Deshpande, et al., 2014)

2.2 Blockchain for FM

In general, technologies that impact organisations can be classified into either sustaining or disruptive technologies. Sustaining technologies aim at enhancing business offerings and improving delivered products, guided by present customer needs meanwhile predicting future needs based on market data analytics.

Disruptive technologies are innovations that may not attract interest at the start due to “fears” of exploring “new territories” and the challenges of entering a market that is unknown to large organisations at the time the technology was conceived (Christensen, 1997). Blockchain (BC), perhaps, the most popular topics in digital transformation trends could be considered both a disruptive technology and a sustaining technology as it has been around since 2008 yet the true potential has only been realised recently (Pazaitis, et al., 2017).

Blockchain emerged as the underlying technology behind “Bitcoin”, which is a cryptocurrency first introduced by Nakamoto in 2008 and was first released in 2009 as an open source platform that allowed the transacting of assets on a blockchain platform without the need for intermediaries (ØInes, 2016; Nakamoto, 2008). Since then, BC technology or the Distributed Ledger Technology (DLT) was realised a futuristic revelation by the financial industry. The conception of Ethereum in 2015 (which allows for building more complex and customised distributed applications) revolutionised the application of decentralised concepts on a BC platform and gave way to the emergence of “Smart Contracts” (Alharby & Van Moorsel, 2017; Kokina, et al., 2017). As widely agreed, the Blockchain technology is considered to be a transformation technology that will impact businesses and society in the near future; facilitating information and transaction exchange built on authentication and trust elements, for governments and organisations (Yli-Huumo, et al., 2016).

In the UAE, Smart Dubai Office launched The Dubai Blockchain initiative in 2017 as a part of the Dubai Blockchain vision 2020. This vision aims at making the Government of Dubai the first blockchain-powered government in the world by 2020 (Sutton, 2017). The federal government followed suit; announcing the

Emirates Blockchain Strategy 2021, which aims to make 50% of the federal government services available on blockchain platforms by 2021 (UAE Government, 2018).

In the UAE, many facilities managers complain about the sheer lack of information during project handover. Hence, it is normal practice that FM managers would carry out a condition survey and collect the data manually. Using a blockchain platform along with an information modelling software would resolve this issue by automating the transfer of data and, in the case of private blockchains, enable building owners to control access to the system thus would improve the decision making process (Muir, 2011; Xing & Marwala, 2008). The review of the literature could not identify academic research done on the concept of having a Blockchain based solution for BIM for FM, so far. Consequently, the challenges and enablers listed in the following section will be based on wider context of BIM and BC rather than the FM specific domain.

2.3 Challenges

Due to the scant literature covering BIM on BC for FM, it was resolved to review the challenges and enablers identified in the wider context of implementing BIM and BC. The list of challenges comprised the following factors: Absence of centralized regulatory body/system (Hendricks, 2016) (Ølnes, 2016); Blurred Reputation: based on bitcoin incidents and public perception (Ølnes & Jansen, 2017); Technical/Scalability challenges (Larios-Hernández, 2017); Privacy (particularly in dealing with confidential information) (Swan, 2015) (Nofer, et al., 2017); Resistance to change (Deshpande, et al., 2017); Lack of clarity in addition to the perceived immaturity of the technology (Deshpande, et al., 2017); Perceived Time lapse (time needed to adapt and implement) (Iansiti & Lakhani, 2017) (Boulos, et al., 2018); Cost verses benefit (profitability) (Yeoh, 2017); Challenges in the areas of quality control and accountability (Coyne & Onabolu, 2017); ICT infrastructure (storage, real time data transfer) (Ølnes, et al., 2017); Security (given the incidents that occurred on bitcoin) (Coyne & Onabolu, 2017); Lack of relevant skills (Salama, 2018); Tracking back ownership (for public systems) (Nofer, et al., 2017); Security against cyber-attacks for this digital infrastructure (Yeoh, 2017); Information and interaction constraints by centralised authorities (Yeoh, 2017).

2.4 Enablers

The enablers were aligned to a reasonable extent with the identified challenges and comprised the following factors; Data Availability and Enhanced Decision making process (Muir, 2011; Xing & Marwala, 2008); Economies of scale leading to reduced costs (Phadke, 2017); Need to enhance efficiency and productivity; Create a culture of trust and reliability within an organization (Skiba, 2017); Local governments commitment to digital transformation (Sutton, 2017); Need for adaptive leadership style, and a well-defined, clearly structured and purposively scheduled skills development programmes (Salama, 2018); Timely development of the ICT infrastructure (Reyna, et al., 2018); Enhanced awareness of the blockchain technology (Larios-Hernández, 2017); Consideration of private blockchain in cases of handling sensitive (confidential) information, Cooperation across industries and Lesser need for relying on third parties (Nofer, et al., 2017) & (Alharby & Van Moorsel, 2017); Timely development of relevant regulations with clear policies, guidelines and procedures; Need for secure exchange of information; Decreased vulnerability to cyber-attacks and Elimination/reduction of unauthorized fraudulent changes (Mizrahi, 2016)&(Yeoh, 2017); Effective time schedule for the transition (Iansiti & Lakhani, 2017); Need to address inefficiencies in current systems & enhance the effectiveness of service delivery (Atzori, 2017). The aforementioned challenges and enablers were utilised in constructing the survey questionnaire as discussed in the following section.

3. Methodology

The set objectives of the study suggested that a deductive approach to verify and rank the list of challenges and enablers identified from the literature. However, it was resolved to follow a mixed methods approach whereby the survey would be followed by a set of interviews with experts to validate and further explicate the findings of the survey data analysis (Creswell, 2009). The survey used a questionnaire that was constructed based on the list of challenges and factors that concluded the findings of the literature review. In total, there were 16 factors listed as challenges and 20 factors listed as enablers (see tables 1 and 2). The questionnaire was divided into five sections; section one included profile information about the qualifications; profession; Familiarity/experience with BIM and familiarity/experience with the blockchain technology. Section two asked participants to rank the challenges identified from the literature according

to the importance (severity) on a scale of 0-10 where 5 indicated “do not know/can’t decide” as a neutral point and 0 indicated very low importance whereas 10 indicated a very critical challenge (Carifio & Perla, 2007). Section three asked participant to rank the enablers identified from the literature using the same scale as the case in section two. A random sampling approach was used to send the questionnaire to a mailing list of 300 professionals; IT specialists and project/facilities. The survey attracted 143 responses; i.e. a response rate of 47.7% (> 40%). The interviews utilised a purposive sampling approach and aimed at investigating the views of experts in facilities management with knowledge about IT, in UAE. The interviews were mainly seeking to validate and explicate the findings of the survey.

4. Data Analysis and Discussion of Findings

The survey data collected from random sample of 300 practitioners in the field of construction and facilities management that attracted 142 responses were tabulated and scores for each question were examined. Notably, the data analysis identified the high frequency of the neutral score that is 5 which refers to the “cannot decide” category for both challenges and enablers factors listed in the questionnaire. The frequency for score 5 for the 16 challenges ranged from 61-72 out of the 142 responses, and the range for the 20 enablers was 55- 74. This gave rise to the need for data cleaning to examine the data set without the influence of the score 5 that can skew the mean score or at the least will affect the dispersion of the data; the mean will appear more clustered around the neutral score (5). Following the treatment of the data (filtering out score 5), the mean scores for each of the challenges and enablers were calculated based on the received scores for each factor, excluding score 5. The means for the challenges and the enablers are shown in tables 1 and 2 respectively.

4.1 Discussion of the findings of the survey statistical data analysis

The most compelling finding of the statistical analysis is the apparent lack of awareness emphasized in the high frequency of score 5 “cannot decide” category. This has been in line the ranking of the Challenges C8 which attracted relatively high score 7.09 as well as the Enablers where E9 is ranked amongst the top 5 most important with a high mean score of 7.39 as shown in table 1. This is a critical factor that needs attention from various stakeholders (Larios-Hernández, 2017)

Challenges facing the implementation of BIM on BC in FM

The ranking of the challenges indicated that the top five challenges are C9, C2, C10, C16 and C15, respectively as shown in table 1. These refer to the cost benefit ratio, the security, quality control issues and authorities role in setting constraints on information and interaction. It is notable that security was featured twice amongst the top five challenges. It is imperative that without clear benefit from moving to BIM on BC in FM, it will be hard to drive the change (Yeoh, 2017). The security factor is a major issue with the technology due to the exposure to cyber risks that can jeopardize organizational confidential data (Hendricks, 2016) (Yeoh, 2017).

Table 1 Ranking the surveyed challenges

SR	Challenge	Mean
C9	Cost verses benefit (profitability)	7.390
C12	Security (given the incidents that occurred on bitcoin)	7.370
C10	challenges in the areas of quality control and accountability	7.256
C16	Information and interaction constraints by centralized authorizes	7.173
C15	Security against cyber-attacks for this digital infrastructure	7.171
C11	ICT infrastructure (storage, real time data transfer)	7.105
C8	Lack of awareness leading to lack of acceptance	7.091
C5	Resistance to change	6.959
C6	Lack of clarity in addition to the perceived immaturity of the technology	6.844
C4	Privacy (particularly in dealing with confidential information)	6.833
C3	Technical/Scalability challenges	6.756
C7	Perceived Time lapse (time needed to adapt and implement)	6.659
C13	Lack of relevant skills	6.654
C14	Tracking back ownership (for public systems)	6.620
C1	Absence of centralized regulatory body/system (Government Challenges)	5.937
C2	Blurred Reputation (based on bitcoin incidents) (public perception)	5.803

The role of local authority is vital in driving and managing this shift (Yeoh, 2017; De Filippi, 2014; Hendricks, 2016 & Ølnes, 2016). This poses a crucial challenge in the case when local authorities are either too authoritarian with very strict rules, regulations and control measures as well as when too lenient and not engaging. The balance is essential but the imposed measures need to be structured, informed, practical and sustainable. C1 that reflects on the absence of local authority being amongst the least critical challenges is a positive indication that reflects confidence in the local authorities to play their anticipated role as perceived by the surveyed sample. C7 and C14 that reflect on the time needed to adapt and the lack of skills respectively also reflect a positive sign resting among the least critical challenges despite being relatively important with mean scores 6.67. This reflects the Dubai and UAE context characterized by being used to change and on many occasions fast moving ones. The least important challenge was the impact of the bitcoin reputation on the shift to BIM on BC in FM. This is good news given the emblematic stereotype; impersonating bitcoin as BC when there is a conceptual and contextual difference. The middle range of importance (based on the mean score) challenges are indicative of the significance of other key issues including IT infrastructure, resistance to change (Deshpande, et al., 2017; Boulos, et al., 2018 & Iansiti & Lakhani, 2017) and technical/scalability challenges.

The Enablers of implementing BIM on BC in FM

The ranking of the enablers based on the mean score reflected less dispersion compared to the challenges which indicated that the surveyed factors are all important and significant enablers to facilitate the pursuit shift. The top five ranks resonated well with the most important challenges. E4; the need to enhance efficiency and productivity links to the cost benefit ratio (C9) as shown in table 2.

The same for E17. E1 and E6; data availability and government commitment to digital transformation are in line with well C16 that is authorities role in setting constraints on information and interaction. This confers confidence in the data set from consistency perspective. In other words, the surveyed sample is not providing mixed messages. Furthermore, the consistency between the ranking of challenges and enablers helped in providing recommendations towards addressing the identified challenges, in general. For example, the cost benefit challenge can be addressed via enhanced efficiency and productivity (E4); economies of scale leading to reduced costs (E3) and better resource utilization and sustainability (E14) (Coyné & Onabolu, 2017 and De Filippi & Loveluck, 2016).

Table 2 Ranking the Enablers

SR	Enabler	Mean
E4	Need to enhance efficiency and productivity	7.610
E6	Local governments commitment to digital transformation initiatives (Dubai smart plan 2021 and Abu Dubai 5-year smart plan	7.506
E1	Data Availability	7.476
E17	Need to address inefficiencies in current systems & enhance the effectiveness of service delivery	7.425
E9	Enhanced awareness of the blockchain technology	7.385
E18	Need for secure exchange of information	7.325
E7	Need for adaptive leadership style	7.301
E5	Need to create a culture of trust and reliability within an organization	7.288
E2	Enhanced Decision making process	7.284
E20	Elimination/reduction of unauthorized fraudulent changes	7.231
E14	Better resource utilization and sustainability	7.221
E12	Well defined, clearly structured and purposively scheduled skills development programmes	7.165
E3	Economies of scale when widely applied leading to reduced costs	7.152
E19	Decreased vulnerability to cyber-attacks	7.147
E8	Timely development of the ICT infrastructure	7.132
E11	Timely development of relevant regulations with clear policies, guidelines and procedures	7.107
E13	Effective time schedule for the transition	7.084
E15	Cooperation across industries	7.039
E16	Lesser need for relying on third parties	6.942
E10	Consideration of private blockchain in cases of handling sensitive (confidential) information	6.806

4.2 Factor Analysis for the Survey Data

Due to the relatively high number of factors on each of the challenges and enablers list, it was resolved to explore the possibility to reduce the data into meaningful factors. The KMO and Bartlett's Test indicated the appropriateness of the technique with values > 0.8 (Hair, et al., 2010). Tables 3 presents the output of the factor analysis using principal component method and varimax technique for the rotation of axes to ensure orthogonal factors.

Discussion of findings of the factor Analysis

Component 1 is loading on (E13) time for transition, (E12) Skills development, (E11) regulations, (E7) leadership and (E5) culture and (E14) utilisation of resources. This component reflects the aspects of Change Management (Brodsack, 2016; Skiba, 2017; Iansiti & Lakhani, 2017 and Salama, 2018). Component 2 is loading on (E3) economies of scale implementing BIM on BC, (E6) commitment of local authorities to digital transformation, (E1) Data availability and (E2) enhancing the decision-making process applied to implementing BIM on BC. This component is inclined towards the IT related factors (Fairfield, 2014; Phadke, 2017 and Sutton, 2018). The third component loads on (E19) Cyber security, (E10) private BC for sensitive data, (E20) elimination/reduction of fraudulent changes. This component reflects on security (Heires, 2016 & Yeoh, 2017). The findings of the factor analysis were congruent with the findings of the statistical analysis and provided meaningful reduction of the data into two factors for the challenges (Technical/Security & Resistance to Change) and three principal factors for the enablers (Managing IT systems; Change Management & Security).

Table 3 Principal Components for Challenges and Enablers

Principal Components				
Challenges		Enablers		
Technical/ Security	Resistance to Change	IT System Management	Change Management	Security
C1	C3	E7	E1	E10
C2	C5	E11	E2	E15
C4	C6	E12	E3	E19
C7	C8	E13	E4	E20
C11	C9	E14	E5	
C12	C10	E17	E6	
C14	C13	E18	E8	
C15			E9	
C16			E16	

Discussion of the findings of the Interviews

In general, the interviews validated and confirmed the findings of the statistical analysis of the survey data. Furthermore, it was noted that once the cost benefit ration obstacle is overcome, then this change can be of great potential and add significant value. Besides facilitating transparency and smooth decision making, the use of BIM on BC can help integrate both phases of the building life cycle, the construction phase and the operations (use) phase. Experts indicated that poor arrangements between the project management team and FM team during the handover phase limits the benefits of the current use of BIM. Hence, the use of BIM on BC for FM will benefit both the construction management team as well as the FM team. In addition, the implementation of BIM on BC in FM will impose continual update of data which is crucial for the effectiveness of BIM. Thus will improve the practice further.

5. Conclusions

There is a clear lack of awareness about the BC, in general, among FM managers. The cost barrier was highlighted as an obstacle for implementing BIM in FM, in small organisations. The most critical challenges were; the cost benefit ratio; the security; quality control issues and authorities’ role in setting constraints on information and interaction. The factor analysis helped in grouping these challenges into two main groups; **Resistance to Change** challenges and **Technical/ Security** challenges. The most critical enablers were: the need to enhance efficiency and productivity; data availability and government commitment to digital transformation. However, the scores for the enablers indicated that all identified enablers were significant and crucial. The three main components identified by the factor analysis for the enablers were: **IT Systems management; Change Management** and **Security**. Furthermore, the identified enablers served as sensible recommendations towards addressing the identified challenges, in general. In addition, the implementation of BIM on BC in will impose the need to continually update the data in FM which is currently lacking thus will improve the practice further. This study provides useful insight for both academics and practitioners due to the scant literature on this topic meanwhile there is urgent emerging pressures on the industry (FM) to cope with the digital transformation and disruptive technologies, amid current and future mandates that governments impose as part of the Smart City initiative, in the context of the sustainable development agenda.

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Section 6
Project and Knowledge Management

Achieving Success in Construction Projects: Is it influenced by Project Management Techniques

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Abstract

It is widely agreed that project management tools and techniques impact on the success and failure of construction projects. There is however little known about how project management success can influence the success of projects. Project management practices failed to deliver successful projects consistently. Furthermore, there is a need to decode the role of successfully applied project management methodologies on project success. This paper aims to demonstrate the current status of project management tools and techniques and the influence of their applications on successful elements of projects.

Data from 142 project managers from ten nations were collected and analysed. A thorough review of literature shows that the theoretical cornerstones are not yet fully agreed upon in project management methodologies and practices. The micro and macro perspectives of project success were discussed. Many different factors, outside the control of project management that may influence project success were researched.

The findings of the study indicate that the majority of successful construction projects implement, but do not fully utilize the capabilities of project management tools and techniques available for use. The influence of project management tools and techniques on project success depends on practitioners' training, the timing and level of implementation achieved, whereas the human factor plays an essential part for achieving project success. The study concludes that project management success is an essential ingredient for achieving construction project success, therefore, positively influencing project success.

Keywords: Project management, Project success, tools and techniques, success factors and criteria

1. Introduction to Project Management

A project has certain characteristics as compared to routine operational task (Turner, 2001). A project has a beginning and end when its stated objectives have been achieved or the project is no longer feasible (PMI 2004, BS6079-1:2010). A project is temporary and its objectives are achieved through a series of planned activities and tasks (Munns and Bjeirmi 1996). Project tasks, however, require the right level of planning that can be of challenge to project teams, in comparison with routine work (Turner and Müller 2003). It is important to note that construction projects can have repetitive elements or deliverables, no two projects are the same and perhaps some may argue that projects fail because project managers use the same tools and techniques to achieve them (Shenhar, 2001).

Koskela and Howell (2002) argue that as of yet, there is no measurable value added by implementing best practices of project management based on the notion that contemporary concept of project management lacks theoretical foundation and is based on a narrow and implicit theory that requires further development and enrichment. Traditional project management, however, causes self-inflicted problems impacting project performance negatively or worse, causing projects to fail (Koskela and Howell 2002). Recent studies point towards the lack of clear definitions of project management and project success (Shenhar and Wideman 2000).

Scholars, researchers and practitioners are yet to agree on the extent to which project management may influence project success. Project management techniques aim to complete projects on time, within budget and to agreed specifications by the client (Koskela and Howell 2002). Despite the fact that project objectives may look straightforward and achievable, projects continue to fail to score high on achieving the set objectives (Hyväri 2006).

Projects have been realised since ancient times going back to the pyramids in Egypt featuring project justification

and project charter (Kozak-Holland 2010). In 1912, the Swiss Engineer Hermann Schuerch, developed and successfully utilized the bar chart as a scheduling tool on a bridge project, approximately 4 years earlier than Henry Gantt who developed the commonly used bar chart, in 1916 (Weaver 2006). Project management methodologies can apply to all projects (PMI 2008). They need to be adapted to individual project objectives, in order to achieve consistent project management success.

2. *Project Success*

To implement project management practices is to achieve success in projects consistently. Belassi and Tukel (1996) discussed how the experience of the project manager influences the success of projects, whereas the traditional definitions, the iron triangle, combined with cost, time and quality to the commonly accepted yardstick for measuring project success (Atkinson 1999). Munns and Bjeirmi (1996) highlight the role project management has in achieving project success, and that several other factors beyond the control of project management, also affect project success. Some researchers argue that project management does not have direct control over cost, time, and quality and that the traditional measurement criteria for successful projects may be quite misleading (Peters and Horner 1997, Dvir *et al.* 2006). Furthermore, there are situations where all success criteria are met as planned but the project did not meet the satisfaction and requirement of client. Based on that Baccarini (1999) concludes that only the combination of project management success with product success will create project success. Project success is typically seen as a single measure, the project is either a success or fail (Kam and Müller 2005). They further argue that if the end product of the project does not perform to customer satisfaction, despite fulfilling the succeed criteria of time, cost and quality constraints, the project could still be seen as a failure. Lim and Mohamed (1999) introduced the macro and micro perspective of project success. The micro view looks at and assesses success in project management at the completion of a project whereas the macro perspective measures success following the operational stage of the project and client satisfaction at long term. De Wit (1988) measures project success against the overall objectives of the project following its completion.

Others highlight that measuring project success should be done from the perspectives of various stakeholders involved in the project including: the individual owner, developer, contractor, end-user as well as the general public (Lim and Mohamed 1999; Freeman and Beale 1992). It is generally agreed that different projects may have unique factors for success (Dvir *et al.* 1998, Liu 1999). Stakeholder satisfaction is commonly agreed to be a valuable addition to the iron triangle whereas a successful project shall also satisfy its stakeholders (Baccarini 1999). In simplistic terms, project success comprises two main ingredients, project management success as well as product success (Baccarini 1999; Kam and Müller 2005; Baker *et al.* 1988; Lim and Mohamed 1999).

3. *Project Management Tools, Techniques And Competence*

The PMI (2008) definition of project management places emphasis on successfully applying techniques and tools in project activities. There are many varieties of tools and techniques applicable to different phases in the project life cycle. Zeitoun (1998) suggests that the influence of the tools and techniques depends on the practitioners training as well as the implementation process. Several success factors, therefore, relate to human factors and not related to tools and technique of the hard project management (Nguyen *et al.* 2004, Scott-Young and Samson 2004, Kloppenborg and Opfer 2002).

Thamhain back in 1999 in a study concluded that only 50% of project managers are familiar with project management tools and techniques, whereas only 28% implement them effectively. In 2014 Al-Hajj & Sayers (2014) reported similar findings of a study conducted in the United Arab Emirates stating that around 42% of UAE practitioners do not utilize essential project management tools and techniques such as WBS (Work Breakdown Structure) in their projects and that around 48% do not use an OBS (Organisation Breakdown Structure) nevertheless, the projects under consideration achieved a success rate (time, cost and quality) of around 66%. Such findings may lead to the conclusion that tools and techniques in project management may not directly influence project success.

Other studies, Pinto and Slevin 1988; Cash *et al.* 1992; Hatfield 1995; Thamhain 1998; Coombs *et al.* 1998; Milosevic *et al.* 2001, concluded that properly and timely implementation of tools and techniques in project management can lead projects to successful completion. Moreover, wrongly used project management tools and techniques may trigger the contrary leading to project failure (Cash *et al.* 1992; Hatfield 1995; Kerzner 2000).

According to Globerson and Zwikael (2002), the responsibility for project success lies with the project manager as he/she is ultimately responsible for developing the project execution strategy. Turner and Müller (2003) recommend that the title "Project Manager" shall be restricted to individuals, possessing professional certificates for creating more confidence and trust to principals or sponsors, during the process of selecting competent project managers. Other studies highlight the importance of competence to achieve project success (Hobbs *et al.* 2001; Turner and Müller 2003). These studies align with the micro and macro perspective for project success of Lim and Mohamed (1999) in that project management success does not necessarily translate into project success. Nevertheless, the competence of the project manager plays a vital role in choosing the right tools and techniques to deliver the necessary project life cycle deliverables. Project management practices need to cope with the ever-changing internal and external factors, influencing project success. Thus, it is important to appreciate the competence of the project manager. Turner and Müller (2003) confirm this point, which leads to the conclusion that proper project management training is a predecessor to the top-ranked project success factors.

The studies of Thamhein (1999) and Sayers (2010) suggest that not all project management tools and techniques are directly associated with project success. Nevertheless, even a thorough literature review could not identify any successfully completed project, without having utilized basic project management practices. Thus, many researchers (Pinto and Slevin 1988; Cash *et al.* 1992; Hatfield 1995; Coombs *et al.* 1998; Milosevic and Inman 2001) highlight that correctly applied tools and techniques may positively contribute to project success.

Project management practices, as referred to in literature is the combination of concepts, processes, tools and techniques (PMI 2008). Besner and Hobbs (2004) highlight the difference of applying tools and techniques, and using generic concepts and procedures. Table 1 shows the project success factors found in literature.

Table 1 Factors of Success in Projects.

Rank	Ashley <i>et al.</i> (1987)	Nguyen <i>et al.</i> (2004)	Toor <i>et al.</i> (2008)	Rohaniyati (2009)
1	Organisational planning	Competent project manager	Effective project planning and control	Project manager's capabilities and experience
2	PM goal commitment	Having adequate funding until project completion	Sufficient resources	Clarity of project scope and work definition
3	Project team motivation and goal orientation	Multidisciplinary / competent project team	Clear and detailed written contract	Organisational Planning
4	Scope and work definition	Commitment to project	Clearly defined goals and priorities of all stakeholders	The use of a control systems
5	Project manager capability and experience	Availability of resources	Competent project manager	PM goal commitment
6	Control system	Top management support	Adequate communication among related parties	Project team motivation and goal orientation
7	Safety	Awarding bids to the right designer / contractor	Competent team members	Safety precaution and applied procedures

Source: Ashley *et al.* 1987; Nguyen *et al.* 2004; Rohaniyati 2009; Toor *et al.* 2008

4. Research Methodology

The main objective of this study is to establish the correlation between the use of project management tools and techniques in construction projects and the influence of that application on successful

completion of projects and their elements via the experiences of many project managers working in the construction industry across many countries in the world including United Arab Emirates and Singapore.

Quantitative data was collected in a survey via a web-based questionnaire, featuring 20 questions sent to 142 selected project managers. Participants were selected based on their background, geographical location and their employment position. More than 75% of the respondents are in managerial positions. This strengthens the quality and reliability of data collected and helps to reach better and reliable findings from the survey. The questionnaire uses the five-point Likert scale questions in combination with matrix ratings.

5. Analysis Of Findings

86.3% of the clients and about 90% of contractors expressed satisfaction with the completed work on various construction projects they are working on. One-third of the project managers surveyed failed to keep their projects and elements of those projects within cost, time and the agreed specifications demonstrating that stakeholder satisfaction is perceived independently. When the study was conducted, about 78% of the projects were still in execution, monitor and control stage. It is therefore not project product success that is influencing the satisfaction of stakeholders because the projects have not gone into operations yet. This finding is not in agreement with the long standing view of some researchers such as Baker *et al.* (1988); Baccharini (1999); Lim and Mohamed (1999); and Kam and Müller (2005), who considered project success a combination of both the project management success and the end product success. The finding further indicated that failing to satisfy the traditional criteria for measuring project success may not influence the satisfaction of stakeholders at certain stages of a project.

Furthermore, the data gathered shows that about 43% of unsatisfied stakeholders report that the projects they are working on are on time, 71.4% are within budget and 29% of projects are delivered as per contract terms and conditions. It is important to note that, none of the unsatisfied stakeholders worked for a client organisation, whereas 50% of the respondents worked for a contractor. The findings clearly show that considering time, cost and quality, as primary success measures is insufficient to assess project success leading to the view that other factors should also be taken into consideration when evaluating success in projects.

The information gathered in the study show that 67% of the projects respondents are working on are within the planned time, about 72% of the projects are within the agreed budget and about 67% are within or exceed the quality requirements. Therefore, the analysis clearly demonstrates that around two thirds of the surveyed respondents' projects are well within the iron triangle and achieving stakeholder satisfaction. In contrast with the said figures, only 20% of the participating practitioners are confident that the projects they are working on will be successfully completed. About 48% of the respondents predict a successful completion. Furthermore, the respondents opined that adequate funding in projects strongly influences the success or failure of a project. In addition, individual project performance can be influenced by global market and industry fluctuations.

With regards to stakeholder satisfaction the analysis shows that about 20% of respondents believe that the quality of work carried out is of excellent quality even exceeding agreed specifications (70% of these answers originated mainly from Singapore. Wang (2006) and Ashley *et al.* (1987) see project success only when delivering results better than expected. Stakeholders in the Chinese construction industry rate the importance of relationships over the iron triangle as a measurement of success in projects. Shenhar *et al.* (1997) rank stakeholder satisfaction before time, cost and quality. Nevertheless, 47.1% of the participants deliver their projects as per contract terms and condition.

Considering the project manager traits and their influence on the success of project management, Figure 1 depicts that Competence as a trait of project managers is the most important trait of a good project manager. This finding contradicts what Turner and Muller (2005) concluded that, there is no impact of the leadership style and competence of the project manager on project success. Nevertheless, a competent project manager should be properly trained and having a professional certificate (Turner and Müller 2003).

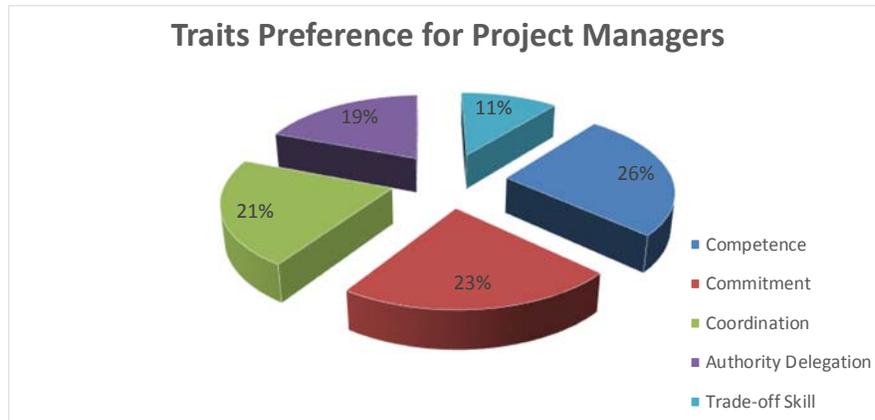


Figure 1: Traits of Project Managers

When asked about professional PM training, 61% of respondents stated that they do not have proper project management training, and around 20% have an affiliation to a professional project management institute. This clearly indicates that practitioners perceive that gaining competence can be achieved without obtaining professional training or through a designed process for professional certification. More than 75% of respondents are in a manager position, 22% are in senior project managers or project directors positions. About 56% of participants have a bachelor degree or higher, with only one-third of them having less than five-year project management experience. Nevertheless, the affiliation to internationally recognised Project Management organizations reveals that most of the respondents do not have any recognized project management training. Therefore, based on the collected data one may conclude that specific project management training is not necessarily related to project success. Furthermore, the majority of participating project managers entered the project management profession through experience rather than through a professional certification process, a finding that does not agree with Turner and Müller’s position in that the title “Project Manager” shall be restricted to individuals, having obtained professional certificates (Turner and Müller 2003).

6. Project Management Tools and Techniques Utilisation

The ranking of tools and techniques in the literature broadly agreed that project success factors show certain similarities to the ranking of this survey. Effective project planning and control achieved a rating of 4.78 out of 5, whereas respondents rank a competent project manager within the top eight success factors, indicating that there could be a universal set of factors leading projects to success, see figure 2.

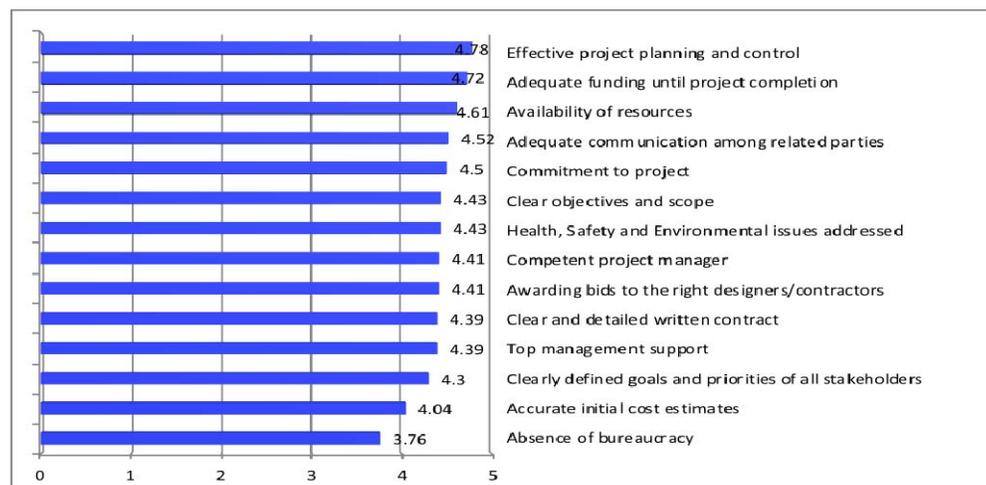


Figure 2: Rating of Factors Impacting Project Success

This finding contradicts with the observations of Dvir *et al.* (1998) and Liu (1999), as they argue that individual projects may have individual success factors (Dvir *et al.* 1998; Liu 1999). As 78% of the surveyed projects are in the execution, monitor and control phase, this may limit the responses to tools and techniques only applicable for this project phase. Nevertheless, about 10% of respondents, perceived effective project planning and control as most important, and rated Earned Value Analysis (EVA) as very important, whereas about 20% reported limited use of EVA, see figure 3. EVA is an essential tool for performance measurement and control of projects (Nagrecha 2002). Another key tool for PM practices is WBS (Work Breakdown Structure) which according to the survey was used by only 66% of respondents. This means that a total of 34% of practitioners did not or rarely used WBS which is very surprising in the construction industry. Clear Objectives is a tool required at the beginning of the project. Respondents ranked it in the sixth place in the pro tors. A finding which partially aligns with the responses of EVA and WBS in that it appears that contemporary project practitioners perceive project planning and control as independent tool and technique, rather than integrated concept, leading to the assumption that practitioners do not fully appreciate project management tools and techniques, indicating a lack of professional training of the surveyed practitioners.

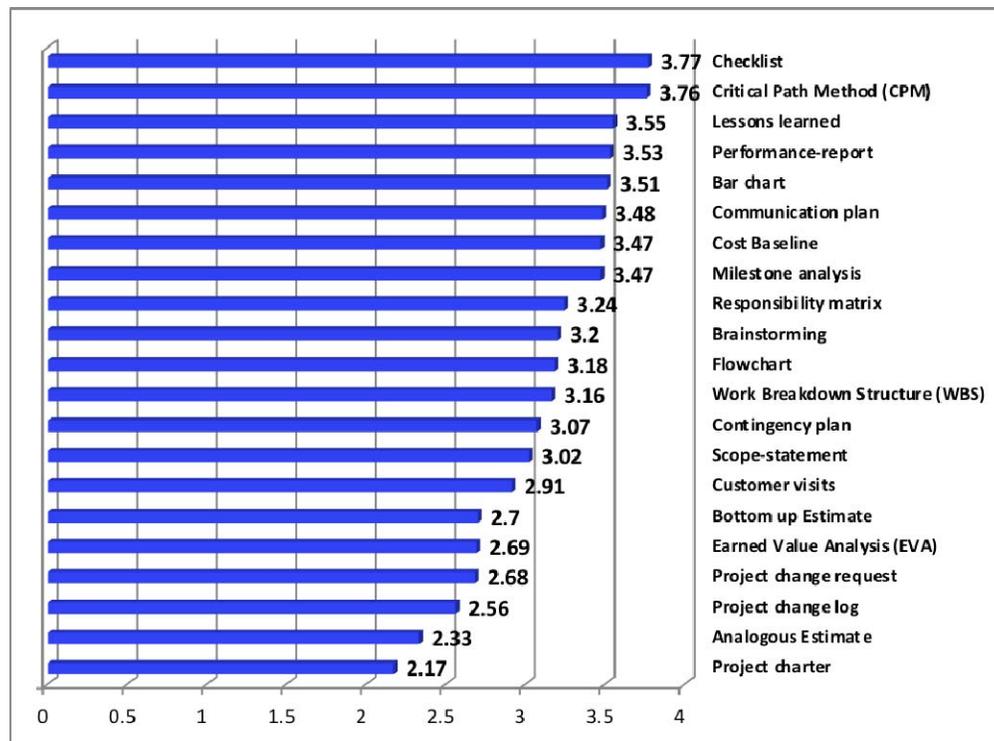


Figure 3: Project Management Tools and Techniques Usage

7. Conclusions

Successful projects are directly connected and correlated to success in the application of project management tools and techniques. Within cost, time and quality remain the preferred criteria to evaluate success in construction projects. Project success is a perceived measure, irrespective of the individual success criteria and factors. None of the surveyed projects indicate the achievement of project success, without utilizing project management tools and techniques. There exists a universal set of project success measures, applicable to all projects in the construction industry. The data features significant similarities representing a new insight. Whereas, the literature suggests that individual projects have project specific success measures. Project practitioners do not fully utilize project management tools and techniques and the vast majority of project managers implement project management methodologies. Project management practices and techniques are widely used in successful projects and therefore, project management positively influences project success.

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The Impact of Knowledge Management on Employees' Performance in Bahrain Petroleum Company (BAPCO)

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Abstract

This study aimed at examining the effect of knowledge management (KM) on employees' performance at BAPCO in Kingdom of Bahrain. Using questionnaire survey the study collected 135 usable questionnaires. Multiple regression analysis was utilized to analyze the data. The study found that both knowledge creation and knowledge application has a significant and strong effect on employees' performance. The study found that both knowledge storing and knowledge distribution have no effect on employees' performance. The study recommends that BAPCO continues to encourage knowledge creation and application in their operations and invest more in its knowledge workers.

Keywords: Knowledge management, knowledge creation, knowledge storing, knowledge distribution, knowledge application, performance

1. Introduction

In this current era of globalized competition, creation of diversified products and services, effective knowledge management becomes an integral part of organizational operation (Nonaka, 1994). Through the last twenty years, the important role of knowledge has been signified by both academics and practitioners (Wu and Lin, 2009). These days, knowledge is regarded as a crucial resource in organizations and countries alike. In a time characterized by uncertainty, successful organizations are those that are capable of continually creating new knowledge and disseminating it organization wide and more. Thus the awareness that knowledge must be effectively managed has become a key concern for executives and policy makers of organizations. Implementing KM in organizations is essential as there is a need to find, reach, share and exchange knowledge to safeguard the achievement of organizational goals.

Still, the simple processing of knowledge does not by itself ensure a competitive or strategic edge (Zack, 2002); rather, knowledge has to be managed. Yet many organizations fail to effectively manage this pivotal asset effectively. Organizations should become effective at knowledge processes like the creation, storing, distribution and application of knowledge. Organizations should grow the KM capabilities in order to carry a range of critical organizational operations and activities.

There is an abundance of literature on the positive relationship between KM and organizational performance. However, while the relationship between knowledge management and organizational performance is almost well established it still remains open for more studies. First, more evidence is needed on the direct relationship between KM and organizational performance. An abundant literature shows evidence on the indirect relationship but more research is needed on the direct one. Secondly, while there is a great amount of research; the topic is still under researched in the Middle East and more evidence is needed to highlight the importance of the concept in light of the low spending on KM and KM initiatives compared to that in developed countries. Thirdly, there are few studies that examined KM in government sector and even lesser in the private sector in Kingdom of Bahrain.

Therefore, this study examines the effect of knowledge management on employees' performance in BAPCO the Bahrain national oil company.

2. Knowledge Management

Researchers and practitioners perceive knowledge management to be multi-disciplinary in nature and therefore a big number of definitions exists depending on the background and differing interests. O'Dell and Jackson (1998) argued that KM is a strategy that can be developed within a firm to ensure that knowledge can reach the right people at the right time in order to improve organizational effectiveness. Walters (2002) defines KM as the organizational capability which identifies, locates, creates or acquires,

transfers, converts and distributes knowledge for competitive advantage. Further, academicians do not agree on a unified definition of KM (Grossman, 2006; Lloria, 2008) despite the similarity between some of the popular definitions found in the literature. A salient thread is that KM is made of processes, actions and practices aimed at creating and using knowledge to achieve or enhance different organizational outcomes, such as organizational performance, organizational goals, competitive advantage, or overall success.

KM helps an organization gain insights and further understanding of its own experience (Davenport & Prusak, 2000; Wiig, 1997). Knowledge management system in place to help executives cut through the noise, share information, and improve their decision-making (Quast, 2012). Knowledge management creates a culture where everyone continuously assesses themselves, their units, and their organization, looking for ways to improve (Garvin, 2000). More importantly, KM activities helps organizations in acquiring, storing and utilizing knowledge to improve processes like problem-solving, dynamic learning, strategic planning and decision-making (Takeuchi & Nonaka, 2004). Many researchers have emphasized three major factors concerning KM: capabilities, processes and organizational performance (Beckman, 1999; Demarest, 1997; O'Dell & Grayson, 1999). This research paper focuses on knowledge management processes and their effects on employees' performance.

Knowledge Management Processes (KMPs)

The idea of knowledge management process capabilities is advanced based on the knowledge system framework that views organizations as "knowledge systems", that are made of a series of socially enacted "knowledge processes" (Berger & Luckman, 1967). These processes are a continuous series of actions that are integrated into the physical and social structure of the organization with knowledge being the final manifestation (Pentland, 1995). Furthermore, Gold et al. (2001) examined an empirically effective KM model from the perspective of organizational capabilities. According to him, knowledge infrastructure, consisting of technology, structure and culture, along with a knowledge process architecture of acquisition, conversion, application and protection, are necessary and crucial organizational capabilities or antecedents of effective knowledge management. KMPs are an organization's capacity to develop/create state-of-the-art knowledge by converting tacit into explicit knowledge, and ultimately altering it into organizational knowledge (Nonaka & Takeuchi, 1995). Similarly, Pentland (1995) defined KMPs a continuous series of actions integrated within social and physical structure of an organization, with knowledge as the final product. Numerous researchers (Gold et al., 2001; Suzana and Kasim, 2010; Aujirapongpan et al., 2010; Chan & Chao, 2008 and more) have examined KMPs in their research. The dimensions are shown in table 1.

Table 1 KMPs.

Classifications	Knowledge Processes
Alavi and Leidner (2001)	Creation – storage – transfer – application
Gold et al. (Gold, et al.,2001)	Acquisition – conversion – application – protection
Ernst & Young (1999)	Generate – Represent – Codify – Apply
Holsapple et al. (1997)	Acquire – Select – Internalize – Use – Generate – Externalize
Young (1999)	Acquire – Develop – Retain – Share
Wiig (1998)	Leverage existing knowledge – Create – Capture and Store – Organize and Transform - Deploy
Liebowitz (2000)	Transform – Identify and Verify – Capture and Secure – Organize – Retrieve and Apply – Combine – Learn – Create – Distribute/Sell
Liebowitz et al. (1998)	Identify – Capture – Select – Store – Share – Apply – Create – Sell
Saint-Onge (1998)	Gather – Learn – Transfer – Act
Van der Spek et al. (1997)	Develop – Secure – Distribute – Combine

Based on the previous discussion, knowledge process capabilities can be classified into seven major categories, i.e., identification, acquisition/generation, organization, storage, distribution or sharing, application and measurement. Each of these processes is described below.

The identification process designate as important which knowledge should be captured in KM actions that can carry and push organizational business strategy. This stage entails the determination of the experiences to be internalized or changed to become knowledge, the current internal knowledge to be drawn, the external sources of knowledge which may cover the gaps, modern sources of knowledge, and the degree of significance of knowledge identified. Once determined as significant, knowledge must be

acquired or generated within/outside an organization and subsequently be integrated with existing knowledge (Alavi & Leidner, 2001).

Acquisition/generation processes, hence, are sometimes referred to as creation, capturing or collaboration (Gold, et al., 2001). The third process is knowledge organization which deal with the classification, structuring, coordination, linkage, integration, indexing and editing processes of the acquired knowledge (Alavi & Leidner, 1999). Knowledge that is captured must be made in a systematic/consistent format before it can become useful to the organization. Then, knowledge must be saved adequately to avoid loss.

More importantly in the saving stage is the security aspects. It should be made sure that knowledge is protected and can only be accessed by the rightful people (Porter-Liebskind, 1996). Despite copyrights, patents and trademarks which provide legal protection security measures should be develop to protect other knowledge that is not protected or difficult to protect but can be a source if competitive advantage for the organization (Porter-Liebskind, 1996). In order to show value from a business perspective, knowledge needs to be shared among organizational members. The distribution/sharing process guarantee that every member in the organizational is aware of the existence and availability of the tacit/explicit knowledge on hand.

Distribution of knowledge happens between organizational members (employees), teams, groups, and departments (Alavi & Leidner, 2001). It is by this internalization process that individual knowledge is changed into organizational knowledge (Nonaka, 1994). However, the end result should be that knowledge needs to be applied or used into operation to improve organizational performance.

Knowledge guides decision-making and action planning (Grant, 1996). In some cases, knowledge application could in addition start knowledge creation and initiate a new knowledge generation cycle (Gopal & Gagnon, 1995). In the end, it is crucial to gauge if the progress and performance of existing KM activities results in the intended objectives. The measurement and evaluation process allows managers to take quick corrective actions or to revise strategies (Bontis, 1999). It seems, however, that most studies agreed on the following four processes as the main ones. Knowledge creation, knowledge storing, knowledge distribution and knowledge application which will be adopted for this study. Figure 1. shows the study model.

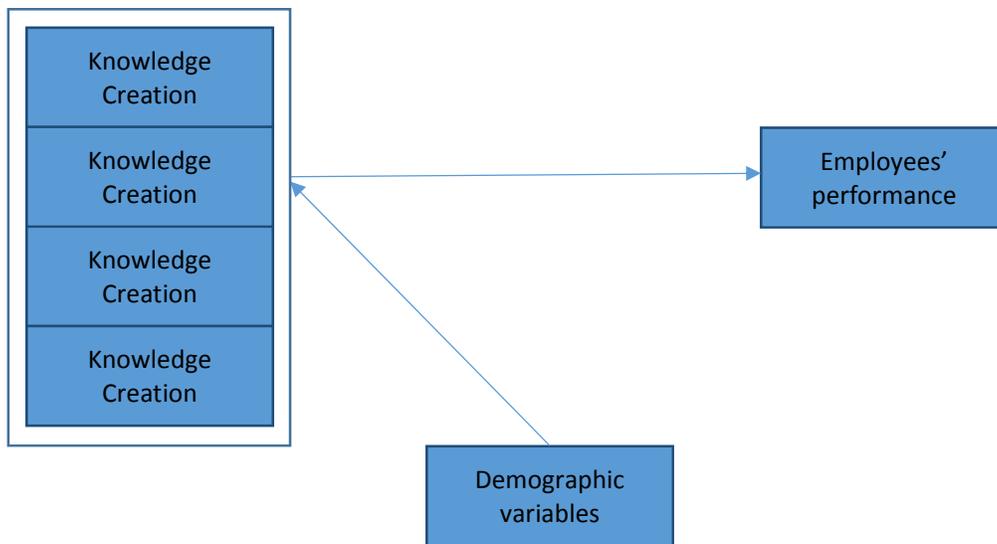


Figure 1: Study model
Knowledge Management Processes

3. Knowledge Management and Performance

Success is seen as a product of human knowledge and is a crucial element to reach and maintain a competitive advantage (Lee & Lan, 2011; Liu & Deng, 2015). Nevertheless, human knowledge can become dated if not adequately managed and utilized in organizations (Karimi & Javanmard, 2014). Thus, to protect

from loss of knowledge it is essential to develop and maintain stratagem for its better management (OuYang, 2014).

It was argued that for implementing the knowledge in its true essence a thorough investigation is required for production, utilization and dissemination of knowledge. Hence, the knowledge management is about delivering the right information to the right people in the organization on the right time.

Davenport and Prusak (2000) argued that efficient and effective knowledge management to be efficient and effective requires knowledge sharing as a necessary component. Harrison and Leitch (2000) also reiterated this argument that keeping knowledge sources up to date is crucial to survive in a dynamic world fluxed with information technology. Quintas et al. (1997) maintained that that knowledge management is the process of collecting and managing the information/knowledge for encountering performance laps. Alvi and Leidner (2001) viewed knowledge management involving use of both tacit and explicit knowledge of the employees enabling them to capitalize productivity. The stepping stone is to make ready and available personal knowledge to other organizational members to improve organizational positioning.

The use of technology can facilitate knowledge sharing and creation across sections, departments, divisions and also crossing organizational borders. In addition, management of knowledge can help in employees' in time decision making which improves their performance and hence organizational performance (Horwitch & Armacost, 2002). Cumming (2004) viewed sharing of knowledge as the facility of sharing task related information, a technique to help others, a cooperation tool in problem solving, to develop new ideas and implementation of policies and procedures. So if knowledge is both well created and shared it will increase the commitment of employee towards their personal and organizational goals and therefore improving employees' performance and ultimately achieving organizational goals.

Therefore, based on the previous discussion the following hypotheses are proposed:

H1: Knowledge management has a positive effect on employees' performance.

H1a: Knowledge creation has a positive effect on employees' performance.

H1b: Knowledge storing has a positive effect on employees' performance.

H1c: Knowledge distribution has a positive effect on employees' performance.

H1d: Knowledge application has a positive effect on employees' performance.

4. Methodology

The study used a quantitative approach to test the model. A self-administrated questionnaire survey was utilized. First communication was made with BAPCO and approval was granted to conduct the study. Then managers (executives, heads of departments and heads of sections) were sent the questionnaire with a cover letter explaining the goals of the study and assuring them that their identities will remain anonymous. There were 45 managers and 92 heads of departments and sections in BAPCO. The study utilized an all-inclusive sample. 137 questionnaire were distributed and all of them were retrieved showing a very high commitment by BAPCO towards scientific research and a very high degree of transparency.

4.1 Measures

Knowledge management processes were measured using the measures developed by: Duffy (2000) for knowledge storing, Gupata and Govindergan (2000) for knowledge distribution, Heisig and Vorbeck (2000) for knowledge application, Nonaka and Takeuchi (1995) and Awad and Ghaziri (2004) for Knowledge generation. While employees' performance was measured by five items developed by Wayne, Liden, Graf and Ferris (1997).

4.2 Reliability of measures

Table two shows the Alpha cronbacks' for the study variables. All alphas are above the accepted 0.7 value showing high reliability.

Table 2 Alpha Cronbach values for the study variables

Organizational performance	0.87
Knowledge creation	0.83
Knowledge storing	0.80
Knowledge distribution	0.80
Knowledge application	0.80

4.3 Analysis of variance

ANOVA was conducted to test the differences in respondent's answers to the study questions. Table 3 shows the results.

Table 3 ANOVA

	Sum of Squares	Df	Mean square	F
Gender				
Between groups	8.002	24	0.333	1.722
Within group	21.301	110	0.194	
Total	29.304	132		
Age				
Between groups	35.305	24	1.471	1.670
Within group	96.888	110	0.881	
Total	132.193	134		
Education				
Between groups	25.343	24	1.056	1.008
Within group	115.205	110	1.047	
Total	140.548	134		
Experience				
Between groups		24	2.176	1.970
Within group		110	1.105	
Total		134		
Job title				
Between groups		24	0.147	0.612
Within group		110	0.241	
Total		134		

As shown in Table there are no significant difference in participants' responses according to their educational level and job title. However, there is a positive effect for age and experience which is expected and is in accordance with the literature. The higher the employee age the higher is knowledge creation and application and the higher is the effect on performance.

5. Hypotheses testing

Multiple regression analysis was conducted test the study model. And the results are presented in the Table 4 below.

Table 4 Multiple regression and hypothesis testing

Hypothesis	B	Beta	T	Decision
H1a	0.139	0.170	1.925	Accept
H1b	0.114	0.116	1.249	Reject
H1c	0.54	0.060	0.712	Reject
H1d	0.459	0.474	4.756	Accept

Results showed that knowledge management has a positive effect on employees' performance. This is in accordance with studies in the literature such as that of Tubigi, et. al. (2013) and Zikmund (2003). Specifically the study showed that both knowledge creation and knowledge application both had a positive and significant effect on employee performance at 5% level. Results also showed that both knowledge storing and knowledge distribution did not have an effect on employee performance.

The findings are in accordance with the literature for the following reasons. BAPCO creates products and services that are required in the market and thus does study its markets well. In addition to be able to generate the required knowledge in trains its employees to the highest international standards. Both the making of products and services and the training of employees is done by generation knowledge by internalizing and externalizing of knowledge to the firm. Indeed the company has started its own training academy that will training and educate its employees in Bahrain onsite.

With regards to knowledge application BAPCO the daily operations, problem solving, production, marketing and almost all activities conducted by the company require some application of specialized and generalized knowledge, hence, the importance of knowledge application.

The study found that sex, experience and age all had an effect on the relationship between knowledge management processes and employee performance. This is also expected as the literature indicates that men and women are different in terms of their knowledge sharing and knowledge management behavior. Studies show that as employees grow older and as their experience grow in the company they become more willing to share knowledge and help other employees. While the study found no evidence that educational level and job title had an effect on the relationship.

6. Recommendations

It is obvious that age and experience are both important for knowledge management and for employee performance. The higher the age and the higher the experience the higher the sharing of knowledge and the higher is employees' performance. Therefore BAPCO must retain its employees well a task that BAPCO does well as it has an excellent remuneration, and employee development programs. It is actually known in the local market that once a BAPCO employee then a BAPCO employee forever.

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Mind the Gap: Skills Shortage within the UK Construction Industry

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Abstract

The majority of the workforce in the UK Construction Industry is nearing retirement age with 22% over 50 years old and 15% over 60 years, considering the UK's state pension age currently at 65, a substantial proportion of skilled construction workers will be lost in the next decade (Henson and Asenievich, 2014). Similarly, the rate of retirement is increasing at a disproportionate level to the UK's population growth. Amid these constraints, the UK's major infrastructure projects and housebuilding demand are not declining and will instead demand a reciprocal of the decline in the active workforce. In the wake of the looming Brexit, something must be in place to reduce the effect and counter measures should have begun over a decade ago.

This research adopts a Quantitative approach in analysing the effects of skills shortages in the UK Construction industry. Non-parametric statistical analyses are utilized to scrutinise the extent of the skills gap and its severity. Initiatives necessary to bridge the skills gap are proposed. The study espouses a desire for a critical debate on a holistic approach to recruitment policy and government strategy to attract new entrants in all built environment fields as well as taking necessary steps in fortifying the apprenticeship programmes.

The study is expected to be of benefits to construction industry practitioners and the country as a whole in seeking avenues for improved productivity and the potential ripple effects on the UK economic growth.

Keywords: Brexit, Construction Industry, Productivity, Skill shortages, Workforce.

1. Introduction

The Construction Industry is arguably the most important sector in the UK economy; it generates £90 billion annually (6.7% of GDP) and employs in excess of 2.93 million people, the equivalent of 10% of UK employment (Mohammed et al., 2017). The UK construction industry is suffering from skill shortages. With the government's 2015 pledge to build 250,000 homes a year along with a plethora of large-scale infrastructure development (Lund, 2019), such as the HS2, Cross rail and Hinkley Point C. This makes one to ponder, how such a huge portfolio of work can be delivered in the wake of Britain's exit from the European Union (Brexit).

Apart from the poor image of the construction industry, which survey findings also revealed that young people have negative images of construction work (CITB, 1988). The work is perceived as being dirty, dangerous, having a low social status and poor career prospects (Agapiou, et. al., 1995). It has also been suggested, that one of the main reasons why young people do not like to work in construction is due to other available white collar and more glamorous jobs in other industry e.g. law, medicine or finance, and the stability and competitiveness of high wages. In 2015, the then Prime Minister (David Cameron), announced plans to increase the number of quality apprenticeships, with a pledge of 3 million apprenticeships created by 2020 in plans to deliver the next generation of skilled workers (Grenyer, 2015), whilst bridging the gap in skills. As a result, the Apprenticeship Levy was introduced in April 2017. The apprenticeship levy is a new tax. It started in April 2017 and applies to all employers, stating that if annual payroll is more than £3m, the employer will pay 0.5% into the apprenticeship levy each month (Apprenticeship-levy, 2016). This bill is used to fund apprenticeship-training programmes with emphasis on the skills and qualifications necessary for future generations.

Estimate shows that 28% of workers in London comes from European Union countries and 7% from elsewhere (Strauss, 2018), that is more than one in three workers in construction. The UK population is continuing to rise and with major infrastructure projects and housebuilding required to support this increase proportionately, and coinciding in the wake of Brexit, there is the potential that the skills gap will increase even further due to the uncertainty of EU nationals working visa's, post Brexit and also their willingness to come to the UK considering the free movement of EU national to the UK (vis-a-vis) post

Brexit. Presently, specific trades' essential to house building such as bricklaying, carpentry, plastering and roofing are proving difficult to recruit with two-thirds of small and medium-sized construction firms struggling to hire and find professional technicians, e. g. plumbers and electricians- 48%, plasterers- 46% and floorers- 30% (Federation of Master Builders, 2018).

The main purpose of this paper is to examine the current status of the skill shortages in the UK construction industry, investigate the reasons for skill shortages and explore the initiatives which aims to bridge the gap, hence enable the research to recommend the actions the government and the industry should take to lessen the impact of the labour shortfall.

2. Literature Review

2.1 Shortage of Skilled Workforce

In 2015, the National Infrastructure Plan published its investment strategy consisting of 564 projects encompassing transport, infrastructure, communications, energy and environmental sectors at an investment cost of £411Billion. It is anticipated that this pipeline of projects in the UK, will create a demand for around 400,000 engineering and construction workers by the year 2020, hence driving the need to recruit and train nearly 100,000 additional workers & retrain and up-skill approximately 250,000 of the existing workforces (HM Treasury, 2015). Whilst these figures may seem incomprehensible, a report from Dutch engineering consultancy Arcadis, describes the shortfall in labour by using the following headline; Britain must recruit one worker every 77 seconds to meet construction needs (Arcadis, 2017). With figures like these, it is clearly apparent that the scarcity of the UK labour supply for an immense variety of skilled trades is a problem for the industry. In particular, the Arcadis report identifies a high demand for the following trades; Electricians and electrical fitters, Plumbing and heating and ventilations engineers, Carpenters and joiners & Construction and building trades. These trades alone make up over half of the annual recruitment of 407,495 necessary for Britain to fulfil and carry out its housebuilding and infrastructure projects between, 2016 to 2021.

Additionally, the Farmer Report (2016), also highlights the disproportion between the pipeline of new workers entering the construction industry and those either retiring or leaving the industry altogether. Again, the 2011 Census data shows us that 30% of the workforce at the time are aged over 50yrs, hence looking forward to ten years (2026) will represent approximately 620,000 people based on the construction classification used, who will have retired from the industry (Farmer, 2016). The 620,000 workers referred to only relates to the house building sector which is extremely alarming as figure 1 leaves you questioning; how the UK can possibly meet the target of building one million homes by 2020 as the pledged by the Government, a target set back in 2015 which is intended to ease the UK's growing housing crisis.

Another commitment made by the UK Government as previously stated, is the target of 3 million apprentices by 2020. Whilst this pledge does not relate to the construction industry alone, its intention along with the apprenticeship levy was to increase training allowances for employers and increase apprenticeship enrolment in the industry, subsequently increase young people entering the industry whilst increasing the quality of their apprenticeship programmes.

However, a critical look at figure 2, obtained from Construction Industry Training Board (CITB, 2016) indicates the decline of first year trainees/apprentices entering the industry since 2005. Perhaps, the main cause for the lack of new recruits is that; school leavers don't choose construction as their career choice because of the negative image of the construction industry, described in the Arcadis' report as a '4D industry' – dirty, dangerous, demeaning and depressing (Arcadis, 2017). Furthermore, from a survey of US's high school students about the attractiveness of different careers, Construction ranked 498 of 500 occupations, thus reflecting the poor industry image (Ho, 2015). There is also the argument, that the grant provided by the CITB is unlikely to cover the full costs to an organisation, taking a trainee through to becoming a skilled and productive worker (Green, 2015). The average overall net cost to the employer over the training period is £23,932, which increases to £26,074 once the costs of dropout are accounted for (Hogarth, et al., 2012).

With the construction industry being so unpredictably volatile and subject to mass unemployment during financial downturns e.g. the late 2000's recession. This combined with the high costs to organisations for having to train up new entrants to the industry, and the further risk of not retaining that individual after training. These can potentially lead to organisations importing 'job-ready' migrant labour at the expense of training (Green, 2015) which will further increase the labour shortfall as young, unemployed UK nationals could have potentially filled these roles. With profit margins being so low amongst smaller to medium sized construction firms and uncertainty over their future workloads, it is not

surprising that many do not take on apprentices or trainees and/or train up current staff due to the risks involved with training and potentially not retaining that investment upon completion of their structured training.

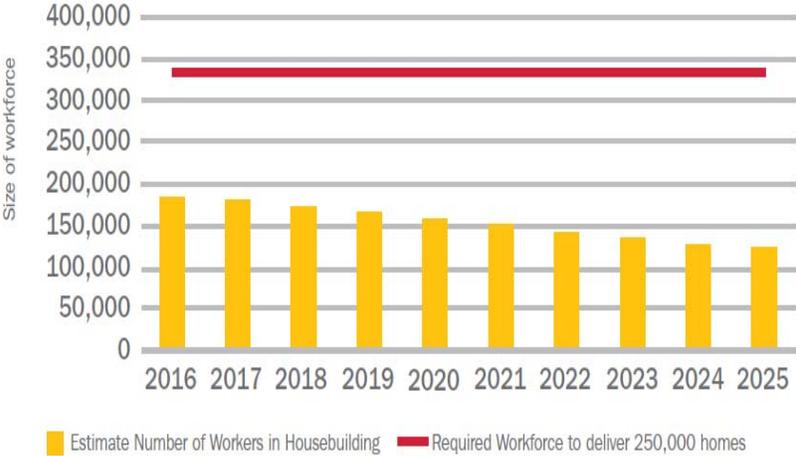


Figure 1: House Building Sector: Forecast Workforce vs Required Workforce
Source: Farmer Report (2016)

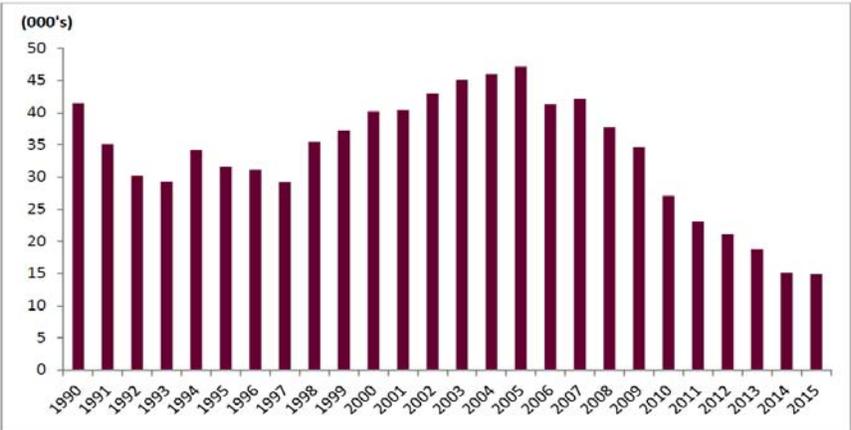


Figure 2: Numbers of Construction and Built Environ. 1st-Year Trainees 1990-2015
Source: Construction Industry Training Board (CITB, 2016)

2.2 Brexit

A further fundamental issue that could worsen the skill shortages in the UK, is the implementation of a ‘Hard-Brexit’ – (the UK’s exit from the European Union without a deal on immigration, border crossing and trade deals). Brexit was first billed for 29th of March 2019, now shifted to end of October 2019, but has been repeatedly delayed by Parliament in order to avoid a ‘No deal’ Brexit and/or a ‘Hard Brexit’, in order to reach a reasonable trade agreement with the EU. Again, The Farmer Review (2016) states that over half the workforce in London comprises migrant labour, without their input the construction industry labour workforce would not be able to deliver its required output. In addition, with no clear guarantee of EU nationals having the rights to remain in the UK post Brexit, the UK could see many of the EU nationals migrating back to their country of origins. This would also lead to a potential reduction in the influx of workers from European Union coming to the UK in search of work and would further have a devastating effect on construction productivity.

Currently in the UK there is a point’s-based system in place for non-EU nationals that wish to work in the UK (Mavroudi and Warren, 2013), this system is based on the Australian system and was launched in

February 2008. It splits the applicants into 5 tiers, with each tier needing certain requirements, in order to achieve the sufficient number of points to gain a working visa for new entrants or to receive the rights to remain and work in the UK for current visa holders (Mavroudi and Warren, 2013). The points are based on the following criteria; age, English language ability, qualifications, earnings, UK experience & certificate of sponsorship, with the number of allocated points for each criterion-varying dependant on each of the tiers (Devitt, 2012). As it currently stands, this system highly favours entrepreneurs, investors and skilled workers applying for roles where there is an evident skills shortage in the UK. Post Brexit it is expected that this point's-based system will be expanded to include EU nationals, depending on the outcome of Brexit. However, as it stands the Home Office have not established how they would deal with the new influx of EU nationals applying for visas. Further to this, at a time where you would expect the UK to welcome an influx of skilled labour migrants from the EU and elsewhere, by ensuring the application processes is simplified and not being used as an immigration deterrent. The government have increased application fees by 4 per cent in addition to the immigration skills surcharge, added to this, is a proposal to double the immigration health surcharge from £200 per year to £400, making the process very expensive (Meadows, 2018). Again, it appears that the UK government are changing the visa application process in a 'preventive manner' at a time the processes should be encouraging skilled visa applicants. Especially when there are other nations e.g. Australia, Canada etc. encouraging skilled migrant workers visa applications. This could lead to the United Kingdom losing potential skills to these other nations, if we do not adopt similar approach to their visa applications and processes.

2.3 Construction industries and Skilled labour Shortages in Other Civilized Nations

Hong Kong faces similar labour and skill shortages, with its construction industry almost replicating the downturn suffered in the UK due to the recession. The Hong Kong government executed plans to stimulate economic growth in the form of ten super infrastructural development projects; capital work expenditure in the public sector rose substantially from HK\$21 billion in 2007-2008 to HK\$62 billion in 2012-2013 and will increase to over HK\$70 billion per year in the next few years (Ho, 2016). Construction in the private sector has also recently picked up due to the rising property price, hence as a result of this sustained high workload, the construction industry is facing the challenges of skill mismatches and an aging workforce (Ho, 2016), a similar situation to the UK. In order to combat this skill shortages, the Hong Kong equivalent of the Construction Industry Training Board (CITB), the Construction Industry Council (CIC) received additional funding from the Hong Kong Government and launched a number of initiatives to recruit skilled workers to work in Hong Kong's construction industry, including the following; construction manpower training scheme which provides a training allowance to attract new entrants & the contractor cooperative training scheme which utilises contractors by using on-site training under the supervision of the CIC for new entrants (Ho, 2016). Nevertheless, the Hong Kong construction industry still, is struggling to recruit workers in several skilled roles.

Australia is another country which has similar issues with construction labour and skills shortages, the Building and Construction Industry Improvement Bill was implemented in 2003, to address the growing shortages of skilled labour identified in the Cole Royal Commission Report (Watson (2007). The report identified the following as causes, that contributed to Australia's skills shortages; an ageing workforce and forthcoming retirement rates; changing skills required from various occupations; differences in demand and/or supply of skilled workers as a result of employment arrangements; poor educational qualifications translating into smaller and lower numbers of successful job applicants; inadequate apprenticeship rates and difficulties in attracting and retaining employees.

It appears the biggest issue Australia's construction industry faces is its inability to ensure apprentices complete their structured training, with numerous drop outs (Eichhorst, et. al., 2015), unlike the UK whom similarly struggle with apprenticeships, but more on the recruitment of new apprentices. With a lack of young people enrolling onto apprenticeship programmes and with enrolment levels declining year on year, but the UK have a much better retention rates for apprenticeships than that of Australia's (Gow, et. al., 2008). A key difference between the two industries is the infrastructure project portfolios with the UK's workload greatly exceeding that of Australia's which would explain the UK's skills shortage as a result of high demand for such huge projects.

In Canada, there is also a deficit in the number of new entrants entering the industry and the number of workers whom are currently employed and are expected to retire over the next ten years. With more than 1.4 million people working in the construction industry, it is expected that 247,900 of these workers will retire over the next 10 years and only 215,700 new entrants will be available to fill the gap, creating a national deficit of 32,200 workers (Chad Chang et al, 2018).

Unlike the United Kingdom, Canada's population growth is beginning to plateau and is slowing at a lesser rate. The Build Force Canada (2018) report states, the results of this will limit the long-term residential outlook translating into fewer new housing starts, but there will be a steady increase in demand for renovation and maintenance work, and an ongoing need for new skilled workers to replace those retiring (Build Force Canada, 2018). However, when comparing Canada's shortfall of labour with the United Kingdom, it is clearly evident that the UK's Construction Industry has a far greater shortfall required to be filled in order to execute and sustain the various infrastructure development plans and major projects planned for the future. This is with the likelihood being that, if effective initiatives are not implemented swiftly enough to expanding the pool of skilled workers, whom are able to work on such projects, many projects could overrun. This will be due to lack of labour availability and budgets overrun due to the increase in wages for high demand labour roles which firms are struggling to recruit (these would mean, the forces of demand and supply at work).

3. Research Methodology

The use of exploratory research is utilised in this paper along with secondary literature review, to explore comprehensively the skill gaps in the UK construction industry. In order, to address and achieve the research aims and objectives, a qualitative approach of utilising construction industry bodies and endorsed institutions' journals, articles and existing case studies was adopted.

Exploratory research is utilised as it purely explores the research question, allowing the gathering of multiple sources of literature, whilst allowing supplementary researches around the research question to give a more holistic view and understanding of the research topic. As the nature of exploratory research is to merely explore the research question and does not aim to reach conclusive solution to the research question (Stebbins, 2001), further quantitative research in the form of analysis of secondary data and the use of qualitative research, collating key industry views on the subject, backed up by data to support these views have jointly allowed for the analysis and discussions. Where possible attempt was made to use qualitative data from academic journals to maintain utmost validity with greater accuracy. Additionally, this research applied inductive reasoning in order, to allow for the use of existing literature and theory to articulate the research question to be explored in this paper. Inductive reasoning begins with observations that are specific and limited in scope, and proceeds to a generalized conclusion that is likely, but not certain, in light of accumulated evidence (butte.edu, n.d.). Whereas deductive research is concerned with developing a hypothesis (or hypotheses) based on existing theory, and then designing a research strategy to test the hypothesis (Dudovskiy, 2019), this research opted not to use deductive approach as many factors which contribute to the skills shortage are current and ongoing, e.g. the present political situation in the UK.

Interviews and questionnaires were not exploited, reason being that skill shortages are current and ongoing; hence individual's opinions and point of views may be subjective and based on political views, affiliations and influences because Brexit is presently a hot political debate. Instead the use of secondary data collection techniques has been adopted for the content analysis, with key focus on industry endorsed research by key industry players and data by recognized regulatory bodies' specific to the construction industry which critique would could say is also subjective as firms might want to speak for their benefits.

4. Findings and Analysis

Arguably, the most fundamental issue for the United Kingdom currently, is the political situation in the wake of Brexit: what the outcome could be, the impact it will have on the UK's economy in general. However, this paper is limited to investigating the skills gap shortages and the speculative effect this could have on construction productivity, in addition to the already existing skilled workforce shortages and the now disproportionate population growth ratio with the skilled labour workforces.

A sizeable bulk of the London and the South East's labour force is from the EU, the negative connotations of Brexit will further constrain the skills deficit and may directly or indirectly create obstructions for increasing construction productivity in the years to come. Table 1; is a summarised and tabulated initiative, potential benefits to the Construction Industry and relevant sources.

Table 1 Potential benefits to the Construction Industry and relevant sources.

	Initiatives	Source of data	Potential benefits to Industry
1	Central and local government in the UK should seek as public procurers and planning regulators, to secure from developers and construction businesses workable obligations to train and develop local people.	CIOB (2015), CIOB Perspectives: An analysis on migration in the construction sector	Expansion of the pool of workers to fill the skills deficit with a large proportion of unemployed young people in the UK through education or training, targeting these individuals by tailoring training to meet the skills required for the industry especially in technical trades with shortages as being experienced in the Construction Industry.
2	The industry needs to continue and enhance its outreach work in schools, ensuring the careers advice presents a fair representation of the huge opportunities available at both trade and professional levels within the construction industry.		A greater proportion of young people will be willing to enter the industry if the image of the industry is improved. Currently most young people would see construction as an undesirable career path, but with many opportunities for progression and a vast range of roles available, there is a career path for anyone with aspiration to work in construction; this will further relieve the burden of skill shortages.
3	Securing the rights for those currently working in British construction industry post Brexit	Arcadis (2017), Talent Scale, The real extent of Britain's construction labour crisis	This is fundamental, the UK needs to retain its current EU workforce and look to attract new EU nationals whom may wish to migrate to the UK post Brexit. Government needs to show that the rights of EU nationals remain is a priority in order to attract more migrant workers to fill the skills gap.
4	Sourcing and Encouraging alternative work source/s e.g. new skilled migrants' workforce, ethnic minorities and women.	Ho (2016), Labour and skill shortages in Hong Kong's construction industry, Engineering, Construction and Architectural Management. Vol. 23 Issue: 4, pp.533-550	Expansion of the pool of potential workers whom can work in the industry, with particular focus on black and minority ethnic (BAME) backgrounds and women. This will enable more entrants into the construction industry to fill the deficit of skill shortages and hence will further relieve and alleviate the burden.
5	The Construction Industry Training Board (CITB) should be comprehensively reviewed and a reformed programme instituted	Farmer (2016), The Farmer Review of the UK Construction Labour Model, Modernise or Die.	More efficient distribution of levy investment required to support industry wide innovation and modernisation, whilst focussing on the longer-term needs of the government. Also, ensuring recruitment quotas for trades where there is a shortage are met and apprentices/trainees complete their respective programmes with greater retention rates post completion, further relieving the burden on skills shortages.
6	Adopt new construction technologies and techniques to enhance construction productivity	Ho (2016), Labour and skill shortages in Hong Kong's construction industry, Engineering, Construction and Architectural	Innovation and technology in construction e.g. offsite construction needs to be re-emphasised, realised and implemented. Example, the use of precast concrete as opposed to in-situ concrete and other construction

		Management, Vol. 23 Issue: 4, pp.533-550	productivity enhancements reducing the labour numbers required on major projects and infrastructure developments.
7	Training and retraining the unemployed and underemployed could be a significant benefit to an industry under significant pressure	Arcadis (2017), Talent Scale, The real extent of Britain's construction labour crisis	Relieving current shortages and leading to a culture of improvement throughout industry with training incentives for employees to allow them to reach career aspirations

5. Conclusion and Recommendations

It is recommended in this paper, that the following initiatives to government and industry be adopted in helping to ameliorate and solve the skills gap in the UK construction industry.

There is the need to increase apprenticeship and trainee programme/s enrolment quotas and retention rates (Feng, 2015); as mentioned previously in this research (illustrated in figure 2), the number of persons enrolled onto apprenticeship and trainee programmes has dramatically fallen since 2005 (Eichhorst, et. al., 2015). As a bare minimum, the industry should recruit the same number of individuals anticipated to retire each year from the industry with apprenticeship or trainee programmes. Although this will not solve the skill shortages immediately, it will ensure that there is a pipeline of young skilled professionals entering the industry for years to come, which could help replace those leaving the industry due to retirement. This will also promote a more positive image of the construction industry as one, which develops individuals into skilled professionals with career pathway to work on major projects with transferrable skills and in construction around the world.

Ensuring that the UK have access to EU labour market post Brexit and retain current EU nationals working in industry (Sumption, 2017); it is vital that the UK government ensures that the deal reached with the EU in the Brexit negotiations will ensure current EU nationals working in the UK construction industry are giving the rights to remain as a priority. Additionally, the government should actively seek not to deter new applicants from the EU whom could fill key skilled roles by making the work visa application process as user friendly and reasonably priced as possible. With over a third of London's construction workforce coming from Europe, it is vital we attract these individuals to stay and any new application process imposed on EU nationals should not act as a deterrent and should appeal to invite skilled individuals to fill key industry shortage roles.

Increase pool of talent which the recruitment of skilled construction labour can be drawn from; the industry should actively look to encourage the recruitment of diverse social groups, encourage and attract females to enrol onto programmes as well as tailoring training and apprenticeship programs for minority ethnic groups. Industry image can act as a deterrent, particularly to females as the industry is seen as macho and male dominated, this stereotype needs to be addressed, perhaps by using school engagement programs to attract females from young age to look at construction as a viable career path. The industry should encourage minority ethnic group's enrolment onto training programs by employing native speakers to carry out tailored made training programs, to fill specific skills required in the construction industry with the aim to alleviate skill shortages. Another approach could be looking to attract ex-offenders onto training programmes, which provide a fast track route into employment, further promoting a positive outlook for the construction industry whilst expanding the pool of workers, which employers can draw from to fill key skill shortages.

Impose quotas on significant government contracts that require contractors and their subcontractors to ensure a proportion of their workforce are apprentices; this recommendation has already been implemented on large scale projects like the Thames Tideway project where contractors are being asked to ensure 1 in 50 places are filled by apprentices from London and the wider Thames Water region (KLH Sustainability, 2019). This study acknowledges there is a great deal of room for improvement and quotas like this should be embedded into the government's house building targets. Also, rooted in the heart of the infrastructure contracts to promote a client and contractor culture of employing apprenticeships and ensuring their development is imperative to securing high profile contracts that brings an abundance of work. This cultural change should promote the recruitment of apprentices and trainees to ensure firms keep growing whilst providing sustainable career paths for the young and unemployed.

These recommendations require complete change in the culture of the UK construction industry, and it is vital to address the issues of skills gap and shortages as discussed in this paper and ensure implementations as recommended.

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Lean Implementation in the UAE MEP Construction Industry

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Abstract

The UAE construction industry, especially MEP (Mechanical, Electrical and Plumbing) can benefit from lean principles. Lean implementation, which is a systematic method originated in the Japanese manufacturing industry can help the minimisation of construction waste without sacrificing productivity. Applying Lean principles to the construction industry reduces the wastes resulting from MEP field. It also helps the reduction of non-value adding activities which cannot provide any final results of the construction work, which consequently reduces the use of residue material.

Concurrent mixed methods for this study were adopted using questionnaire and interviews among the construction professionals in the UAE who analyse the way lean can be implemented in the construction industry, the barriers to its implementation, and the way it provides benefits from the current situation. Various lean tools and techniques like Last Planner System, Just In Time, etc., the construction industry's current situation, wastes produced, barriers to lean implementation has been analysed and discussed. The results of the analysis show the benefits lean provide to the construction industry even though many barriers can be faced at the time of implementation.

Keywords: Construction industry, MEP, Lean, Lean tools and techniques, Last Planner System, Just In Time.

1. Introduction

Lean principle started from the manufacturing industries to make excellence in operation. The main five essential lean methods are Just In Time method, Automation, Kaizen/ Continuous improvement, Total Productive Maintenance and Value Stream Mapping (Reyes, 2018).

When the project success is considered from the side of a project manager, it is as Meran, (2013) reveals determined by the delivery of the project before the deadlines given, completion of the project within the budget, and by estimating whether the project output is meeting the expectations of the stakeholders. Maturana et al., (2007) states that construction waste sources of the present situation of the industry are mainly :

- Overproduction- when the fabrication of the material is done too early or because of the quality is less which leads to the ordering of extra material other than producing and delivering the required amount of materials at the needed time.
- Waiting- mostly happens when the team will be waiting to start next activity because of pending delivery of the material, sometimes waiting for the further plan to proceed or for an RFI, waiting of payrolls etc.
- Transportation- unnecessary movements which happen while transporting materials from one site to another, one yard to lay down or actual work area.
- Over-processing- those are the unwanted measures taken in the value chain of the project also steps taken, which lead to the double data entry like forms which require multiple signatures.
- Inventory- when the overproduction making way for the excess materials like the materials at site storage, work in progress, unused parts or tools etc.
- Motion- it is the extra effort taken by the team to complete a work which also includes time wasted while looking for a proper tool required.
- Defects- this is the improper work which needs a repair, reworks or replacement, which includes damage due to not using the materials specified.
- Unused employee creativity- this includes the inappropriate utilization of the skills of the people, knowledge, creativity etc. Employees must be empowered with the tools for providing proper working method.

The complicated delivery process, long project process is the particularity of the construction field according to RIBA plan of work 2013 every stage is particularly flexible with long and complicated process.

Various tools and techniques can be used for the controlling and task planning like break down structure, Program Evaluation & Review Technique, Gantt chart or bar chart, CPM (Critical Path Method) etc.

As per Mawed et al. (2014), cost estimation accurately at the early stage can avoid the cost overruns in the construction project. The contractor or the estimators are employing engineers, estimators, so the chance if the failure of the project due to the cost overrun or to achieve desired results does not involve the incompetence. The main cause of the failure is due to the recognition issue regarding the size and complexity of the steps which are undertaken for the essential resolution of the problem (Hicks, 1992). The main cause of the cost overruns is the failure to accommodate the unforeseen factors during the early conception and design stages. The factors which affect the performance of the cost is at the preconstruction and construction stages of the project.

Additionally, the ability of the contractor to manage the site is the main requirement for the control of the project costs (Doloi, 2013). The procurement method in the construction ranges from the activities which lead to the proper materials or resources needed at the exact time for the successful close out of the project. The traditional procurement processes that are used in the constructions projects are, Construction Management method, Design and Construct, Lump Sum Contracting, On Call Contracting, maximum price guaranteed method, Reimbursable Full cost method etc. (Rajeev, 2015).

2. Literature review

Lean was invented to help the manufacturing industries excel in operation, which allows the organisation to meet their primary objectives like quality, profit, efficiency, customer responsiveness etc. The main five essential lean methods are Just In Time method, Automation Kaizen/Continuous improvement, Total Productive Maintenance and Value Stream Mapping (Reyes, 2018).

The basis of the lean thinking was put forward by the Production System of Toyota in Japan. This approach put forwarded by Taiichi Ohno and associates who were employed by Toyota after the Second World War. The main basis for coming out with lean was to eliminate waste originated during the production or manufacturing process (Pepper, 2009).

Lean was applied to the large manufacturing sections which exclusively manufacture high volume and facilities of low variety. After the application of these principles in Toyota, western companies followed the lead and the first one of them was US automotive manufacturers. The main lean tools which can be applied in the construction industry can be summarized as below:

Value- This method can be used to identify the value for the client. Reduction of wastes can be increased, and additional features can be added by this method (Picchi and Granja, 2004). This can be applied for focusing on the whole enterprise for getting the determination of the product characterisation and for the benefits which are associated with it, and the client is ready to pay which mentioned as the first step for the identification of wastes (Womack and Jones, 1997).

Value stream- Value streaming can be applied for the mapping of materials and information and after identification of the need of the new requirement of the value stream mapping which can be implemented by proposing necessary improvements and identification of adequate tools (Picchi and Granja, 2004). As Elfving et al. (2002), states that when the lead times for the items like electrical switchgear can be reduced, it can control the higher number of design changes and order changes.

Flow- The works structuring method can be used for the identification and minimization of the process wastes. The workflow can be created by implementing the work division pattern among teams and workers and also work can be standardized by this method (Picchi and Granja, 2004). This tool is related to the ideal flow of the activities which is having value or flow of value, waste eliminations and lead time reduction of the generation of new services and products (Womack and Jones, 1997).

Pull- This will provide a proper communication system among the systems for the appropriate coordination and arrangement of materials on time and also for the proper coordination among different individuals (Picchi and Granja, 2004). When this is implemented properly, benefits are being reported as small buffers, project completion in an earlier stage and higher level of productivity (Tommelein and Weissenberger, 1999).

Perfection- This method can be used for the establishment of procedures which can provide continuous learning and developments in the level of hierarchy which can help the identification of variations from the standard work process (Picchi and Granja, 2004). When this strategy is adopted, ensuring the identification of problems in an efficient way and solving it rapidly. (Spear and Bowen, 1999)

2.1 Last Planner System (LPS)

Last Planner System has four levels;

- Master and phase plan consists of the overall project plan which has been evolved from the design stage and it will support the aims of the project and which contains the lead time for each activity (Kenley and Seppänen, 2010).
- Look ahead plan consists of the works arranged which should be carried out and week number is decided according to the characteristics of the project, the planning system reliability, the acquiring information lead time required and as per the material, labour and the works tools requirement (Ballard, 2000).
- Weekly progress plan includes activities of what should be done can be made to what can be done, and it can form what work can be done, and any variation in quantity and reason in each task in the weekly work plan will be recorded (Ballard, 2000).
- Percentage plan complete feature is used for tracking the works which have been carried out which is calculated by the number of completed assignment divided to the complete assignment number in each week. The failure reason is found out in this method, and proper measures are taken for the completion of assignments (PMI 2008).

2.2 Just In Time (JIT)

The stock downstream process and inventories of the process were minimized by Ohno. So the main advantage is that the identification of the problems can be done from the roots and solved which can lead to more progress and very less amount of defects (Ballard. G & Howell, 1995).

Monden (2011) mentions that the implementation of lean in any area is for the elimination of wastes. This process will continue up to the time when each process will pull the necessary parts needed from the previous process in a whole stream. Kanban system can be used for the coordination of the entire process (Monden, 2011).

2.3 The functionality of BIM in construction

BIM can be used in construction projects for editing, compiling, evaluation and reporting information which is related to the construction projects (Hammoud et. al., 2017). BIM tools and modelling share the fundamental technology of all functionality (Sacks et al. 2004). The BIM tool of the object modelling uses software which can be applied to gather the data and manipulates for the representation of the real world concepts. Several parametric objects are applied to the model object and it can be used for the analysis of the expression of objects, manipulation of the behaviour of the objects by the application of rules. Like a door also should move along with the wall when the wall is moved from its current position (Tolman 1999).

2.4 Value Stream Mapping (VSM) in lean construction

This Value Stream Mapping method can be used for the elimination of wastes and making the supply chain of an organization complying to lean and making it much more responsive. This tool can be used to highlight processes, inefficiencies, and communication issues and to get guidance do improvement in these (Womack, Jones, 1990).

It helps to maximize the activities which are happening inside and can be used for improving the whole flow which happens inside the construction project (Salem, 2006).

2.5 Preconstruction and modularization

The construction waste production is mostly due to the selection of the construction method, on site-sorting availability, construction wastes recycling method, workers level of training and education (Poon et al., 2004).

The timber formworks which is used for the construction of buildings can be made by using the cast-in-situ construction technique. Also, the change being done in the last minute is one of the main reason for

the construction waste and also the works like masonry, plastering, concreting which are usually done in the site are considered as another largest waste in the industry (Osmani et al., 2006). The reduction of wastage was reached about 77% percentage. Also, Tam et al. (2005) claimed that timber wastes were reduced to 74-87%, plastering works to 100% and concrete works were reduced to a level of 51-60%.

Prefabrication method lacks flexibility in the case of manufacturing. The design of the prefabricated element cannot be changed or modified at the time of the construction phase to the demand in the market (Chu and Wong, 2005).

Modularization can be considered as building blocks usage which is simple or the use of pre-assembling materials. It is like the construction done by fitting various modules which can be used to produce various volumes. Modularity can be defined as product structure and functionality (Mullens, 2004).

2.6 Kaizen technique in construction

According to the certification under ISO-9000, it was also developed as part of the Total Quality Management System (TQM). This method motivates the stakeholders for doing development and improvement to existing systems by rectifying the defects which can affect the overall improvement of the work environment (Melles, 1994). According to Ashmore (2001), the origination of the Kaizen technique was an issue which happens in the current management system, and there was a shortage of labour. Japan wanted an improvement to this by solving the problem by providing co-operation with the workforce. When this method is implemented in the construction industry, the improvement is expected or maintained when the standardization of the methodologies of this method is done permanently (Melles, 1994).

2.7 5S plan

Hirano (1995) explains 'Seiri' as an organization that mentions the exact item is needed and what all items need to be removed or not required. But Seppänen et al. (2010) define the organization of the required things so that anyone can find and use the things early. Seiso is meant for cleanliness, which means for keeping or making the things in order. Seiketsu means for the standardized cleanup, which includes the organization, cleanliness and orderliness to be done properly. Shitsuke means about the discipline, which is to be followed in all procedures (Hirano, 1995).

1S Organization, most of the organization the people will not discard things thinking as they will be required in future. Maybe that item will come to use in future, but most of the time the chances are less. This will result in the accumulation of unnecessary items, and it will destruct the work safety and efficiency (Hirano, 1995). According to Rahman (2010), 1S means keeping things in to wanted and unwanted. Then removal of everything must be done which materials are unwanted.

2S Neatness, Ho (1998) mentions that for achieving neatness following steps need to be followed. First of all, the analyse data like how and how much time are people taking to get items out and how much time are they taking to store it back. The proper labelling of the items must be done, which must be matched with the name of the item and the location which it has been kept (Ho, 1998). The monitoring whether the area is neat must be done in a proper way for making sure that it is happening in a proper way and the areas that must have higher considerations for neatness must be considered properly. All participants in the project must take responsibility for maintaining the neatness all over the project (Rahman, 2010).

3S Cleaning, Ho (1998) mentions that everybody is equally responsible for cleaning. For better management of sanitization in the work site, the cleaning responsibility must be assigned as per their scope of works and according to the areas. Each subcontractor's people must be given the responsibility for getting their own areas cleaned and for monitoring this process there must be an authorized person. All the unwanted materials which have been sorted in 1S process in each stage must be removed from the site at regular intervals (Rahman, 2010).

4S Standardization, Rahman (2010) mentions that everything which is happening must be in a standard. For all items, it must be maintained properly and must be identifiable and also properly inspected. All critical or important areas must be properly identified to everyone. According to Ho (1998), visual management can be used for making improvements in an organization continuously. This includes the Transparency, Labelling, Visualization of the conditions, Maps and Quantification. Labelling means making sure appropriate labels has been done which can be made of eye-catching colours. Quantification means the measurement, analysis of the data and the areas which is having less performance is identified and necessary action is taken for making everything on track (Ho, 1998).

5S Discipline principle means the creation working environment. There must be certain rules which need to be followed for removing bad habits. For a society to run smoothly, the basic tool is to follow the rules. If discipline is attained, this is a guarantee for the performance continuity and its repeatability. If the cleaning process is followed as a discipline by a worker in a construction site, the site will always be clean and maintained in a tidy way (Ho, 1998).

Rules are made to be followed in the site. Especially while taken site safety into consideration. All the respected head of each department must make sure the rules are followed properly for making the works flowing in proper co-ordination. At the start of a project and also during regular intervals proper awareness regarding the need for rules and following of that should be advised (Rahman, 2010).

2.8 Barriers to lean implementation

Morris and Lancaster (2006) state that, the idea must be adopted by the management of the company who need to accept the lean principles by understanding certain changes to be made to the lean principles as it is getting transferred from a manufacturing industry to another sector in order to avoid the barriers causing its implementation difficult. As per Olatunji (2008), the classification which comes when the implementation of lean principles to the construction industry are related to Knowledge and skills, Management, Government, Attitude, Resource & Logistics. Some other barriers are also there for the application of lean principles.

One of the main obstacles for learning and co-operation in the organisations which is that the existence of subcontracting and fragmentation (Mossman, 2009). The participants of the organisation usually have different priorities and views, but all of them are having the same objective to complete the project successfully (Abdullah et al., 2009). When the lean concepts are trying to get implemented, poor communication will act as a barrier for successful coordination and delivery of the project (Mossman, 2009).

In Contracts and procurement, Mossman (2009) mentions that lean principle is not found in the traditional procurement methods be used for having an adversarial relationship among the participants involved and this can increase the production of wastes.

As per the statement is done by Johansen and Walter (2007), if any design works are getting delegated to the designer outside the team and if there is no follow regarding that this can get the design separated from the construction process and objective of lean implementation cannot be done.

If lean principle need to be implemented as a new method in the construction industry, first of all, the attitudes of the participants in that construction industry matters really which means a fresh approach must believe that removal of waste must be done, make a continuous flow, increase the value for the customer etc. (Rooke et al., 2003; Rooke et al., 2004).

As per Mossman (2009), it is better to learn new skills and better-thinking possibilities at an early stage other than waiting for a crisis to happen. If any firms are satisfied with the current objectives which they are being achieved using traditional management methods, then the industry will not be ready for having a change even if they are having improvements in their current performance, increase in quality and increase in their productivity rates (Abdullah et al., 2009).

Proper finance or funding is needed for providing the necessary facilities, tools, equipment, rewards, proper wages, expense in training and professional development programs and expense for the employment of a lean expert at the time of initial stage of lean implementation (Bashir et al., 2010). According to Olatunji (2008) and Mossman (2009), mostly occurred barriers in the lean implementation are not having proper funding, construction market instability, scarcity of social amenities, motivation and incentive scarcity, less remuneration etc.

Out of these, some of the lean principles applied in the manufacturing industry cannot be directly applied in the construction field. Certain changes to be done to get these principles applied in the construction field (Eriksson, 2009). As per Abdullah et al. (2009), an advanced study regarding the lean method or principle must be done thoroughly before application of that in the Lean Construction.

Bashir et al. (2010) mentioned that several awareness programs had been done regarding the Lean construction by the various practitioner, researchers, professional bodies etc. sustainable implementation of Lean Construction cannot be done due to the educational barriers threats.

As per the statement from Alarcón et al. (2001); Terry & Smith (2011), most of the non-value adding activities are invisible because traditional method of control's main focus is on activity conversion other than concentrating on the activity flow and it is much more important to track the improvement by getting the problems detected and identifying the causes which are causing that problem instead of simply doing the reporting of problem.

3. Research design and methodology

A mix of methods were used for data collection according to the research objectives. The questionnaire is distributed among various professionals for analysing their response for questions. The interview of the various professionals is also done, and their response is analysed. The validity and the explanation of the problem of research are getting failed to explain using the quantitative method of research and lacking in the study using the statistics is the problem of the qualitative research. This mixed method helps the quantitative and qualitative research come together for getting the results properly to achieve the research objectives (Creswell, 2017).

Quantitative data collection was done through a questionnaire distributed among 140 construction professional using various electronic communication methods and the data received was from only 67 respondents. This means 47.86% of respondents. Various project participants provided the data which provided proper understanding regarding the aim of objectives of this research.

Interviews were conducted among three construction professionals who were well experienced in the construction field. A semistructured interview including a covering letter and research-based questions were shared which provided a response with critical analysis for the research objectives.

4. Result analysis and comparison

This section analyzes the response received for the questions which have been asked to 140 construction professionals, which include clients, subcontractors, contractors, suppliers, consultants etc. as shown in Figure 1.

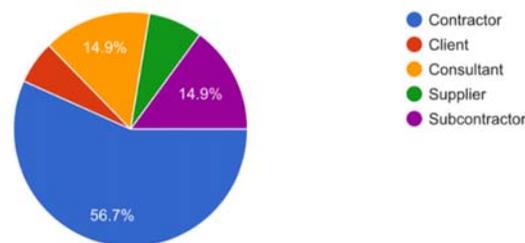


Figure 1: Chart showing the type of organisation of the respondents

The questionnaire was distributed to 140 construction professionals, and the number of responses received was 67. That means 47.86% is the percentage of respondents. The outcomes of the questionnaire were analyzed and discussed in the sections which have been given below.

The responses were received from Contractors (56.7%), Clients (6%), Consultants (14.9%), Suppliers (7.5%) & Sub-contractors (14.9%) and out of these respondents:

- 19 respondents (28.4%) were having a work experience of 0 to 4 years,
- 22 respondents (32.8%) were having an experience of 4 to 8 years,
- 10 respondents (14.9%) were having an experience of 8 to 12 years and;
- the remaining 16 respondents (23.9%) we had an experience more than 12 years.

Refer to Figure 1 and Figure 2 for more details.

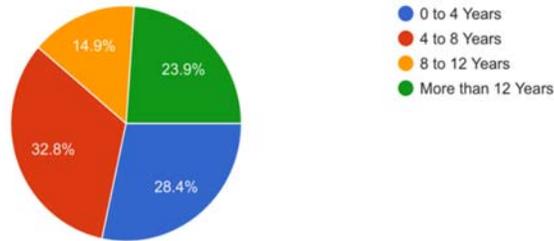


Figure 2: Chart showing percentage of experience of the respondents

The overall response from the professionals showed that around 70% of them agreed that the construction industry is a waste producing industry and 15% moderately agreed to this statement and remaining 15% didn't agree to this statement. While analysing this and also according to the present situation of the construction industry, the performance can be considered as poor. That means waste is a part of the construction industry as of the current situation and its quantity can be varied. This may be due to the way resources are utilised, methods used, lack of planning, etc.

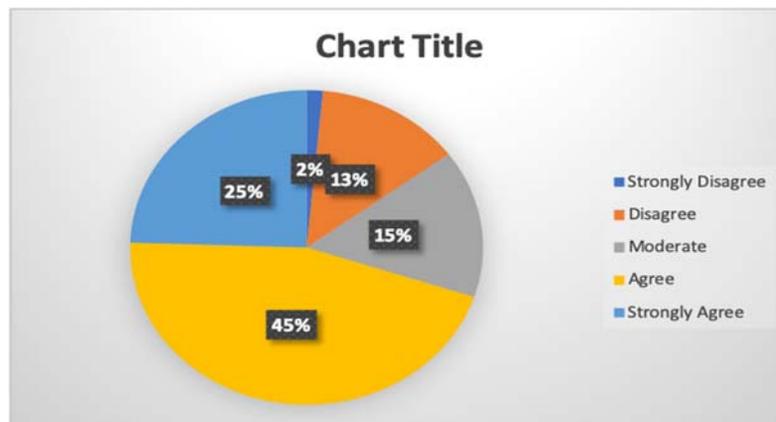


Figure 3: Chart showing opinions regarding waste produced in construction projects.

Respondents were asked to rate the benefits for the implementation of BIM to the lean principles from 1-High to 5-Low. Refer Figure 4 for more details. When the BIM is getting applied in the construction industry, everything goes systemically. This increases the collaboration of benefits among different disciplines and subsequently improves the productivity and the efficiency of the work. As BIM can provide the exact details of the services going through the building coordination between different disciplines, it can avoid various disputes because co-ordination issues can be solved at an earlier stage. The final product can be made visualize at an earlier stage as BIM can provide all the details of the final product at an earlier stage so necessary changes can be carried out so that final product can be made better. Also, when the BIM is applied to the construction industry it adds several improvements to various stages in construction, like it can make the coordination of various services efficiently. Lean principles are making the existing system to follow many efficient methods. So BIM can make the implementation of the lean principles much easier.

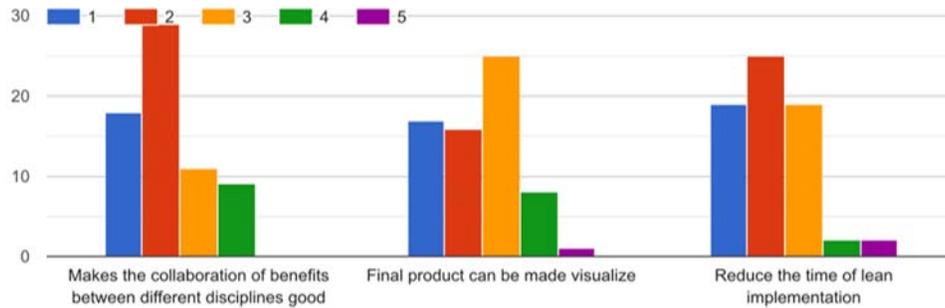


Figure 4: Chart showing respondents views on benefits due to lean construction

As of the data received from the response, barriers from various levels can affect the implementation of lean in the construction industry. Many barriers from internal, external and even political barriers can be expected. As these principles are new to the construction industry, it will be very difficult for the people directly and indirectly involved in the construction field to adopt it and to follow the principles for making it a success. The subcontracting and fragmentation can lead to various difficulties as the main contractor must convince them to follow lean principles properly, and it can lead to various disputes. In general, people are prone to stick to the traditional management methods which they are already trained in and experienced to work with. To get lean implemented in various phases in the construction industry, a lot of financial support (which should be accepted by higher management) is required, and a lot of changes need to be made to the current methodology and infrastructure to meet the requirements.. Most of the participants have little knowledge about lean construction, its benefits, and how it is going to affect the construction industry. If introduced to it, some may be unwilling to accept the implementation of the lean principles due to fear of not being able to follow the principles properly. Refer Figure 5 for analysing the barriers rated by professionals.

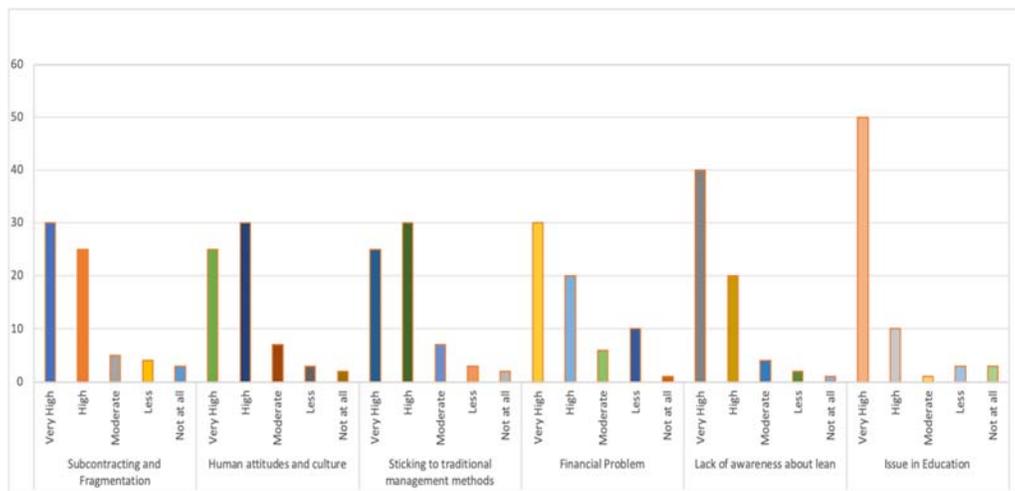


Figure 5: Chart showing respondent's views on the influence of given barriers while implementation of lean is done in the construction industry

As per the overall response received, lean will present many benefits if it is implemented properly in the construction field. It can provide benefits in the areas of safety, quality, proper resource utilisation, makes environment-friendly, making delivery proper etc. Many flaws in the existing methods can be solved using lean application in construction like co-ordination issues, which is still happening even though we have approved co-ordination drawings. The lean principle's application in the construction industry can get the final product quality can be improved at a higher level than the quality which is getting received by

following the traditional method of construction. The final product quality improvement means improved customer satisfaction, which should be the first aim of a company. When lean principles are followed properly, the work quality can be improved, and improved work quality can lead to an improved working environment which can lead to the safest working environment which can increase the accident-free working hours. This can lead to employee satisfaction so that they can contribute their best in work. The main aim of the lean principles was the reduction of wastes, which means the better utilization of resources in the construction field. This can lead to a reduction of wastes, and unwanted expenses can be reduced. When the wastes are there, that is a curse to the environment and can have a negative impact on the environment. For example, improper handling of chemical and improper disposal of hazardous materials like rock wool insulation, paints etc. can lead to many harmful impacts in the environment.

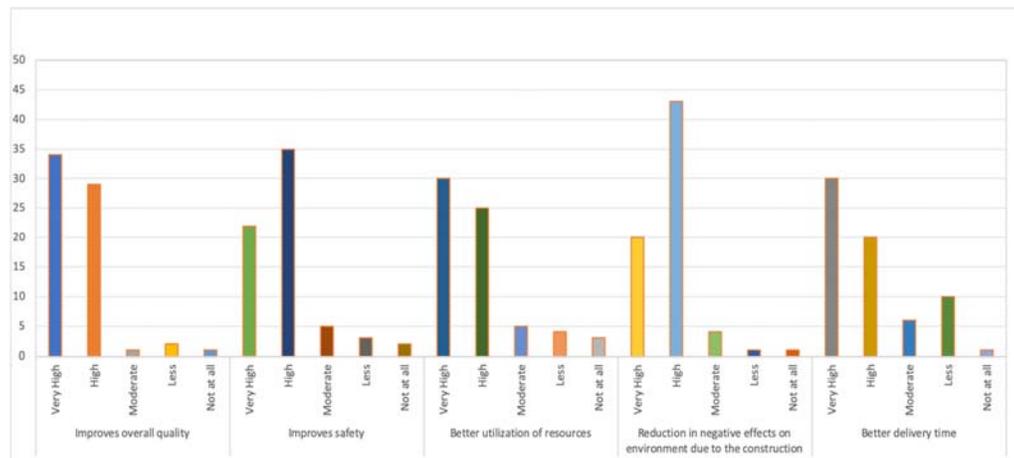


Figure 6: Chart showing the respondent's views on the effect of lean on the final product

5. Interview analysis

The interview was targeted to the highly experienced and efficient professionals working as a Project manager, Quantity Surveyor and Consultant having an experience of more than ten years in the UAE construction industry. They are well known to the traditional methods currently followed in the construction industry. The interviewed professionals belong to leading organizations who deal with building projects in UAE, which helps the researcher to understand the way participants deal with different projects in the UAE.

5.1 The current situation in the UAE MEP construction field

The dominant opinion of the professionals was that the situation of the UAE MEP construction industry can be in a better state, given the advancements made in the industry. In general, waste accumulation and high rate of consumption of resources etc. were some of the ongoing disadvantages in the construction industry according to the perspective of the project manager

A quantity surveyor mentioned the costs coming up after the project has started. And he also mentioned that the customer has to plan for the extra revenue from the final project because sometimes the cost can go up beyond the expected value. When the projects are given to the contractors at the tendering stage, they have to understand the complete scope and tender the project according to that. The client is preparing the funds for the projects based on that tender. The additional variation put forward by the contractors is making unnecessary delay.

MEP consultant's mentioned that construction industry is developing fast but not according to the technological advancements in other sectors. According to his opinion, some of the problems existing in the construction industry can be solved due to technological advancements.

The participants were not happy with the current situation of the UAE construction field, and all of them needed improvement from the traditional methods, which is usually followed in the MEP construction field. The major opinion of the professionals was that the situation of the UAE MEP construction industry can be in a better state, given the advancements made in the industry.

5.2 Perspective about lean construction in MEP

All of the interview participants had some idea about the lean principles. The overall response shows that it will be difficult to get implemented in the construction field, and if it is implemented, various significant changes can be expected in the construction field.

Project manager's perspective showed that the implementation of the lean in the construction industry can be expensive and can be time-consuming for getting all the participants to follow lean principles.

Quantity surveyor raised that implementation of lean principles has done many advancements in the manufacturing industry and so the proper application of the lean in the construction industry can provide various advantages like a solution for the unwanted costs and completion of works in a professional manner.

MEP Consultant's response was that lean must be implemented in the construction industry as soon as possible especially in the MEP field which is one of the most complicated parts of the lean construction as changes from the existing design which are getting followed from the long time even it has so many disadvantages.

The common response from all professionals showed that the lean can provide many benefits from the current situation when getting it implemented in the UAE MEP construction industry.

5.3 The barriers to the implementation of lean in construction

Different barriers were put forwarded by the participants according to their opinion. All participants strongly agree that there will be barriers to getting the lean implemented in the construction industry.

- Project manager pointed out some barriers like issues faced while getting the participants trained in lean construction, new resource consumption must be done to avoid traditional principles and replace them with the lean principles.
- According to the Quantity Surveyor, the client must accept that the lean can provide many advantages from the existing situation in the industry and he/she must also be willing to accept the extra cost for getting these principles implemented in the construction industry.
- The MEP consultant was concerned about the hidden problems which may be faced during various stages when the lean implemented in the construction field.

All participants mentioned some barriers that may be faced during lean construction implementation, especially the changes that need to be made in the existing system, extra cost and also about the hidden problems which may occur during its initial implementation.

5.4 Benefits can be expected in the construction industry after getting the lean implemented.

The participants put forward many benefits which can be achieved during the lean construction. Overall responses showed that lean provides many benefits to the construction industry.

The major benefit which can be achieved when lean is implemented was the reduction of wastes and also providing smooth operation of the works in the field as per the opinion of the Project Manager.

Quantity surveyor concluded that the lean implementation can reduce the unwanted cost which normally happens in the construction industry. Lean tools and techniques can also avoid the variation to a large extent so that the full scope can be completely covered at the tender stage.

New efficient design for the projects and improved documentation can be achieved which will help the site team better understand the complete scope of work, reduce delays, and improve coordination between various participants as pointed out by the consultant.

Regarding the benefits of lean implementation, all responses showed that all have huge expectations regarding the benefits when lean is implemented. Lean can avoid many problems which result during construction like possible delay in handover, wastage of materials, improper coordination, clashes of MEP services etc.

6. Conclusions

Lean principles can influence and benefit the construction industry in the UAE in various ways. The difference between the construction industry and the manufacturing industry is due to its particularity and due to change in the process of delivery of its products. The product delivery in construction while comparing to manufacturing is complex, which can be repeated and therefore, many unexpected issues and events may rise in this industry.

The performance of some projects in the UAE MEP construction field can be improved, which may lead to the reduction of waste that is normally produced in the construction industry. The industry faces some problems relating to the handover of projects, budgets, technical issues, working of MEP services, health and safety, etc. However, when lean is implemented in the construction industry, better utilization of resources, improved client support and product sole sourcing can arise on the basis of the effectiveness according to their experience.

The responses received from the questionnaire and interview show that the overall responses from the professionals support lean implementation in the construction industry. They also shed light on the barriers and difficulties that may be faced during the lean implementation phase, and the benefits of lean implementations in the UAE MEP construction field. They also mentioned how lean will help with some coordination issues that may be caused by the MEP services in building, the various types of training which can be provided to the participants in the construction field to implement lean which may lead to changing the traditional working practices, thus consequently improving the performance of the construction field.

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The Power of Coaching: Impact of Coaching Programs on Employee Performance in Bahraini Companies

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Abstract

The study aimed to analyze the "The effect of Coaching on employee performance", as a case study of a petrochemical industrial company in the Kingdom of Bahrain. Formulation of the research topic was based on previous theoretical models that guided researchers to understand the concept of Coaching and its theoretical base. The research methodology used for this paper was the descriptive analytic one as it was the most suitable regarding the nature of the topic and the data gathering method. The paper used SPSS statistical analysis software to perform the statistically tests on the data gathered from the sample. One of the main findings of the study is that there is a prevailing tendency from employees towards self-development and making maximum use of the coaching program. In addition, there is a continuous communication between the coach and the coachees, which sustains the positive results of coaching program. One of the most important recommendations is the importance of continuous development of the accompanying guidance program and keeping pace with the improvement of the interaction methods in the orientation sessions, which is accompanied by the results reflected in the interaction of employees and the extent of their commitment to apply the guidelines in practice.

Keywords: Coaching- Employee Performance- Human Resource- Performance Development.

1. Introduction

Although coaching has gained a wide popularity in the business world, it still has a long way to go in the Middle East. Coaching practiced in the business organizations are not clearly set and in most times it contradicts with the objectives and strategies of the traditional training. Responses of the coachee are difficult to be measured due to the lack of a clear strategy that sets the criteria and provisions of the coach and the efficiency of the process on the employee and the business environment in general. In a perfect world, managers usually care for their roles as managers and monitors and tend to focus on the comprehensive and cooperative interaction. In addition, even though managers in the middle east tend to consider the training in general as a useful process, they still consider it as a waste of time that should be spent on work instead.

The word Coaching stems from the Roman (Kocsi), which was the name of the village that designed the carriage pulled by horses. The expression was first used for the first time in 1830 at Oxford American University to imply the tasks of the teacher who develops the student and enable him to move up the stages. There are a lot of expressions that refer to Coaching, such as personal enabling, personal counselor, effective guidance, and personal training.

If we look at the international business tendency towards coaching, we find that recently they have adopted coaching styles sourced by their future orientation that comply with the importance of coaching inside the organization and its effectiveness for the employees and organization as a whole. As part of the training process, coaching shares the same objectives and directions to develop employees' skills and abilities in organizations, as it sustains the professional and behavioral change for the coachee through the self-awareness and sustaining and developing of the self-skills, which contributes to the individual and group guiding within the organization. Behavioral and skills change, within the organizational change, leads to opening numerous training chances as a means of implementing and sustaining change. Moreover, coaching could be used to encourage the group work and development of newly formed teams in addition to enhancing the communication skills among team leaders and members from one side, and among team members with each other on the other.

Hence, the main contribution of this work is that it increases the awareness of coaching in this part of the world with its primary features, in addition to analyzing the effects it has on employees and organizations and how it contributes to the improvement on both levels. Concerning the potential practical implications

of the paper, it offers substantial guidance that could help managers from different levels to evaluate the desirability of investment in the coaching process and addressing future planning of the their organizations, especially when it comes to the strategy of their human resources.

2. Theoretical Background

The majority of the literature about the issue claim that it helps improve the employees and the organizational performance, (Agarwal, Angst & Magni, 2009) argue that it provides a little empirical evidence concerning the effects of the practice. Hence, there is a necessity to explore the process and its empirical effects (Gray, Ekinci & Goregaokar, 2011). Hence, this lack of empirical evidence concerning the effectiveness of the process raises doubts about the feasibility of investing in the program and its justifications.

2.1 Definition of Coaching

There are many definitions for Coaching in the literature. Kama-Kolesch and Anderson (2001) states that "it is a form of systematic feedback intervention that is designed to improve the professional skills, interpersonal awareness and personal effectiveness", while Peterson (1994) considers it as a process that equips employees with tools, knowledge (Gil & Carrillo, 2013) and opportunities that they need for professional development, and to increase their effectiveness.

Wesemann (2015) describes coaching as a form of training that was developed to cope with the business environment which is distinguished by the existence of the element of interaction and guidance between the coach from one side and the coachee from the other. This eliminates the partnership element that was used by Katz & Miller (1996) to describe a basic aspect of the relation that makes training a unique among other intervention. Though the study of Kilburg (1996) did not use the partnership element in its definition of the process, it described training as a support relationship that is formed to achieve a number of specific objectives interchangeably, Rhea (2004) indicates that the relationship between the client and the manager is independent upon the tit for tat relation rather than one way one.

2.2 Development of coaching expression

- 1930-1950: Psychology consultants, practitioners, and scholars played the role of "advisors" who employed practices similar to those of coaching process. At that time, coaching focused on sales skills through use of skills sustaining methods of a sales rep. (Flückiger, Aas, Nicolaidou, Johnson, & Lovett, 2017).
- 1960-1970: Coaching appeared in the business world when leaders role within organizations were looked forward from the organizational development side and the importance of employing psychology in the mission. Coaching at the time appeared as a result of the organization leaders' endeavors. By the end of 1960s "scientific consultation" appeared to describe the consultant's role in implementing coaching programs to groups of workers and investigating their personal lives. (Flückiger et al., 2017).
- 1980s: Timothy Gallwey Inner Game introduced a method of sports and practices that were accommodated for commercial activity purposes and was called "Coaching". At the time, the first organization providing coaching services was established in UK and USA. (Whitmore, 2010).
- 1990s: More and more institutions specialized in coaching were established and programs were developed and enhances. The number of specialized institutions jumped from 2 in 1995 to 164 in 2004. At the time, we began to see professional conferences specialized in coaching. Moreover, during the 1990s, tasks and missions of coaching were specified and formulated within organizations. (Whitmore, 2012).
- 2000 till present: Numerous studies and books were published on the issue and as the culture concerned in business were more familiar within business environments (Nicolaidou, Karagiorgi, & Petridou, 2018; Wu & Parker, 2017), and many organizations applied coaching programs to develop its functions and productivity within the work fields.

2.3 Coaching and other concepts

Even though the objectives of coaching and other related, and sometimes mixed up with, concepts could be close to each other, there are substantial differences among them. In the following, we shall demonstrate the differences between coaching on one side and some of the common concepts on the other.



Figure 1: Coaching and other concepts

Source: <http://www.free-management-ebooks.com/faqch/principles-03.htm>

2.4 Coaching and Training

Despite the fact that they are different activities, these two methodologies can work very well when utilized together. One exemplary hindrance experienced in business learning is the obstacle of transferring skills and abilities from the classroom or workshop to the working environment. Coaching is a great method for helping individuals apply what they gain from a course to their everyday work.

The part of “manager as coach” is ending up progressively boundless particularly in business organizations that have a prevailing empowerment culture. While training is driven by the trainer himself/herself, and he/ she controls the greater part of both the procedure and the content of the process to transfer information/ knowledge or build up another skills as proficiently as efficiently as possible, on the other side we find that Coaching is driven by inquiries routed to the coachee, who at that point explores what they know, however in a way that would most likely not jump out at them without the direction of a coach. Mark McGuinness (2007).

Training and coaching adopt different ways to promote learning, which is the main objective of both:

1. While training focuses on teaching specific skills or knowledge, we find that Coaching focuses on facilitating someone else’s thinking and helping them learn on the job.
2. While training usually occurs off-site or in specified classes, we find that Coaching occurs in the office and can be integrated into day-to-day workplace conversations.
3. While training is more typically carried out in groups, we find that Coaching is tailored to the individual’s needs is usually a one-to-one process.
4. While training is usually delivered by an external consultant or dedicated internal trainer – Coaching can be delivered by an external consultant or by a manager.

Mark McGuinness (2007) puts it that way, “Although they are distinct activities, these two approaches can work very well when used together. One classic obstacle encountered in business education is the difficulty of transferring skills and enthusiasm from the seminar room to the workplace. Coaching is an excellent way of helping people apply what they learn from a course to their day-to-day work”.



Figure 2: Coaching and Training

Source: <http://www.free-management-ebooks.com/faqch/principles-03.htm>

2.5 Coaching and Mentoring

There are some shallow similitudes among mentoring and coaching, as they are both regularly balanced discussions conducted to encourage proficient advancement, however there are additionally noteworthy contrasts: Mark McGuinness (2007).

- A Mentor is generally a more senior individual who offers involvement and prompts a lesser individual working in a similar field – A Coach isn't really higher ranking than the individual being coached, and does not ordinarily give guidance or pass on understanding; rather he/she uses questions and input to encourage the other individual's reasoning and viable learning.
- A Mentor isn't commonly the line supervisor of the individual being tutored, yet somebody who is accessible for exhortation and direction when required – Coaching is every now and again conveyed by line managers with their subordinates.

2.6 Coaching and Counselling

Once more, there might be a shallow similitude in that both of these activities are one to one discussions, however their purpose and tone are totally different: Mark McGuinness (2007).

- Counselling and treatment manage personal issues – Coaching tends to deal with working environment performance.
- Counselling starts with an issue – Coaching can start with an objective or yearning.
- Counselling is looked for by individuals experiencing issues – Coaching is utilized by high achievers as much as novices or individuals who are trapped.
- Many (yet not all) types of Counseling center on the past and the roots of issues – Coaching centers on the future and building up a functional arrangement.

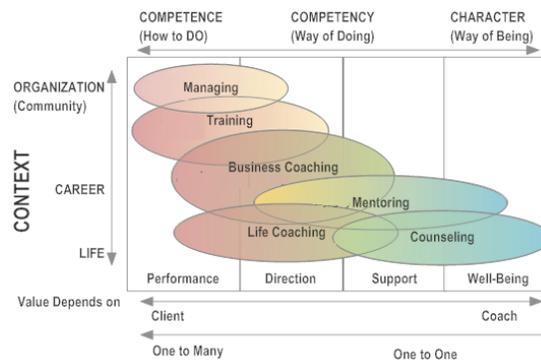


Figure 3: Overlapping of Coaching and like concepts

Source: Gainmore, 2010

2.7 Structured Coaching Plan

Objective setting and an organized coaching plan, as generally utilized, are depicted by Locke and Latham (2012) as a very successful motivational device and has been shown to build management profitability (Locke, 2011). Anderson (2012) found that joining objective setting with openly posted feedback and praise improved the performance of employees. Objective setting in blend with feedback was likewise found to increase performance in managerial interviewing skills (Nemeroff, 2011). Successful objective pursuit can be undermined by diversions except if suitable self-administrative abilities are utilized to adapt to alluring exercises irrelevant to the objectives a worker and coach have settled upon (Gollwitzer, 2010). In spite of the fact that there are numerous social-mental factors related with objective aim, the strength of a person's goal to finish is thought to positively affect self-regulation of behaviors (Bandura, 2012).

As per Hunt (2014), Employee's performance is a rating framework utilized in most enterprises to decide the abilities and result of the employee. The five components of performance are: monitoring, planning, training, rewarding and developing. The planning stage includes defining objectives with the goal that the employee work time can be estimated and the coach can check whether the employee can meet the set objectives or achieve new ones. Monitoring is the stage where the objectives are taken a gander at to perceive how well one is getting along to meet them. This can likewise be a criticism organize in which managers decide whether advancement is being seen or not. The employee improves any poor performance at the developing stage. The rewarding stage is the last stage toward the end of the cycle.

Coaching sessions may keep going for a little while or numerous months, with ebb and flow research revealing that 48% of coaching contracts are between 7 months to a year, which speaks to the overwhelming time allotment of the coaching assignments (Coutu and Kauffman, 2010). The writing depicts how coaches are careful about clients building up a reliance on the services they provide (Wellner, 2012). Around 40% of coaches express that they have needed to manage a client who is excessively reliant while 8% of coaches express that they have had an agreement to reach out for over 19 months (Coutu and Kauffman, 2011). The coaching procedure is commonly intended to push a client to autonomously settle on decisions and choices that achieve objectives when the coach is no longer around, so deep rooted reliance, which is morally flawed, ends up pointless (Wellner, 2012).

2.8 Coaching Environment

When coaching inside an organizational context, there is an eighth part to progress, which is organizational support for the coaching process and assignment of adequate time and finance by the organization (Kilburg, 2011). Wasylshyn's (2013) study showed that coaches trust it is their obligation to deal with the organization with the support, and notes that effective administration of this viewpoint adds to the probability of a positive result.

An investigation led by Arnott and Sparrow (2004) of 1,153 organizations in the UK, found that the organizations utilized coaching for three principle reasons: supporting a strategic initiative, supporting leadership development, responding directly to individual request. This is additionally upheld by an ongoing CIPO Training and Development survey (2004), which demonstrated that organizations are currently setting expanding significance on making and cultivating societies that bolster learning and improvement. Reassuringly, over 70% of organizations evaluated this among the three most significant variables when supporting powerful learning. The overview discoveries likewise demonstrated that respondents felt that it was basic for line managers to assume a huge job in exhorting on and supporting improvement action. Notwithstanding, the study inferred that 66% of respondents asserted that there was no formal composed methodology for their coaching activities occurring in their organization, and just 6% professed to have one that secured all staff. Moreover, just 5% professed to have line managers who had been prepared to coach their colleagues, and a stressing 49% just had a minority of prepared line managers who were a part of a more extensive management preparing program.

2.9 Linking coaching to employee performance

As can be summarized from the concerned literature, introducing coaching into organizations positively affects both employee and organizational. This is bolstered by numerous researchers who have analyzed performance among numerous other coaching results (Ellinger et al., 2003; Baron and Morin, 2009). In such manner, Ellinger et al. (2005) have decidedly connected coaching with employee performance and improved organizational related performance. Furthermore, Hunt and Weintraub (2002) avow that

coaching empowers workers to improve and develop, something that enhances their performance. Hence, this new HR practice is perceived as an effective way to boost employee performance and to encourage organizational changes and improvement. In any case, the connection between coaching interventions and employee performance isn't that immediate and basic. For employee performance to improve, numerous variables play their parts in the process.

2.10 Performance Tracking

Olivero (2012) study demonstrated that executive coaching increases the employee performance. Furthermore, Anderson (2012) demonstrated that coaching adds to behavioral change; yet the inquiry remains, "What characterizes an effective coaching intervention?" Brotman et al. (2011) indicated that sustained behavioral change is the best performance tracking apparatus. Sustained behavioral change was characterized as: "a displaced change in the target behavior by the

Executive". This change is steady even under strain or stress. Internalizing the mental bits of knowledge and the bothersome conduct behavior continues the new conduct while coaching makes the insights to be down to practical steps.

5. Analytical Framework and Hypotheses Development

In this paper, an analytical framework is developed to depict the relationship between Coaching with its dimensions and the Employee Performance, and the relative demographic variable that might affect the responses of the paper sample:

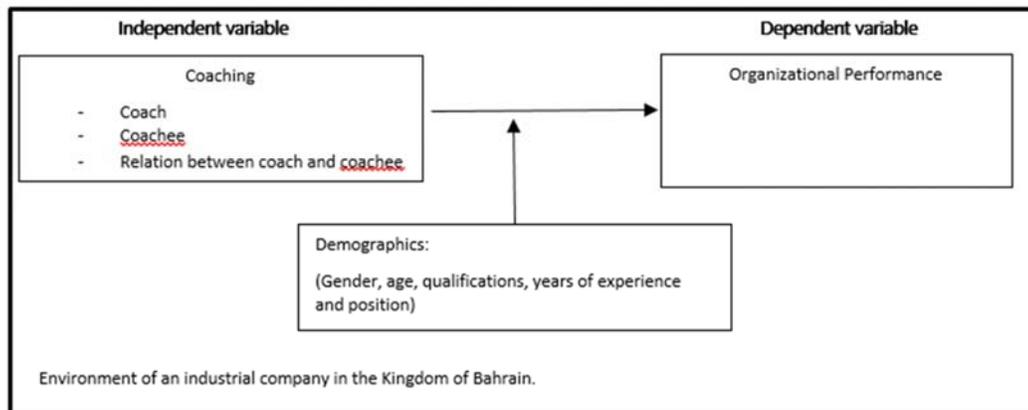


Figure 4: Illustration of the paper framework

5.1 Paper Hypotheses

H1: There is a significant effect of Coaching (Coach, Coachee, and Relation between coach and coachee) on the employee performance in an industrial company in the Kingdom of Bahrain.

H1₁: There is a significant effect of the dimension of Coach on the employee performance in an industrial company in the Kingdom of Bahrain.

H1₂: There is a significant effect of the dimension of Coachee on the employee performance in an industrial company in the Kingdom of Bahrain.

H1₃: There is a significant effect of the dimension of Relation between coach and coachee on the employee performance in an industrial company in the Kingdom of Bahrain.

H2: There are significant differences around the significant effect of Coaching (Coach, Coachee, and Relation between coach and coachee) on the employee performance in an industrial company in the Kingdom of Bahrain that could be attributed to the demographic characteristics (Gender, age, qualifications, years of experience and position).

6. Methodology

6.1 Data Collection

Data collection was conducted by the use of a specific developed survey that consisted of 42 statements distributed on 2 sections, 28 statements are categorized in 3 dimensions of coaching 14 statements are categorized in the employee performance, in addition to the demographic part. Survey was disseminated among all employees who were subject to the coaching program within the company.

6.2 Research Population and Sample

The researchers selected the census (n=70) of all employees who were subject to the coaching program within the industrial company in the Kingdom of as they are the most capable ones to provide the required information for the research.

6.3 Research Instruments

Survey consisted of the following:

- a- First Section: the demographic variables, to include the elements of age, gender, qualifications, experience, and job title.
- b- Second Section: Coaching, to include:
 - 1) Coach,
 - 2) Coachee,
 - 3) Relation between coach and coachee.
- c- Third Section: Employee performance.

6.4 Response Scale

The study depended upon Likert Scale, which is a 5-point scale that offers a range of answer options — from one extreme attitude to another as follows:

Table 1 Used Likert Scale

Response	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Level	5	4	3	2	1

The following table was used to determine the weight of each category to be used for the different statements of the survey. Al Fatouh, (2012):

Table 2 Weight of Categories

Average	Weight	Category
1.0-1.8	% 36 - %20	Very Low
1.8-2.6	% 52 - % 36	Low
2.6-3.4	% 68 - % 52	Medium
3.4-4.2	% 84 - % 68	High
4.2-5.0	% 100 - % 84	Very High

7. Data Analysis and Discussion

7.1 Testing the Normal Distribution of the data

To assure the normal distribution of the research tool, researcher used Kolmogorov–Smirnov test to confirm the validity of the normal distribution. Results of the test came as follows:

Table 4 Normal Distribution of the sample data

Survey Sections	No. of Statements	Kolmogorov-Smirnov	
		Z Value	Level Of significance
Section 1: Coach	10	0.693	0.724 (Insignificance)
Section 2: Coachee	9	0.743	0.639 (Insignificance)
Section 3: Relation	9	0.848	0.468 (Insignificance)
Section 4: Emp. Performance	13	1.123	0.160 (Insignificance)
Total	41	0.637	0.813 (Insignificance)

The above table shows that the results of the Kolmogorov-Smirnov came statistically insignificant on all sections of the survey and on the total survey as well. This confirms that the sample data are normally distributed, and hence, it is proper to use the parametric statistical tools.

7.2 Characteristics of the Sample and ANOVA analysis of Demographics

Table 5 "t" test for Gender Variable

Survey Section	Gender	n	Mean	SD	df	t value	t significance	Significance
Section 1: Coach	m	46	38.80	6.35	66	0.762	0.449	Insignificant
	f	22	40.05	6.12				
Section 2: Coachee	m	46	36.04	5.66	66	1.17	0.244	Insignificant
	f	22	37.73	5.21				
Section 3: Relation	m	46	33.93	6.68	66	2.51	0.014	Significant at 0.05
	f	22	38.27	6.59				
Section 4: Emp. Performance	m	46	53.85	7.54	66	1.33	0.186	Insignificant
	f	22	56.50	7.90				
Total	m	46	162.63	23.48	66	1.61	0.112	Insignificant
	f	22	172.5	23.90				

The above table reveals that there is no statistically significant differences in the sample individuals' responses about the role of the Coach nor defining the coachee that could be attributed to the gender variable. In the meantime, we have statistically significant differences at 0.05 significance level in the sample individuals' responses about the relation between the coach and the coachee that could be attributed to the gender variable. Such differences were in favor of females. Moreover, there is no statistically significant differences in the sample individuals' responses about defining the employee performance that could be attributed to the gender variable. Hence, there is no statistically significant differences in the sample individuals' responses about the effect of Coaching on employee performance that could be attributed to the gender variable.

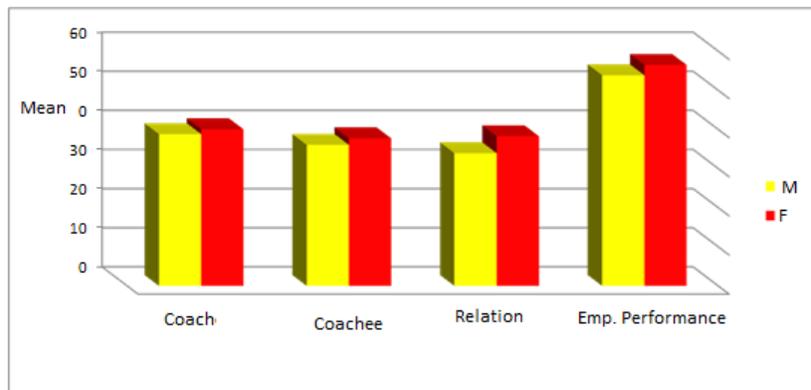


Figure 5: Differences among the responses attributed to "Gender"

Table 6 ANOVA Analysis for Age Variable

Survey Section	Source of Variation	Sum of Squares	df	Mean Square	F Value	Level of Significance at (F)	Significance
Section 1: Coach	Among Groups	15.667	2	7.833	0.195	0.823	Insignificant
	Within Groups	2613.451	65	40.207			
	Total	2629.118	67				
Section 2: Coachee	Among Groups	8.360	2	4.180	0.133	0.876	Insignificant
	Within Groups	2048.111	65	31.509			
	Total	2056.471	67				
Section 3: Relation	Among Groups	17.880	2	8.940	0.182	0.834	Insignificant
	Within Groups	3185.341	65	49.005			
	Total	3203.221	67				
Section 4: Emp. Performance	Among Groups	49.304	2	24.652	0.408	0.666	Insignificant
	Within Groups	3922.814	65	60.351			
	Total	3972.118	67				
Total	Among Groups	74.216	2	37.108	0.063	0.939	Insignificant
	Within Groups	38175.666	65	587.318			
	Total	38249.882	67				

The above table reveals that there is no statistically significant differences in the sample individuals' responses about the role of the Coach nor defining the coachee, nor the relation between the coach and the coachee, nor defining the employee performance that could be attributed to the age variable. Hence, there is no statistically significant differences in the sample individuals' responses about the effect of Coaching on employee performance that could be attributed to the age variable.

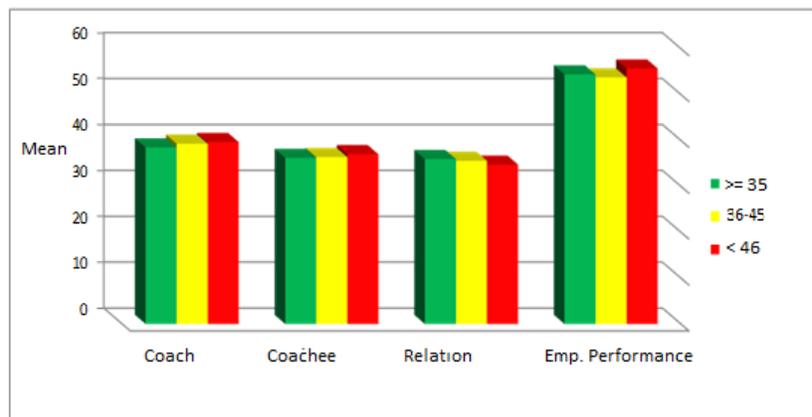


Figure 6: Differences among the responses attributed to "Age"

Table 7 "t" test for Qualification Variable

Survey Section	Source of Variation	n	Mean	SD	df	t value	t significance	Significance
Section 1: Coach	BA or Less	33	39.24	6.75	66	0.046	0.963	Insignificant
	Higher Studies	35	39.17	5.86				
Section 2: Coachee	BA or Less	33	36.00	5.59	66	0.848	0.399	Insignificant
	Higher Studies	35	37.14	5.51				
Section 3: Relation	BA or Less	33	35.64	6.34	66	0.343	0.733	Insignificant
	Higher Studies	35	35.06	7.50				
Section 4: Emp. Performance	BA or Less	33	54.27	7.94	66	0.446	0.656	Insignificant
	Higher Studies	35	55.11	7.56				
Total	BA or Less	33	165.12	24.04	66	0.234	0.816	Insignificant
	Higher Studies	35	166.49	24.07				

The above table reveals that there is no statistically significant differences in the sample individuals' responses about the role of the Coach nor defining the coachee, nor the relation between the coach and the coachee, nor defining the employee performance that could be attributed to the qualification variable. Hence, there is no statistically significant differences in the sample individuals' responses about the effect of Coaching on employee performance that could be attributed to the qualification variable.

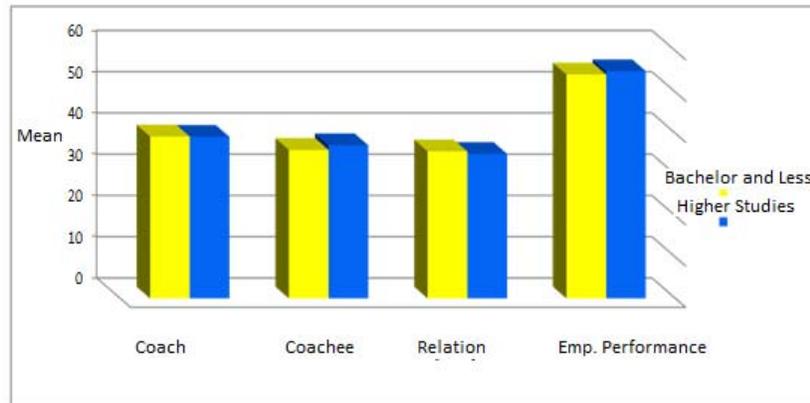


Figure 7: Differences among the responses attributed to "Qualification"

Table 8 ANOVA Analysis for Experience Variable

Survey Section	Source of Variation	Sum of Squares	df	Mean Square	F Value	Level of Significance at (F)	Significance
Section 1: Coach	Among Groups	9.945	2	4.973	0.123	0.884	Insignificant
	Within Groups	2619.173	65	40.295			
	Total	2629.118	67				
Section 2: Coachee	Among Groups	10.950	2	5.475	0.174	0.841	Insignificant
	Within Groups	2045.521	65	31.470			
	Total	2056.471	67				
Section 3: Relation	Among Groups	35.914	2	17.957	0.369	0.693	Insignificant
	Within Groups	3167.307	65	48.728			
	Total	3203.221	67				
Section 4: Emp. Performance	Among Groups	59.941	2	29.970	0.498	0.610	Insignificant
	Within Groups	3912.177	65	60.187			
	Total	3972.118	67				
Total	Among Groups	77.484	2	38.742	0.066	0.936	Insignificant
	Within Groups	38172.398	65	587.268			
	Total	38249.882	67				

The above table reveals that there is no statistically significant differences in the sample individuals' responses about the role of the Coach nor defining the coachee, nor the relation between the coach and the coachee, nor defining the employee performance that could be attributed to the experience variable. Hence, there is no statistically significant differences in the sample individuals' responses about the effect of Coaching on employee performance that could be attributed to the experience variable.

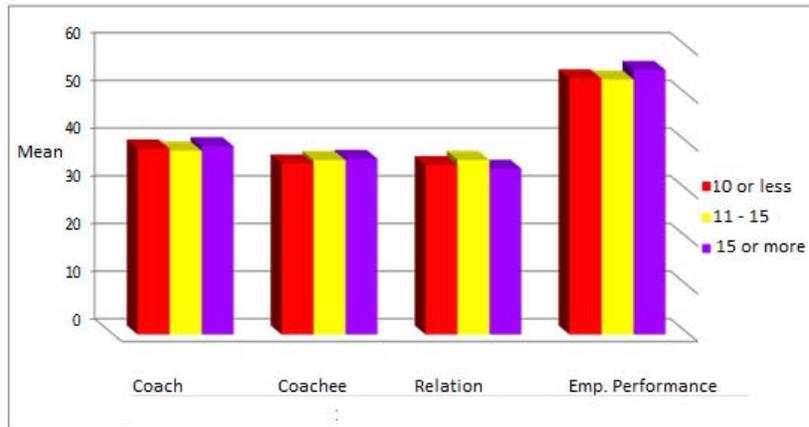


Figure 8: Differences among the responses attributed to "Experience"

Table 9 ANOVA Analysis for Job Level Variable

Survey Section	Source of Variation	Sum of Squares	df	Mean Square	F Value	Level of Significance at (F)	Significance
Section 1: Coach	Among Groups	94.274	3	31.425	0.793	0.502	Insignificant
	Within Groups	2534.844	64	39.607			
	Total	2629.118	67				
Section 2: Coachee	Among Groups	209.662	3	68.887	2.422	0.074	Insignificant
	Within Groups	1846.809	64	28.856			
	Total	2056.471	67				
Section 3: Relation	Among Groups	82.659	3	27.553	0.565	0.640	Insignificant
	Within Groups	3120.562	64	48.759			
	Total	3203.221	67				
Section 4: Emp. Performance	Among Groups	371.309	3	123.770	2.200	0.097	Insignificant
	Within Groups	3600.809	64	56.263			
	Total	3972.118	67				
Total	Among Groups	2635.744	3	878.581	1.579	0.203	Insignificant
	Within Groups	35614.138	64	556.471			
	Total	38249.882	67				

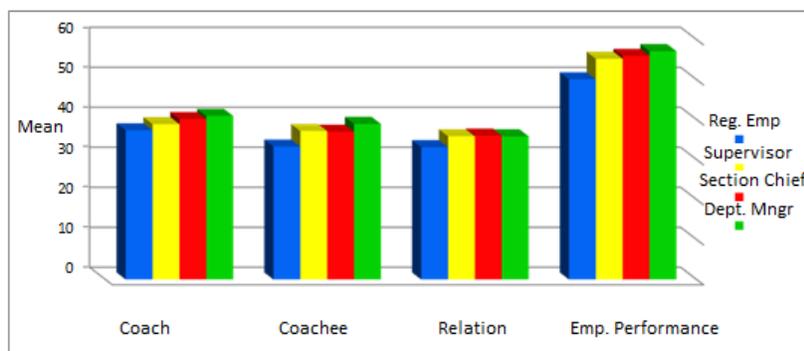


Figure 9: Differences among the responses attributed to "Job Level"

7.3 General Results of the data analysis:

For the first main hypothesis "H1: There is a significant effect of Coaching (Coach, Coachee, and Relation between coach and coachee) on the employee performance in an industrial company in the Kingdom of Bahrain", three sub-hypotheses were formulated and tested as follows: "H11: There is a significant effect of the dimension of Coach on the employee performance in an industrial company in the Kingdom of Bahrain".

Table 10 Anova Test for the first sub-hypothesis

Source of Variation	Some of Squares	D F	Mean Squares (MS)	"F"Value	P Value	Level of Significance
Regression	164.014	1	1641.014	46.46	0.00	0.01
Residual Value	2331.104	66	35.320			
Total	3972.118	67	-			

The above table demonstrates that the F value was 46.46, which is statistically significant at 0.01. This indicates that there is a significant effect of Coach Dimension on the employee performance at the studied industrial company. Hence, we cannot accept the null hypothesis and we accept the alternative one.

Table 11 Regression Analysis for the effect of Coach Dimension on Employee Performance

Dependent Variable	Independent Variable	B	Correlation Coefficient R	Coefficient of Determination R ²	% Contribution	"t" Value	P .Value	Significance
Emp. Performance	Stable	23.73	0.643	0.413	% 41.3	5.158	0.00	0.01
	Coach	0.79				6.816	0.00	0.01

The above table reveals that the R square is 0.413, which indicates a positive effect for the coach dimension on the employee performance at the study company, and that the coach contributes 41.3% of the variance interpretation of the dependent variable.

For the second sub-hypothesis "H1₂: There is a significant effect of the dimension of Coachee on the employee performance in an industrial company in the Kingdom of Bahrain".

Table 12 Anova Test for the second sub-hypothesis

Source of Variation	Some of Squares	D F	Mean Squares (MS)	"F"Value	P Value	Level of Significance
Regression	2529.522	1	2529.52	115.73	0.00	0.01
Residual Value	1442.596	66	21.858			
Total	3972.118	67	-			

The above table demonstrates that the F value was 115.73, which is statistically significant at 0.01. This indicates that there is a significant effect of Coachee Dimension on the employee performance at the studied industrial company. Hence, we cannot accept the null hypothesis and we accept the alternative one.

Table 13 Regression Analysis for the effect of Coachee Dimension on Employee Performance

Dependent Variable	Independent Variable	B	Correlation Coefficient R	Coefficient of Determination R ²	% Contribution	"t" Value	P .Value	Significance
Emp. Performance	Stable	14.127	0.798	0.637	% 63.7	3.704	0.00	0.01
	Coachee	1.109				10.75	0.00	0.01

The above table reveals that the R square is 0.637, which indicates a positive effect for the coach dimension on the employee performance at the study company, and that the coach contributes 63.7% of the variance interpretation of the dependent variable.

For the third sub-hypothesis "H1₃: There is a significant effect of the dimension of Relation between coach and coachee on the employee performance in an industrial company in the Kingdom of Bahrain."

Table 14 Anova Test for the third sub-hypothesis

Source of Variation	Some of Squares	D F	Mean Squares (MS)	"F"Value	P Value	Level of Significance
Regression	2334.818	1	2334.818	94.117	0.00	0.01
Residual Value	1637.299	66	24.808			
Total	3972.118	67	-			

The above table demonstrates that the F value was 94.117, which is statistically significant at 0.01. This indicates that there is a significant effect of Relation Dimension on the employee performance at the studied industrial company. Hence, we cannot accept the null hypothesis and we accept the alternative one.

Table 15 Regression Analysis for the effect of Relation Dimension on Employee Performance

Dependent Variable	Independent Variable	B	Correlation Coefficient R	Coefficient of Determination R ²	% Contribution	"t" Value	P .Value	Significance
Emp. Performance	Stable	24.536	0.767	0.588	% 58.8	7.745	0.00	0.01
	Relation	0.854				9.970	0.00	0.01

The above table reveals that the R square is 0.588, which indicates a positive effect for the coach dimension on the employee performance at the study company, and that the coach contributes 58.8% of the variance interpretation of the dependent variable.

Based on the above, we cannot accept the first main hypothesis and we can accept the alternative one that "There is a significant effect of the Coaching on the Employee Performance at the industrial company in the Kingdom of Bahrain".

8. Conclusion and Direction for Future Research

The study demonstrated how important the coaching process is for both, the individual employee, and the organization in general. Findings of the paper agree with other papers on the same issue but in different contexts, such as, Murithi (2016), Achi and Sleilati (2016) and others.

Furthermore, the study agrees with Núñez-Cacho et al. (2015) in which it reveals insight into the advantages of coaching process, both for the employee and the organization. The findings give an extra perspective to managers so as to welcome the advantages of the coaching procedure in a more extensive thought, both for employees and firms. On one hand, managers can understand the advantages of the coaching process for the coachees, which add to exploit the capability of the human resource of the organization, and on the other hand, a pertinent contribution of this paper are the benefits of coaching process in the organization, which can be estimated regarding the organization development.

Findings of the study revealed that while individual coaching may deliver positive outcomes within the short range, its viability as a tool for leadership development could be resolved over the long one. The main objective behind the coaching session ought to be very much disclosed to the worker by the coach with the goal that the employee has realistic expectations, and this likewise decreases sentiments that are uncertain in nature and furthermore guarantees the people don't misconstrue the explanations for the coaching.

In spite of the importance of the process worldwide, we still at the Middle East have a long way to go in this regard. According to ICF, the Middle East in general and Bahrain in specific began to act positively in this direction, and many Bahraini organizations adopted the Coaching strategies as part of their everyday life, but the issue still needs more studies and analyses to prove the appropriateness on the local business environment. Moreover, several specialized institutions within Bahrain made agreements with ICF, by virtue of which they are able to grant certified qualifications to applying coaches.

Furthermore, we believe that increasing the awareness of the benefits of the coaching process could encourage other organizations in the Bahraini market to adopt the process as a way of knowledge transfer within them.

The researchers hope to call upon further studies on areas such as the social factors, such as age, marital status or education background among others, that might affect the coaching programs in Bahrain, and how different coaching methods could be used to effectively impart knowledge to employees of different educational background and job disciplines.

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Challenges of Expanded Public Works Programme in the Provision of Construction Skilled Workers in South Africa

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Abstract

Despite the existence of the expanded public works programme (EPWP) in South Africa, which is geared towards providing some measure of respite for the unemployed and at the same time train and develop their skills, skill shortage is still a predominant feature in the country, especially within the construction industry. Understanding the challenges facing the EPWP and the measures for improving the programme in a bid to providing more skilled workers within the industry, was deemed necessary. A quantitative survey approach was adopted and questionnaire was administered to beneficiaries and coordinators of EPWPs in Gauteng province. Descriptive statistic tools were used in analysing the data gathered. Findings revealed that the major challenges of EPWP are low wages, lack of discipline among participants, limited duration of the training, and delay in payment of stipends to participants. In order to improve the programme, there is a need for improved coordination, management and administration among programme officials, improve communication, adequate funding, and improve training. This paper contributes to the body of knowledge as it brings to light the challenges of EPWP and the possible measures of increasing the efficiency of the programme in a quest to increase skilled workers in the South African construction industry.

Keywords - Expanded public works programme, Construction skilled workers, Talent development

1. Introduction

The Construction industry is one of the industries in South Africa that employs more people both on a temporary and permanent basis. However, the country at the moments is facing a skill shortage, which invariably has a negative impact on the quality and timely delivery of services within the construction industry (Mbeki, 2014). According to Werner (2014), the South African situation can be described as a paradox, as the country experiences a high unemployment rate, yet there is a shortage of skilled workers. The Human Science Research Council (HSRC) (2009) stated that the skills shortage in South Africa is largely regarded as a key factor preventing the achievement of targeted growth rates. This is quite unfortunate as skilled workers are seen to play important roles in the survival and growth of the construction industry since they are mostly engaged in the practical realisation of construction projects (Olofijin, 2016). Phillips (2004) therefore suggests that programmes which require the use of labour must be established in order to overcome the shortage of skills by providing training and skills developments to South Africans.

The Growth and Development Summit (GDS) held on June 2003 concluded with an arrangement agreed upon for starting of programmes that will employ people on a temporary basis, in order for them to acquire skills and training, and also receive salaries while they work (Department of Public Works, DPW, 2009). Former President Thabo Mbeki in 2003 during the State of the Nation Address, made the announcement that there will be a programme which will be a tool for the government to meet its promises of halving the high rate of people who are not employed by 2015 (DPW, 2007). A product of the GDS agreement and the president's announcement is the Expanded Public Works Programme (EPWP) established with the sole aim of providing work opportunities combined with skills and training to improve lives of the disadvantaged (Mukanyima 2012). The EPWP was established in 2003 and launched in 2004, to reduce poverty by providing salaries to beneficiaries who work on public projects on a temporary or contract basis, and at the same time acquire certain skills and undergo training in the process. The government uses projects in different sectors to provide labour intensive programmes to grow the economy, reduce unemployment and at the same time develop the skills of participants (Phillips, 2004). McCord (2005) also noted that one of the crucial aspects of the EPWP is the skills

development and training that participants stand to benefit. The acquired skills and training is aimed at ensuring that beneficiaries can secure longer-term employment after working on any EPWP project.

Thus, considering the construction industry where a shortage of skilled workers is evident, it is believed that programmes such as the EPWP can help increase the number of skilled labour in the industry. However, this is not the case, as a major factor affecting the delivery of construction projects within the industry is still skill shortage (Khplant, 2016; Mbande, 2010). It is therefore imperative to assess the challenges facing this obviously beneficial programme, and the possible measures for improving same, in a bid to increase the number of skilled workers it is producing. Based on this background, this study assessed the challenges facing EPWP in South Africa, and the possible measures for increasing the performance of the programme. Subsequent parts of the paper include the review of relevant literature, the methodology adopted for the study, the findings of the study and the conclusions drawn from the findings. Based on the conclusion, recommendations were made for the possible improvement of EPWP in the country.

2. Literature Review

2.1 Overview of EPWP in South Africa

The impact of skilled workforce/craftsmen has been observed to be crucial both in the construction industry and in its end products (Medugu *et al.*, 2011). This is because they are directly involved in the realisation of construction projects delivery. The impact of the availability of this set of workers on construction projects, coupled with the ever-increasing pressure on construction contractors to deliver projects of desired quality, cost and on schedule time, has also been sufficiently reported in literature (Institute of Management and Administration [IOMA] 2005; Olomolaiye and Ogunlana, 1989; Medugu *et al.*, 2011; Ugheru, 2006). According to Bustani (2000), the quality and availability of a skilled workforce are considered an important factor in the effectiveness of the construction sector. The insufficiency of technically qualified personnel in the face of increased demand has led to a situation whereby big contractors are considering investing in training and development. However, the government through public works have continued to provide programmes that will help in the development of citizens and through training, increase the skilled workforce.

McCord (2009) noted that public works programmes were initiated in the United States of America during the great depression in 1930, and was later implemented in Africa and other countries around the world. Approaches such as cash for food or food for work is being utilised in many developing countries to pay their workers during these programmes. India, Botswana, Tanzania and South Africa are some of the countries that have employed the public works programme to reduce the high rate of unemployment and improve rural and urban areas. Braun *et al.* (1991) explained that public works programmes provide infrastructure to the public through the use of more labour and few machineries in order to provide and create work opportunities for people. Aside from creating jobs, Phillips (2004) emphasised that the main purpose of these programmes is to provide and create a suitable experience to people who are disadvantaged and needy, generate temporary wages, and help in developing more skills and decrease alienation.

The EPWP which is one of the public works programmes was first known in South Africa during the state of the nation address by then-President Thabo Mbeki in 2003 when he announced the multi-feeding programme. In June 2003 during GDS the agreement of initiating EPWP was concluded and confirmed to make the lives of South Africans easier (DPW, 2007). In May 2004 at Giyani Limpopo province President Thabo Mbeki officially launched the programme to provide skills and training to people of South Africa and to give a meaningful drop in the high rate of people who are unemployed and giving them a chance to earn income while employed on a temporary basis. The EPWP uses a mix of labour and light machinery to ensure that project objectives come into existence. However, the programme has its successes and setback (DPW, 2009). Thwala (2011) described the EPWP as a five-year programme geared towards increasing the number of people who are not working by providing them with job opportunities. While increasing the quantity, EPWP also impacts significantly on the quality as it serves as a means of training and development of the skills of beneficiaries. The EPWP is saddled with the responsibility of drawing a meaningful number of people who are not employed into productive work so that they can be able to earn salaries, providing education, skills, and training to people who are unemployed, help participants of the programme to be able to start their own businesses or find good jobs after exiting the programme, use budgets in the public sector to reduce unemployment, and start

social and economic infrastructure thereby giving social services as a means of meeting basic needs (DPW, 2007).

2.2 Challenges of the EPWP in South Africa

Despite the obvious usefulness of this programme, it is not without its own challenges. Van der Walt (2014) revealed that restricted communication is one of the most significant challenges faced in public programmes such as the EPWP. Since these programmes deal with the provision of public infrastructures, insufficient cooperation and coordination can be seen among participants. This can be as a result of diverse political interested in such public infrastructure project. DPW (2009) also indicated that insufficient knowledge to monitor, coordinate and evaluate the projects gives rise to lack of reporting and irregular monitoring. Kitchin (2012) noted that as a result of insufficient knowledge and commitment to the establishment of EPWPs in some municipalities has become difficult. Hemson (2007) also found that accountability of EPWP which is done through proper reporting of the progress of the programme is not done in some of the local communities. This has negative effects on overall parties involved in the programme and the success of the programme itself. Van der Walt (2014) also noted issues surrounding proper accountability of funds. It was observed that the transfer of fund from one financial year to the other is not remarkable as it tends to make auditing and the practice of accounting difficult. Kitchin (2012) further noted issues of inconsistent payment of wages to participants. Wages assigned to participants are not received as agreed; participants take 2 to 5 months without receiving any stipends which tend to demotivate them. Some of the participants end up leaving the programme as a result of this shortcoming. DPW (2009) emphasised that there were no enough budgets available for training to commence at the local government level. It was stated that the biggest challenge was not approving the accredited training for EPWP participants at the time of project evaluation, due to lack of fund. This situation can be linked to the inconsistency and delay being experienced in the wages of beneficiaries of the programme.

McCord (2005) noticed that there is also the issue of inadequacy in the training time given to beneficiaries of the EPWP. It was stated that training opportunities of 2 days for every 20 days worked, is given to the majority of the beneficiaries in EPWP. This is believed not to be enough to provide participants with training from unskilled to semi-skilled workers. Dube (2013) noted that the disabled in South Africa are mostly part of those people in need and have no work opportunities, as they are being rejected in the labour market. Restricting their participation in training programmes is a depressing issue for them since they will be stuck in poverty. Disabled people are not included in EPWP as result of not having enough skills to communicate with them, and their inability to carry out some of the required task. Providing means of accommodating these set of people rather than placing restrictions, would have gone a long way in promoting the intended effect of the programme on the alleviation of poverty within beneficiary communities. Lack of discipline among beneficiaries has also been identified as a crucial challenge of public programmes. Late coming and disobedience of beneficiaries to certain laid down rules have been noted (Dube, 2013; DPW, 2014)

3. Research Methodology

The study adopted a quantitative survey approach with a questionnaire administered to EPWP coordinators and beneficiaries in Gauteng province, South Africa. The choice of selection of the study area is premised on the fact that Gauteng has a high amount of EPWP projects going on within the province. The targeted respondents were monitors, directors, administrators, coordinators, project managers, learners and general workers who are currently working within the programme. These respondents were sampled using a convenience sampling approach as it was difficult to ascertain the exact number of beneficiaries and coordinators as at the time of conducting the study. The use of a questionnaire as a research instrument was deemed suitable due to its ease of usage and ability to cover a wider range of respondents within a short period of time. Moreover, Blaxter *et al.* (2001) have earlier stated that the questionnaire is among the most widely used social research techniques.

The questionnaire used was designed in sections with the first section geared towards gathering information on the respondent's background. The second section, assessed issues relating to the challenges of the EPWP and possible measures for improving the programme. A 5-point scale was adopted in measuring the variables in this section. A total of 65 questionnaires were distributed to respondents, out of which 59 were retrieved and deemed fit for analyses. Data collection was done through self-administering of the questionnaire. Aside from making the questionnaire simple enough for

the respondents to understand, painstakingly reading and filling of the questionnaire for those set of beneficiaries without any form of formal education to be able to read and understand the set questions, was done by the researchers. Data analyses were done using percentage, frequency, mean item score and standard deviation (SD).

4. Findings and Discussions

4.1 Background Information

The analyses of the data gathered on the background information of the respondents revealed that in terms of the type of respondents, 5.1 % of the respondents were monitors, 3.4 % were coordinators, 10.2% were project managers, 3.4% were administrators, 77.9% were general workers which include those that enter into the programme just to learn a trade or two, and those working to earn a living. Regarding their level of education, 10.2% of had no formal education, 16.9% had standard 8/Grade 10, 28.8 % had Grade 12/Matric, 23.7 % had N6 certificates, 5.1% had Diploma certificate and 15.3 % of the respondents had degrees. Furthermore, findings regarding the number of years within the EPWP revealed that, 64 % of the respondents are less than one year in the programme, 10.2% had 2 years, 10.2% had 3 years, 5.1% had 4 years, 3.4% had 5years, and 6.7 % of respondents had 6 years and above. On average, the entire population for the study has an average of 3 years within the EPWP. Based on these results, it is evident that key parties in the EPWP were well represented, with a considerable level of education and years of being involved in the programme attained. Therefore, the response gotten from the respondents in the subsequent parts of the survey can be relied upon.

4.2 Challenges of Expanded Public Works Programmes in South Africa

The review of related literature shows some significant challenges of public work programmes and these challenges were present to beneficiaries and coordinators of EPWP in Gauteng province, for them to rate. A scale of 1 to 5 was employed in measuring these challenges (5 - very high significance, 4 - high significance, 3 - average significance, 2 - low significance, 1 - not significant at all). The result in Table 1 shows the ranking of these challenges as perceived by the respondents. From the Table, it is evident that 10 out of the 11 assessed challenges have a mean value of above average of 3.0. This means that to a considerable extent, respondents believe that these 10 challenges are affecting the proper function of the EPWP in the Gauteng province. Chief of these challenges are low wages with a mean value of 3.93, lack of discipline among participants with a mean value of 3.66, limited duration of training with a mean value of 3.64, and delay in payment of stipends with a mean value of 3.56. The least challenge with low significance is the improper recruitment of participants with a mean value of 2.54. This implies that respondents of the study do not see how the recruitment process tends to affect the success of the programme as a whole.

The sole purpose of creating public work programmes like the EPWP is to attract the unemployed within the community with a view to engaging them, and them, in turn, getting wages for the job they do in order to survive. Bhavna and Swati (2012) and Haq *et al.* (2014) have earlier observed that factors relating to wages being given to workers have a significant effect on their satisfaction and commitment to work. In the same vein, low wages are bound to make beneficiaries of these public work programmes to be dissatisfied and their commitment level if bound to be affected. This finding further affirmed Kitchin (2012) submission that the inconsistency in the payment of wages to participants is a key challenge facing the progress of the EPWP. While these inconsistencies in wages exist, delay in making payment to beneficiaries as observed in this study is bound to also affect their commitment to the programme. An individual working expects to get paid as at when due and any deviation in this might considerably affect their satisfaction with the organisation for which they work. Kitchin (2012) have earlier noted that wages assigned to participants of public works programmes are in most cases not received at the agreed period. The DPW (2009) noted the issue of lack of fund to conveniently run some of these programmes, and this can result in the delay in payment of wages being experienced.

Majority of beneficiaries of the EPWP are unemployed and the possibility of them not being involved in any formal settings/work prior to their participation in the programme exists. Thus, it is not surprising to see factors such as indiscipline among these participants being a crucial issue affecting the smooth running of the programme. This can prove to be a serious problem to the programme as discipline is a key to proper training and development of any individual or group of people. This finding is in line with

DPW (2014) and Dube (2013) submissions that the lack of discipline such as late coming and disobedience of beneficiaries to certain laid down rules, are crucial challenges of public works programmes. Aside from providing a means of survival for its participant, the EPWP is also geared towards their training and skill development (McCord, 2005; Phillips, 2004). There is the need to make out time to adequately training these beneficiaries in order to achieve this feat. The present period allocated for training on the programme is deemed insufficient. This result is in tandem with the submission of McCord (2005) which stated that there is an inadequacy in the training time given to beneficiaries of the EPWP.

Table 1 Challenges of Expanded Public Works Programmes in South Africa

Challenges	Mean	SD	Rank
Low wages	3.93	1.285	1
Lack of discipline among participants	3.66	1.154	2
Limited duration of training	3.64	1.047	3
Delays in payments of stipend	3.56	1.523	4
Lack of communication and coordination	3.36	1.256	5
Inability to include disabled people	3.34	1.226	6
Lack of accountability	3.14	1.166	7
Lack of funding	3.14	1.196	7
Inconsistent reporting and management of information	3.07	1.158	8
Improper implementation	3.03	1.231	9
Lack of knowledge and communication	3.02	1.167	10
Improper recruitment of participants	2.54	1.369	11

4.3 Measures for improving Expanded Public Works Programmes in South Africa

In improving the EPWP in the study area, certain measures were presented to the respondents for them to rate based on their level of agreement. A 5-point scale was adopted with 5 as strongly agree, 4 agree, 3 neutral, 2 disagree, and 1 strongly disagrees. Result in Table 2 shows the ranking of these identified measures. A look at the table shows that all the identified measures have a mean value of well above the average of 3.0 with the least ranked measure (improved implementation process) having a mean value of 4.0. This result implies that, to a considerable extent, the identified measures have the tendency to help improve EPWP within the study area. Most important of these measures are improved coordination, management and administration, improved communication, provision of adequate funding, improved training, and provision of exit policies for participants with a mean value of 4.41, 4.25, 4.20, 4.19 and 4.19 respectively.

The role of proper coordination, management and administration cannot be overemphasised in the successful attainment of the goals of the EPWP. Kitchin (2012) suggested that different sectors of EPWP must come up with ways to build knowledge at different levels to meet the goals and objectives of the programme. Van der Walt (2014) further stated that different strategies that are available to facilitate the inter-government relations must be used to address coordination and administrative challenges as well as the principle of cooperative government. Communication is germane to proper coordination, management, and administration of every public works programme. Only through proper communication across all levels can the goals of the programme be achieved. This finding is in line with Mkhize (2012) who noted the need for all officials in public works programmes to regularly communicate in order to ensure a clear understanding of project objectives. The issue of proper funding is also crucial to the success of EPWP, as result shows that adequate funding is important. Makanyima (2012) have earlier noted that for public works programme to grow and have strength in the future, one must ensure that the finance used in the current moment is used in such a way that it will have a massive improvement on labour intensives programmes and stakeholders must be present to accomplish the strengths and growth. Van der Walt (2012) also emphasised that the budgets used for public works programmes should be allocated in such a way that it will be sufficient to overall projects cost.

For a successful programme, there is the need to further train officials in a bid to broaden their knowledge as regards the smooth running of public work programmes. Gafane (2011) suggested that officials should undergo training on how to monitor and organise programmes meant to provide skills development and training among South Africans. In addition, the time given for particular training should

be enough for beneficiaries to acquire all the information in both learnings in classrooms and on-site practical to ensure by the time their contracts expire, the training they have acquired will enable them to be ready for new employment. Furthermore, Thwala (2011) added that local government should be more involved in all the projects of the programme from commencement to completion so that training follows the right procedures. The finding of this study is in line with these submissions as improved training in EPWP is seen to be crucial to the success of the programme.

Table 2: Possible measures for improving Expanded Public Works Programmes

Measures	Mean	SD	Rank
Improved coordination, management and administration	4.41	0.673	1
Improved communication	4.25	0.779	2
Provision of adequate funds	4.20	0.664	3
Improved training	4.19	0.880	4
Provision of exit policies	4.19	0.776	4
Improved quality of employment	4.17	0.854	5
Increase in infrastructure projects	4.05	0.879	6
Required capacity building	4.03	0.850	7
Improve reporting system	4.02	0.841	8
Improved implementation process	4.00	0.910	9

5. Conclusion and Recommendations

The construction industry lacks adequate skilled workers despite the fact that the industry is labour intensive in nature. In a bid to increase the availability of skilled workers in the industry, public work programmes such as the EPWP is seen as a viable option due to its ability to provide skills development and training to its participants. However, since the advent of the EPWP in 2004, nothing has changed as regards the increase of skilled workers in the South African construction industry. Based on this knowledge, this study assessed the challenges facing the EPWP, and the possible measures for increasing the performance of the programme in a bid to providing more skilled workers within the industry. The study through the survey of beneficiaries and coordinators of EPWP in Gauteng province has been able to ascertain the major challenges of the programme and the possible measures that can help increase the performance of the programme.

Based on the findings, the study concludes that the major challenges facing EPWP in the study area are low wages, lack of discipline among participants, limited duration of training, and delay in payment of stipends to participants. In order to improve the performance of this programme, there is a need for improved coordination, management, and administration among programme officials. Also, improved and efficient communication system among officials at all levels and beneficiaries is important. Provision of adequate funding, improved training for both officials and beneficiaries of the programme, and provision of exit policies for participants are all important to the success of EPWP.

It is believed that the findings of this study will go a long way in assisting those responsible for the successful implementation and handling of the EPWP around the country in understanding the main challenges being faced in the programme and the means available to overcome these challenges. In addition, if the findings of the study are implemented, it will go a long way in increasing the number of skilled workers being turned out from the programme, thus, increasing the availability of craftsmen in the construction industry. Although this study contributes to the existing body of knowledge in terms of the challenges facing EPWP, it provides a guideline for future research in the area of assessing the effect of EPWP on the construction industry and its activities.

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An Evaluation of Equality and Diversity Issues within the UK Civil Engineering Industry

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Abstract

The construction industry has always been known for being predominantly male-dominated and seems stubborn for change. The industry in recent years has seen a change, and there has been an increase in women joining the construction sector. However, is there still an obvious lack of workforce diversification and inequality? Throughout this research paper, the objective is to find out the equality and diversity issues which currently exist in the UK civil engineering industry.

The aim of this study was to investigate the perceived barriers and stereotype that women and ethnic minorities (EM) suffer in the construction industry. 14 barriers were found in which restricted women and EM from entering the construction industry. There have been policies and organisations that have been trying to recruit more women and ethnic minorities. Furthermore especially for women in executive board level positions. This helps provide likely solutions which could strategically form a framework which can be embedded into construction companies.

A mixed method research was used to collect data. 8 participants were interviewed, and 19 participants took part of an online survey. The questionnaire and interview questions aimed to find out what stakeholder views were on the barriers within the construction industry, and the participant's individual experiences, taking into consideration of both EM and female responses to see if their experiences corresponded with the barriers mentioned in the literature review. Several recommendations were created to display how to tackle these barriers and improve the equality, and diversity within the construction industry. The conclusion of this study reviews the main findings, and completes with recommendations for development, and also paths to further research that is required.

Keywords: Equality, diversity, issues, women, ethnic minorities, engineering.

1. Introduction

What is equality and diversity? And why is it so important to address issues relating to diversity and equality in the UK civil engineering industry. Firstly, understanding what these terms mean and why we should encourage a more equal and diverse work environment is very important. 'Equality is ensuring individuals or groups of individuals are not treated differently or less favourably, based on their specific protected characteristic, including areas of race, gender, disability, religion or belief, sexual orientation and age' (university of Edinburgh, 2016). Even though there are initiatives and legislation been put in place to tackle inequality, 'women make up approximately 10% of employees in construction, compared to 46% across all industries' (Katherine Sang, Abigail Powell, 2010). Abdul

Despite acts put into place, it hasn't made a significant difference, and this research project wishes to explore why these issues still exist, and what legislation and acts have the civil engineering industry done to address these issues. Diversity 'aims to recognise, respect and value people's differences to contribute and realise their full potential by promoting an inclusive culture for all staff and students' (university of Edinburgh, 2016).

There many policies out there that tries to tackle equality and diversity issues. For example, the Government home office has many strategies and policies in place to try and encourage workforce diversification, and inequality. The GOV home office stand to, 'incorporate equality into our core objectives, making every effort to eliminate discrimination, create equal opportunities and develop good working relationships between different people' (Home Office, 2016). Furthermore, the equality act 2010 was introduced by the equality duty within the public-sector line of work. These objectives aim to 'have addressed equality issues across our functions and the services we provide'. We work with stakeholders to

deal with the issues that are most pressing for the department.' (Home Office, 2016) Moreover, this policy holds no ground for discrimination of any sort, regardless of gender, age, race, etc.

Looking at different policies regarding equality and diversity is important and it will help analyse them and construct a framework for a policy which should be embedded in the civil engineering industry. The ICE which stands for the institution of civil engineers is a 'professional membership body that government and industry listen to while providing unrivalled support to our 90,000 civil engineer members' (ICE, 2017).

2. Literature Review Findings

A review and critical analysis is carried out of different studies regarding the lack of women and ethnic minority in the UK construction industry. Journals, articles, books, websites, have been used alongside other sources of materials to compare and conclude what previous studies have found on the current underlying diversity, and equality issues in the UK civil engineering industry. Women are underrepresented in the UK civil engineering industry. Research carried out by (Amna Silim, 2014), supports this, as they found that in 2013, 7 percent of the engineering workforce was made up of women, and only 4 percent being engineering technicians. Even though nearly 50 percent of the overall workforce in the UK is made up of women, meaning nearly half of the UK's workforce is women, a very small amount work in the engineering sector, and the industry itself is not doing enough to attract, and encourage females to work in the field.

As research by (Amna Silim, 2014) found that the engineering workforce across Europe is only one-sixth female. This does question what is the UK civil engineering industry doing to tackle these inequality issues? Moreover, is it the educational system which is the cause of the lack of encouragement for women to join the construction industry? There are many barriers which prevent women from working in the construction industry. Research supported by (Pepper, 2005) discusses these obstacles which are the main reasons as to why women are put off going into construction. Firstly, the image of construction itself is not great the women are unenthusiastic to consider it as a career option, and it does not appeal to them. This is also supported by research (Andrew Caplan, et al, 2009) who also found that the construction industry has 'one of the worst public images of all industries'. This shows how industries portray themselves and the perception they give off is very important, and in this case, the construction industry only shows to appeal to employ men.

Moreover, the argument of gender bias is another reason as to why many women are disinterested and reluctant in joining the construction industry. Evidence from (is it time for more women in the construction industry?, 2016) identified that from a young age, young boys do more of the physically handy labour, such as helping to build a shed, or mowing the lawn, whereas the girls would do more domesticated tasks such as helping with laundry or washing dishes. Accomplishing a career in the construction company requires strong qualifications in subjects like physics, maths, science, design etc. However, segregation in education has made it difficult for girls to meet the requirements for these subjects (Pepper, 2005). Surveys carried out by found (WES, 2016) 'Men were much more likely than women, to be in engineering and technology occupations six months after completion of their courses' for example of 2010/11, graduates of a bachelor engineering course, 66.2% of the men were working in engineering, and only 47.4% of the women were in engineering.'. This shows that even when women do graduate with construction-related courses, fewer of them end up working in the industry.

One of the reasons as to why women do leave the industry is extra pressure they receive to start a family. Studies carried out by (Women in construction, 2007) found that the women who want to have babies, and raise a family as an importance are less likely to apply and attain a high-ranking position within the construction industry. Furthermore, women who not hold these same values are applying for these elevated position jobs just as many men are. Consequently, this doesn't give women the opportunity that they can have a high-ranking position within the industry, also having children too, so it means they must decide on either having a successful career or raising a family. Over the last several years the construction industry is facing a skills shortage, thus the sector is placing new initiatives to encourage more skilled workers in the construction industry. This includes both ethnic minority and women. A deficiency of awareness within the industry, alongside how the construction sector is perceived is one of the main reasons as to why women do not join the industry (43%) (Ranstad, 2016). 42% said due to the 'lack of suitable role models', and 41% described the reason why they wouldn't follow a career in construction is it is 'macho'. Furthermore, '16%, of women also said the lack of flexible or part-time working was one of the reasons as to why they left the industry (Ranstad, 2016). However, from 2017 onwards, a new scheme has been put into place, where parents are given thirty free hours of childcare a week for those who have young children. This is a good step put into place, to ensure that the needs of women are trying to be met, thus trying to encourage more females to join.

Further research carried out by (Ranstad, 2016) had asked women what would attract them to pursuing a career in the construction industry. The results show that 44% said they wanted 'improved flexibility', 35% wanted 'equal pay', and 23% wanted 'improved mentoring and sponsorship programmes'. These again further highlights the poor image of construction that is portrayed to women and explains the underrepresentation. There are many issues within the industry which needs to be addressed to develop and become more diverse and inclusive. According to (Karunanithi, 2013), a work-family conflict is an 'inter-role conflict in which the role demands of one sphere (work or family) are incompatible with the role demands of another sphere (work or family)'. This means that the requirements from a job cannot be met alongside family commitments, and vice versa, where of the family commitments cannot be met alongside having a job. Moreover, this causes issues for women who have high aspirations for their careers. For professionals working in the construction environment that have work and family obligations is much of a bigger problem for women than men.

Women's on board is an organisation which offers, '**formation, encouragement and connections** to help women get to the top within their own company or to take on a board or committee role as a non-executive director (NED), trustee or governor' (Womens on Board, 2012). Through these initiatives and organisations, WOB wants to break down the barriers that currently are restricting women getting into these high positions within these companies. WOB is a great organisation and initiative for women in the construction industry to break that 'glass ceiling' and attain a board level position within the industry. As women already have a low level of confidence in their abilities and skills in a construction workforce and have that added pressure of proving themselves as it's a predominately male-dominated environment which in time is why women leave the industry, WOB can help female overcome this.

The pipeline was another organisation which was created to deliver an 'exceptional executive leadership programmes specifically designed for women' (Margaret McDough et al, 2017). Similarly, to Women on board, they have also realised that organisations and companies run better and more successful when there is a bigger diversity of gender at the senior board levels. Within the construction industry black and minority ethnic (BME) professionals working in the sector constantly must prove themselves to show that they are fit enough to do the job, thus have many brinks to get through, and ceilings to break. Studies from (Centre for Ethnic minority studies, 2005) found, 'The reality is if those at the top continually resist change in the upper levels of an organisation, then the 'glass ceiling' can never be broken'. (Centre for Ethnic minority studies, 2005) Research carried out by the centre for ethnic minority studies interviewed students who had a variety of different work experiences found that numerous students observed that there was a lack of BME at senior levels in the companies.

Research from the 'glass ceiling' effect that BME professionals are facing in the construction industry was also supported by (The college of Estate Management, 2014). She carried several surveys among people of different ethnic backgrounds in senior roles and managerial positions. The results of the survey shown that only 8% of BME professionals hold senior roles. This shows there is a glass ceiling within the civil engineering sector. 'Leaky pipeline is phrase commonly used to describe the progressive loss of capable women from more senior roles in STEM disciplines' (Chemistry a european journal, 2016). Moreover, it represents women who have started Science, technology, engineering, and maths (STEM) subjects at a university degree level, and but do not follow it through as a career prospect or drop the subject halfway.

The construction industry loses both ethnic minority and women due to many obvious reasons, for instance, discrimination, institutionalised racism, unfairness, and raising a family. Moreover, for women, it can come down to them not having enough confidence, and personal perception of her own capabilities or being good enough of not being able to pursue a career within the construction industry (Chemistry a european journal, 2016).

Research shown by (Web archive, 2005) found that after interviewing people who experienced discrimination in a construction work environment, they found that discrimination became much subtler as they moved up the hierarchy, and it was not as prevalent. 'It's a lot more insidious because you can't see it; it is behind closed doors', (Web archive, 2005). This issue would be difficult to confront, as there is no concrete evidence that proves any sort of discrimination occurs, such BME individuals knowing that they are on lower pay rates than their white work colleagues even though they may be working at a higher or same level as them, however they felt nothing could have been done to solve this. An ongoing perception that the white counterpart is being offered more promotions and opportunities within their companies compared to the ethnic minorities, thus which would make move up the hierarchy much quicker.

However, this is hard to keep track of some of the people interviewed had very strong experiences, "I couldn't move forward, I couldn't progress...so for me, wanting to develop as a professional and not wanting to be pigeonholed, I took a conscious decision to move outwards and onwards, and certainly it's

benefited me. It's a small organisation that I run here, but I've got the ability to influence things and to take the organisation forward' (Web archive, 2005). This shows that what the person experienced, they did not feel as if there was space for progression in their workplace, and constantly feel the need 'to fit in with the prevailing white, male culture', due to them being an ethnic minority. This should not be tolerated in any workplace regardless, and ethnic minorities should not be facing rejection within recruitment.

Further research which supports this is shown by a study carried out by (Andrew Caplan, et al, 2009) who found that much ethnic minorities (EM's) refuse to give up their cultural identity, and up leaving the industry for a more accepting profession. For the ones who stay within the industry, do find themselves attaining a successful career in construction. However, the number of individuals for this is small and a minority. Thus, further proving that the construction industry is still quite far from breaking this axiomatic 'glass ceiling' metaphor. The small minority who do end up being successful within the construction and built environment sector cannot make a significant improvement to EM all over in the construction industry. As these individuals are working towards building up their career within their area of work, whilst also tackling any racism or prejudice they encounter. Thus, making it difficult to make an influence on the overall majority negative insights which continue to suffocate the construction industry (Andrew Caplan, et al, 2009). Furthermore, this means to make any harsh or apparent differences would be very difficult on a larger scale. As the construction industry is facing a skills shortage, there is a fantastic opportunity for companies to create policies and initiatives within their companies to create a more diverse workforce, rather than trying to display a current illusion of partaking one.

Research carried out by (Pepper, 2005) conducted interviews on stakeholder perspectives that held various positions within the construction industry such as directors, managers, associates, architects etc. They were interviewed to explore the employment of ethnic minorities, women and disabled people. Attaining the stakeholder perspective is important as these people hold high positions within the construction companies. Thus, they are the ones that are responsible for implementing changes and policies, and their perspectives are needed for apparent developments to occur in the diversity and equality policies and identify the barriers causing these issues. (Pepper, 2005) Found that a lot of the participants mainly focused their answers on the stereotypical characteristics of the type of groups that were involved. Findings from (Pepper, 2005) showed that some participants blamed it on the culture, for example, considering Indian culture that working in the construction industry means carrying a low status, as one of her interviewees made a statement saying, "The aim of an ethnic, is to be a doctor, dentist or a lawyer... I have some Indian friends myself and they would be aghast at the thought of any of their children entering the building industry. So, it's the parents that are the main problem, in getting them to accept their children working in the construction industry". (Pepper, 2005) There are positive initiatives which companies are incorporating into their policies to create a more diverse workforce. For example, Balfour Beatty, WISE, The ICE, The Athena SWAN.

3. Methodology

To meet the objectives of this research, several types of research methods need to be explored, and use the best type of research method which will help attain the best set of data. As the research study explores ethnic minority and women's experiences within the UK construction industry, the best form of research method to gain data from this is using face to face interviews. This is because the information required is trying to find out about their experiences, face to face interviews would be the right choice of research method to carry out.

There are many advantages to doing face to face interviews as it would give a more accurate screening as to what the gender, age, race of the participant is, where as if it was a questionnaire or online screening, the information could be false. Moreover, the researcher is the one who controls the interview and keeps it focused, thus also capturing true behaviour and emotions. Furthermore, using this method you can identify what do the ethnic minority and women think of working in the industry, do they think they are treated fair, Are the right procedures and policies put into place for them to be treated equally? Also, what made them go into the civil engineering industry, and what are their thoughts on how the industry can improve to create a greater workforce diversification.

However, there are disadvantages to doing interviews, and that is that they are very time consuming, which also come to cost quite a bit and become expensive. Also, the quality of the data needs to be considered, and this needs to be unbiased. Also, if it is a large sample size, it would difficult to conduct, fortunately, the sample size is small, and so this would not be an issue.

Another research method which will be used for my research study is conducting questionnaires and asking civil engineering students and companies. Using questionnaires is great research method for this as

it is both practical, substantial amounts of information can be carried out, and, the results can then be compared on a large basis, and separate on gender and country. However, doing questionnaires does have its disadvantages, as it can lack validity, or participants reading the questionnaires could interpret it differently. Furthermore, this could be the case in this research study, as an international comparison need to be carried out so data will be taken from will be taking the data from different countries, so diversity and equality can be seen differently in different perspectives.

4. Discussion

It can be clearly stated that women, ethnic minority, and disabled people are underrepresented in the construction industry. The industry needs to see a change, not only to improve its diversity and equality issues, but also to aid the skills shortage that the construction sector is facing currently. Not only in the construction industry but a lot of the other economies, women are constantly undermined and underrepresented. The construction industries poor efforts and lack of enthusiasm to try and recruit women is one of the reasons as to why there is an underrepresentation of women.

Table 1 Respondent Details

Main Details	Results	No. of Respondents
Gender	Male:	18
	Female:	8
Age	18-24:	11
	25-34:	6
	35-44:	4
	45-54:	4
	55-64:	1
	65 or over:	0
Ethnic Background	White/ British/ English/ Scottish/ Welsh:	9
	Gypsy or Traveller:	0
	Asian/ Asian British-Pakistani:	11
	Asian/ Asian British- Indian:	0
	Asian/ Asian British- Bangladeshi:	1
	Asian/ Asian British- Chinese:	0
	Black/ Black British- Caribbean:	0
	Black/ Black British- African:	2
	Mixed Heritage- White and Black Caribbean:	0
	Mixed Heritage- White and Asian:	0
	White and Arab:	1
Other:	2	
Qualification	GCSE:	0
	A-level	2
	Degree	20
	PhD	4
	Other	0
Occupation	Graduate Civil Engineer	4
	Civil Engineer	11
	Construction Manager	1
	Lecturer	3
	Student studying Civil Engineer	3
	Quantity Surveyor	2
	Structural Engineer	1
	Project Manager	1

5. Comparison of Findings

Table 2 Comparison of Findings

Barriers	Findings from Literature Review (Secondary Research)	Findings from Interview (Primary Research)	Findings from survey (Primary Research)	Analysis			Summary
				Literature Review Findings	Survey Findings (N=19)	Interview Findings (N=8)	
Lack of Role models		✓	✓	Literature review did not support findings on this barrier. However if the researcher had more time, more research into this barrier could have been undertaken.	2 out of the 19 respondents who disagreed were male that this is not a barrier and rated it as the least important barrier, however seeing as majority of the industry is male, and they wouldn't find a lack of role models an issue for them entering the industry. Where the rest of the 17 participants agreed the lack of female role models is a barrier which restricts women from entering the construction industry.	As everyone was predominantly white I didn't feel like I could relate and I do feel like being a girl and of ethnic minority my capabilities were underestimated. I felt I had to prove myself more being the only girl and of ethnic minority on site.	There wasn't much discussed in the literature review regarding the lack of role models. Survey shows that majority of participants felt that due to the lack of female role models, this restricts and acts as a barrier into women entering into the construction industry. In comparison to responses from interview, a much deeper analysis and personal perception was given of the stakeholders views.
Lack Equality and diversity policies			✓	Literature review did not support findings on this barrier. However if the researcher had more time, more research into this barrier could have been undertaken.	Survey responses did not support findings on this barrier. However if the researcher had more time, more research into this barrier could have been undertaken.	I don't think equality nor diversity plans are making a significant difference, because there would be an increase in both women and EM. These barriers also would be more subtle, and it's evident that they are not.	In regards to this barrier the literature review and survey didn't give much responses and information in regards to the lack of equality and diversity policies. However the interview responses gave a much better insight as respondents didn't think the policies were making a big difference.
Male dominated	✓	✓	✓	The construction industry shows to display the largest segregation by sex. Research conducted by (Pepper, 2005) found that the overall construction workforce is 13% female, in where two-	Out of 19 respondents, 5 thought it was the least important barrier as to why women don't go into construction, and a majority of 13 respondents thought it was the most important factor into why women don't go into construction.	I do feel as working with predominantly male environment I think it did affect my decision making, and I was undermined quite a lot of the time. I felt like at first my opinions were overlooked when	From the literature review it's evident that there is a huge segregation in gender in the construction industry, with majority of it being male. This in itself causes a barrier and stops women from wanting a career within the industry. The literature review also supports this as 13 respondents agreed. Moreover further supporting this,

				<p>thirds of the roles in which they hold are clerical roles. This underrepresentation is not only a singularity in the UK, as it is a problem within Europe. The industry portrays a 'persisting 'laddish' culture in a white, male-dominated environment'. 'male-centric company culture shared by most of construction firms'</p>		<p>working on different projects and I don't feel people respected me in the same way because I am a woman.</p>	<p>the interview responses also show that respondents felt that they personally were undermined because they were a woman. This is evidently a big problem, however policies are being to create in order to resolve, but is the progress too slow?</p>
Family commitments	✓	✓	✓	<p>Women working in construction industry not only having the extra pressure of having to prove themselves within the industry, also deal with the pressures to start a family. A work-family conflict is an 'inter-role conflict in which the role demands of one sphere (work or family) are incompatible with the role demands of another sphere (work or family)'. This means that the requirements from a job cannot be met alongside family commitments, and vice versa, where of the family commitments cannot be met alongside having a job.</p>	<p>All female participants agree to strongly agree that they struggle to balance their home life with their work responsibilities.</p>	<p>An interviewee stated, 'When I have children in the future I don't know how I will balance work and family, and due to the lack of flexible hours in the construction company. An interviewee mentioned, 'Within Pakistani and Indian culture, parents don't usually encourage their daughters to pursue a career within construction. Also subjects such as medicine and law are encouraged more than construction'.</p>	<p>The pressures that women face in regards to starting a family are hard enough deal with alongside balancing and progressing within their careers. Thus the industry needs to create a platform where they provide a stable balance for women. Also cultural values and belief could a restriction in itself as women are not encouraged.</p>

Lack of Flexible hours	✓		✓	<p>Furthermore, '16%, of women also said the lack of flexible or part-time working was one of the reasons as to why they left the industry.</p> <p>The industry needs to take on more women through placing initiatives for them, such as having flexible working hours. (Ranstad, 2016) Had asked women what would attract them to pursuing a career in the construction industry. The results show that 44% said they wanted 'improved flexibility',</p>	<p>Survey responses did not support findings on this barrier. However if the researcher had more time, more research into this barrier could have been undertaken.</p>	<p>Due to the lack of flexible hours in the construction company it gives me no choice but to leave.</p>	<p>In the literature review 16% of women said the reason they left the industry was due to lack of flexible working. This was further supported by findings from interview responses. Thus showing that this is a barrier that needs to be tackled, and initiatives need to be created in order for a suitable platform to be created for women to allow them to work hours which are suitable for them, instead of leaving the industry. Thus also proves this as a case of the leaky pipeline.</p>
Lack of women on board level	✓	✓	✓	<p>To try and attain more women on board level, WOB does this through building up an assembly of women who are in elevated position within their companies,</p>	<p>Majority disagree to strongly disagree that women are given equal opportunities to me to get to board level position. 4 respondents neither agreed nor disagreed, and 4 respondents agreed</p>	<p>I did not see many women in CEO or managerial roles at all; I don't think they have created a platform or a ladder in which women can attain to that position within construction companies.</p>	<p>In the literature review, it doesn't address the issue of the lack of women of board but presents many initiatives, which does in itself present that there is a problem. Furthermore the survey responses, majority agreed to strongly agree that there are equal opportunities for women to get onto board level. However, the interview response gives actual personal experience how the respondent whilst working within a construction environment didn't see any women in CEO position, thus showing that the construction industry have a clear lack of opportunities to help women not only get into the industry but also progress.</p>

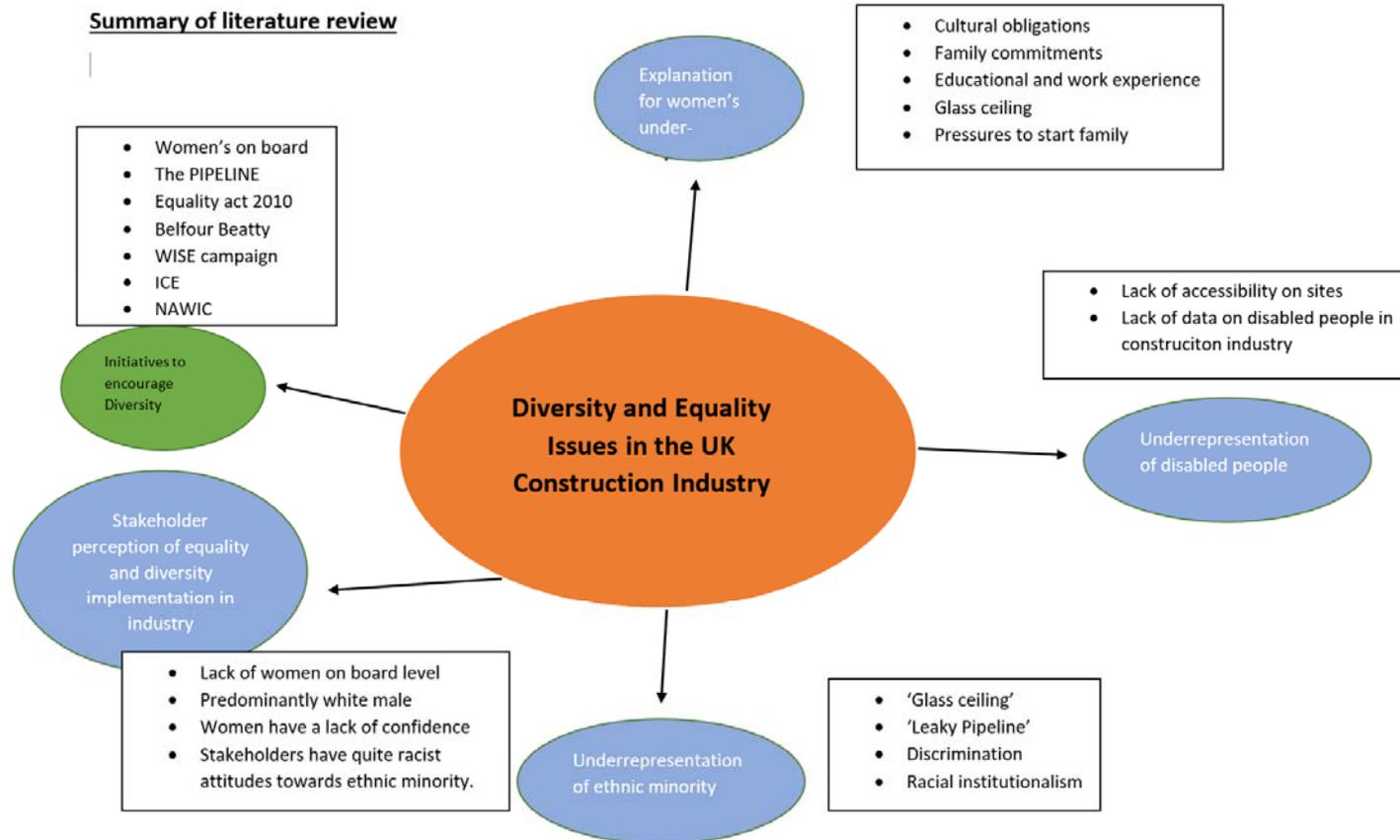


Figure 1: Summary of Literature Review

6. Conclusion

It can be concluded that the main reasons as there is such a lack of diversity in the construction industry are because of the macho image the industry portrays, discrimination of the predominantly white male work colleagues towards the ethnic minorities, lack of flexible hours, and lack of educational encouragement. Furthermore, there is also a clear evident lack of women in high-level board positions especially in the construction industry, and this is due to the meagre efforts companies put in to recruit women to senior roles. However, taking all of this into consideration, there are many organisations and schemes out there which provide support and guidance such as women on board and the diversity action plan from the ICE that does help encourage recruitment into the construction sector.

7. Authors Note

Since writing this paper, I have been employed on the Kier group Graduate scheme as a graduate civil engineer for Kier Utilities and Rail for over a year. In this role I have seen many women and ethnic minorities who work within the industry working as graduates, site managers, project managers, and even directors for the company. It is apparent that the industry recognises it must do more at all times to increase its diversity which creates a better business which is in 'balance'.

Working as a graduate means I have had the opportunity to work in different sectors of the business, both site and office.

My first placement was involved in working in a site office on the Hs2, working on diverting a 42 inch main water pipe. I was involved in assisting and managing a site team, and site inspections. From my observations it was a great experience, and the team both site and office were welcoming, helpful, and encouraging in my time there. For my second placement I was working in an office based role in the business development team, in which I was involved in assisting in the tender and estimating process for bids for projects. Working with directors and senior staff within the company also was very inspiring and broadened my understanding.

As my paper does outline the issues within the construction industry in regards to equality and diversity, I do strongly believe working as a professional engineer within Kier has changed my perspectives in that things are improving from an equality and diversity point of view. I haven't felt like I have been discriminated against because I am a woman, or of ethnic minority, but instead have been inspired, accommodated, and motivated by my work colleagues within Kier in how to successfully contribute and develop my career as a civil engineer.

Recently Kier ran an article on Project RISE which is a new strategy that helps aim to **'to help the business break with tradition and become more inclusive and diverse'**. One of the driving forces behind the project is Shahab Ahmad. The winner of the Customer Focus Award at the 2018 Kier Annual Awards, Shahab is the first to admit that he's not an equality and diversity specialist – in fact, he's a senior project manager'. This shows that construction companies are creating more initiatives, and very open to tackling the diversity and inclusion issues that currently exist. Working in Kier I find a positive start to my working life, and I am very grateful and excited for the opportunities and future they are giving me in helping me to create a pathway to become a chartered engineer. It is important in life to always be able to take advantage of learning and development and to adjust one's views based on practical experience.

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A Choosing by Advantages Approach for Selecting and Identifying Off-Site Construction Components

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Abstract

Many studies have shed light on the importance of applying lean manufacturing principles in construction through adopting off-site construction systems. Although efforts were channeled towards comparing off-site versus on-site construction systems, none has performed a granular comparison among the system components, in particular the off-site ones. In fact, off-site components present different advantages and disadvantages despite belonging to the same system. This implies a need to evaluate the value maximization in terms of cost, time, quality, etc. when selecting the appropriate off-site component. There is thereby a need to develop a decision making evaluation tool that optimally selects off-site construction components while maximizing the project value. Therefore, this paper aims at: (1) extracting and elaborately analyzing the attributes associated with the different off-site components, and (2) identifying the optimal ones through a Choosing by Advantages (CBA) technique. The outcome of this study will yield standardized policies for properly choosing optimal off-site components.

Keywords: Lean construction, Off-site construction, Decision support system, Choosing by advantages, Value maximization, Waste Minimization.

1. Introduction

On-site construction methods, popular since the end of the 19th century (Mydin et al., 2014; Kamali et al., 2016), are defined when the construction is built on site after the design is done and the contractor is hired. These methods are usually called as "site-built", "on-site", "conventional", or "traditional" construction. The respective systems had predominantly been built using reinforced concrete frames and they are typically divided into two groups. The first group is the structural system which includes cast in-situ columns, beams, slabs and frames. The second one includes bricks and plaster as the non-structural infill material. However, these traditional methods have been witnessing a high level of waste in production, low productivity rates, high costs, poor safety records, poor quality control, and long project durations (Deffense et al., 2011). As a result, off-site construction emerged as an alternative modern method aimed at enhancing the overall traditional process (Vernikos et al., 2013; Howell, 1999; Bekdik et al., 2016). Off-site construction refers to the planning, design, fabrication and assembly of elements of a construction project at off-site factories typically situated at a different location from the jobsite.

After World War II, this technology became one of the major construction methods in many developed countries as it was tested and applied to provide soldier accommodation during the war (Arditi et al., 2000; Ghazilla et al., 2015). However, it didn't get the full attention of both academia and industry in these developed regions (e.g. United States, Australia, parts of Europe) up until late (Kamali et al., 2016) where engineers have increasingly turned to using the off-site method due to its ability to reap the benefits of automotive manufacturing principles and achieve the lean construction goals of adding value while reducing process and material waste (Howell, 1999; Vernikos et al., 2013; Antillón et al., 2014; Bekdik et al., 2016). More specifically, off-site systems allow projects to be delivered with higher value to the users, shorter construction times, lower on-site labor cost, higher safety level through eliminating the on-site risks, higher on-site productivity rates, lower waste production and tighter control of quality (Polat et al., 2005). Furthermore, many studies tackled the division of the off-site construction into several classifications to assist in understanding the differences among off-site systems (Gibb and Goodier, 2007; Li et al., 2014; Švajlenka et al., 2017). As shown in Figure 1, the first level, sub-assembly and component manufacturing, involves small-scale elements assembled in the factory environment (e.g. windows). The second level is the non-volumetric manufacturing which defines pre-assembled units that do not enclose a usable space (e.g. wall panels). On the contrary, the volumetric manufacturing involves pre-assembled

units that enclose a usable space (e.g. toilet pods). The units are processed inside the factory and do not form a part of the building structure. Finally, the complete manufacturing, also known as the modular construction, involves pre-assembled volumetric units that form the actual structure and fabric of the building. (Gibb, 1999; Goodier and Gibb, 2007).

Key

Materials	
Examples	Definition
	Sub-category Category
Examples	Subcategory

Various materials		Steel, precast concrete, timber, aluminium, advanced composites, hybrids		
Door furniture, windows, etc Bricks, Tiles, etc	Items always made in a factory and never considered for on-site production	Pre-assembled units which do not create usable space		
	Factory-made components	Component manufacture & sub-assembly	Non-volumetric pre-assembly	
Sub-assemblies	skeletal			
Edge of town retail units, motels, prison blocks, medium rise residential	Factory clad	Modular Building	Volumetric pre-assembly	
	Clad on site			Within another building
	Pre-assembled volumetric units which form the actual structure and fabric of the building			Onto another building
				Plant rooms, etc
Steel frames, stressed skin plywood, precast concrete, various cladding materials	Dry-lined lightweight steel frames, precast concrete, advanced composites		Toilet pods, shower rooms	

Figure 1: Off-site construction categories (Gibb and Goodier, 2007)

On the other hand, several off-site systems were identified in developing countries based on the previous literature (Li et al., 2014) and four off-site systems, namely Sub-Assembly Systems, Non-Volumetric Panelized and Natural Systems, Volumetric Systems, and Hybrid (Panelized-Volumetric) Systems, were recognized in Lebanon and Syria, in particular, based on a recent study conducted in the regional and local manufacturing market (Zaheraldeen et al., 2019).

However, none of the previous works have selected the optimal off-site construction system component for a given project while considering value maximization and waste minimization. Therefore, the objective of this research study is to design a new decision support tool targeted at identifying and selecting the best off-site component for a project at hand while maximizing the value and meeting customer requirements through continuous improvement and waste elimination.

2. Methodology

2.1 Off-Site System Components Investigation

In order to achieve the aforementioned objective, the first step consists of researching about respective off-site system components available in Lebanon and Syria in this case. Using combined key findings gathered from the literature review and regional investigation, the following components were identified and are listed in Table 1. More specifically, as the panelized systems are widely adopted in the region, only their respective components are taken into consideration within the scope of this research work.

Table 1 Off-site construction systems and components in Lebanon and Syria

	Systems	Components
Off-Site Construction	Sub-Assembly Systems	Precast Concrete Frames Precast Concrete Slabs Pre-Fabricated Foundations Floor and Roof Cassettes
	Panelized Systems	Light-weight Steel Open Panels Light-weight Steel Closed Panels Precast Concrete Panels Light-weight Composite Solid Precast Sandwich Panels Sandwich Steel Panels
	Natural Materials Systems	Open Panel Timber Frames Closed Panel Timber Frames Cross Laminated Timber (CLT) Structural Insulated Panels (SIPS)
	Volumetric Systems	Modular Construction Pod Construction
	Hybrid Systems	Semi-Volumetric Construction

2.2 Proposed Choosing By Advantages (CBA) Decision System

Having identified the alternative off-site system components, the next step comprises developing a conceptual decision model to select the most suitable one based on the decision maker's goals. In this case, the Choosing by Advantages (CBA) approach is used. CBA, developed in 1999 by Jim Suhr, is a decision-making tool that assists the users in reaching the best decision by comparing different choices (Jim Suhr, 1999). It is labeled as a suitable prioritization technique due to its flexibility and simplicity, which leads to enhanced data collection and improvement in the quality of comparisons among the results (Koga, 2008; Pan et al., 2012b). Moreover, decision makers can easily fill out the CBA table without having previous background or experience with CBA. Figure 2 depicts the proposed six-stage CBA model.

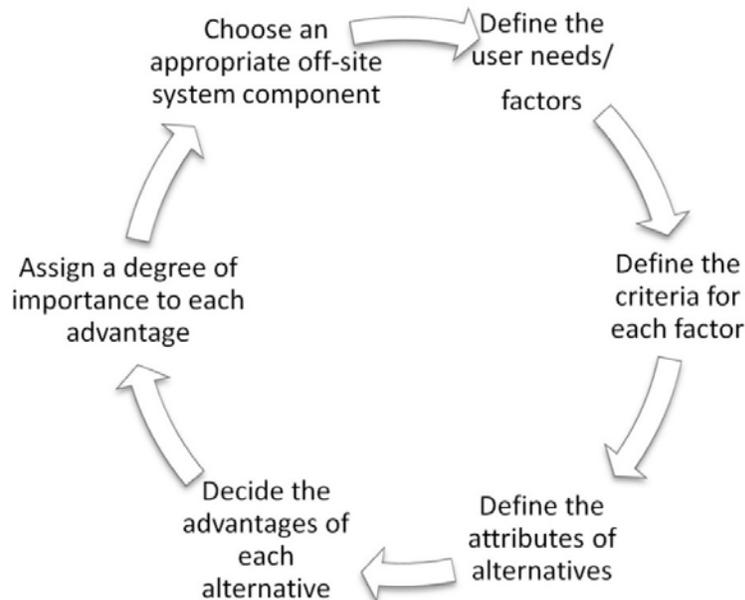


Figure 2: The proposed decision model

The first and second stages consist of establishing the user needs (e.g. factors) behind a certain decision and defining the main decision criteria for each factor respectively. A wide range of factors was identified from the literature review in relation to the adoption of off-site construction methods (Pan et al., 2012a). After conducting semi-structured interviews with construction practitioners in Lebanon and Syria, seven specific factors were singled out, namely:

- 1 Design and execution: the amount of design input, design flexibility, finishes solutions, design process, design connections, ability to alter on-site, thermal protection solutions, fire resistance and earthquake resistance.
- 2 Quality: high quality achieved in erecting the building, high customers' satisfaction, more robust and durable facility, and great building appearance and aesthetics.
- 3 Health and Safety: minimization of the on-site risk and the need of the on-site safety requirements.
- 4 Sustainability: high building energy efficiency, energy savings, on-site solid waste minimization, water reduction, off-site components reused and LEED certification achievement.
- 5 Cost: the cost of design, maintenance, off-site components, heating and cooling energy as well as additional rework cost due to design or manufacturing errors.
- 6 Time: the duration of the design process, installation and assembly, work coordination and the overall construction time.
- 7 Process: the need for logistics, planning of installation and possibility of damage during transport.

Table 2 depicts a sample part of the proposed CBA framework for one of the factors (i.e. design and execution) together with criteria for few subfactors.

Table 2: Sample CBA tabular method

Factors		Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
		Precast Concrete Panels	Composite Solid Precast Sandwich Panels	Light Weight Steel Open Panels	Light Weight Steel Closed Panels	Sandwich Steel panels
Design and Execution						
1	Design Input					
Criteria	Minimal amount of information is desirable					
Attribute						
Adv./Imp.						
2	Design Flexibility					
Criteria	Ability to change at a late stage					
Attribute						
Adv./Imp.						
3	Design Process					
Criteria	The easier the better					
Attribute						
Adv./Imp.						
4	Design Connections					
Criteria	Easy Connections are better					
Attribute						
Adv./Imp.						

The third stage consists of identifying the attributes for each off-site alternative. For example, in the case of the design flexibility subfactor, one attribute can be: no flexibility for late changes.

The fourth stage includes determining the advantages of each alternative by contrasting, given each subfactor, two attributes at a time. More specifically, the least preferred attribute (i.e. near-zero advantage) for each factor is first identified then the advantage of each alternative's attribute relative to that least-preferred one is decided.

The fifth stage consists of allocating a degree of importance for each advantage by assigning numerical weights. In this case, the paramount advantage for each factor is first chosen then used as an anchoring point to weigh other advantages through comparisons. Finally, the allocated importance grades are summed up for each alternative.

Based on the aforementioned five stages, the final stage results in the decision maker selecting the off-site option with the highest grade and thereby the most beneficial to adopt.

2.3 CBA Case Study and Participants

The final step of this research study involves taking an off-site building as a case study and conducting the CBA decision-making system with construction stakeholders. The building case at hand consists of a 600 m² studio building that was recently built at the American University of Beirut (AUB) in Lebanon using the off-site sandwich steel panel option (Figure 3). It was constructed to temporarily house the design studios of Architecture and Graphic Design students. Each story consists of a big studio, one office, one kitchen and two bathrooms.



Figure 3: Studio building at the American University of Beirut

The CBA case study was conducted with a selection of 24 off-site construction stakeholders in the Middle East whereby 33.33% are off-site contractors, 33.33 % are AUB students majoring in Architecture and Graphic Design, 16.67% are AUB professors in the department of Architecture and Design, and 16.67% are members from the Facility Planning and Design Unit (FPDU) members at AUB. In fact, prior to completing the CBA table (Table 2) following the aforementioned steps, participants are presented with the available off-site components that are used in the Middle East and asked about their choice and whether a decision making process should have been followed in the case of the AUB case study building.

3. Results and Discussion

In the first part of the CBA method, it was found that off-site construction stakeholders have opted for a certain off-site component according to personal evidence without relying on any rigorous data. Additionally, construction participants have agreed that adopting a decision support tool to choose the optimal off-site component can potentially reduce the construction waste while expanding the value of this method.

Following the second part of the CBA method, an analysis was conducted to combine the individual comparison judgements from the 24 participants so that a single table is produced for each group (i.e. Owners, Contractors, Professors, and Users). This was achieved by computing an arithmetic average for each response. Afterwards, proper mathematical procedures were implemented to compute the accumulated scores for each off-site option/alternative based on the data filled in the CBA table. Figure 4 depict the variance in the importance of the off-site options among the different stakeholders and with respect to the established factors. The purpose behind these results is to highlight how choosing the most suitable off-site component varies according to different construction stakeholders and given various factors.

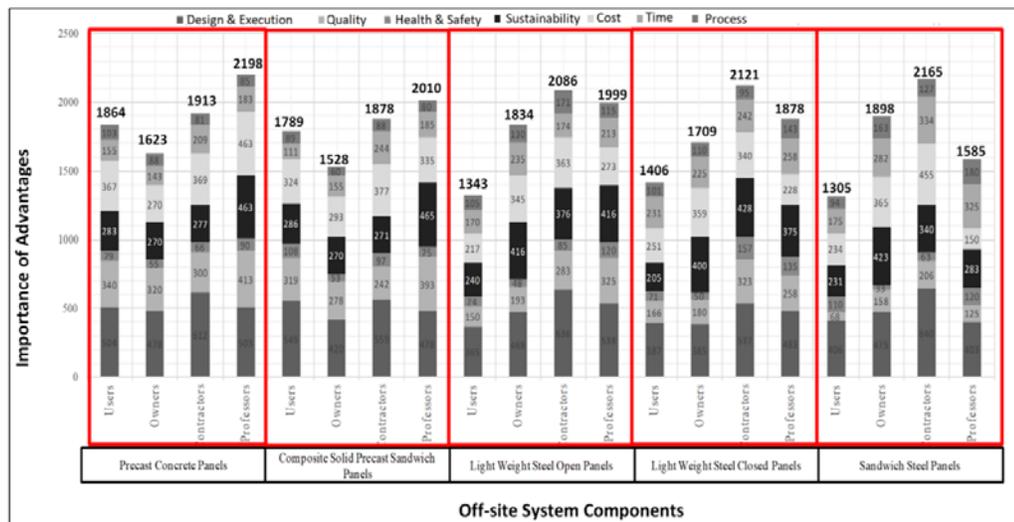


Figure 4: The accumulated CBA scores

3.1 Stakeholders' Feedback

As presented in Figure 4, the results of the CBA case study reveal that owners, in the case of the AUB studio building, would rather opt for the sandwich steel panels with an accumulated score of 1898 upon grouping all factors. Nevertheless, this option scores the lowest with respect to the quality and health and safety factors when compared to other off-site alternatives. However, if the decision is to be taken solely based on design and execution quality, and health and safety factors, the owners would rather select the precast concrete panels. Similarly, the off-site contractors in Lebanon and Syria also prefer the sandwich steel panels over other off-site alternatives with an accumulated score of 2165 upon grouping all factors. Furthermore, in the case of sandwich steel panels, off-site contractors accord the highest importance to the design and execution, cost, and time factors when compared to other off-site alternatives. However, the choice shifts to the lightweight steel closed panels whenever the decision is based on the quality, sustainability, and health and safety factors. On the other hand, the results of the CBA case study reveal that professors mostly prefer the precast concrete panels with an accumulated score of 2198 upon grouping all factors and accord the highest importance to the quality and cost factors and the lowest to the time factor when compared to other off-site alternatives. However, they would opt for the composite solid precast sandwich panels when the decision is based on the sustainability factor. The decision switches to the light-weight steel closed panels when the health and safety is of paramount importance. Moreover, it is worth noting that the professors, as opposed to owners and contractors, give the sandwich steel panels the lowest rate with respect to the design and execution, sustainability, cost,

and quality factors. Similarly, results reveal that users also prefer the precast concrete panels the most with an accumulated score of 1864 upon grouping all factors. Furthermore, in the case of precast concrete panels, users score the highest on the quality and cost factors when compared to other off-site alternatives. This is mainly attributed to the fact that these panels are common to users and have been widely used in the region. However, the choice shifts to: (1) the composite solid precast sandwich panels whenever the decision is based on design and execution and sustainability, (2) the light-weight open steel panels whenever the decision is based on the process factor, (3) the light-weight close steel panels whenever the decision is based on the time factor, and (4) the sandwich steel panels whenever the decision is based on health and safety.

In a nutshell, results reveal that a conflict among stakeholders exists which, in turn, results in a reduction in the user satisfaction level. Therefore, in order to maximize the value of a certain off-site method adoption, a decision should involve all stakeholders and mutual agreement should be reached when selecting the most suitable off-site option.

3.2 Other Interviews and Discussion

Due to conflicting results among stakeholders, two additional interviews were conducted; one with a senior project manager from the FPDU at AUB (representing the owner) and another with the operation manager of the studio building (representing the users). In this case, interviewees were asked about the process they think decision makers followed to select an off-site option for the studio building. Both agreed that the decision maker:

1. Selected a steel temporary off-site building without taking into consideration the other available off-site options in Lebanon and Syria.
2. Considered only the economic aspect and a fast construction process, and the ease of disassembly of this building after 2 to 10 years without taking into consideration other factors.
3. Allocated a short duration to the design process without giving careful consideration to the design requirements needed for educational buildings.

As a matter of fact, during the erection of the sandwich steel panels, several quality and safety deficiencies were pinpointed. As such, the contractor visited periodically the jobsite to prevent the rainwater from penetrating the building. Besides, both of the interviewees noticed that the connections of the panels are bad and the assembly process of the sandwich panels did not follow any safety procedure. Additionally, the educational building was delivered with poor sound insulation among the stories, which significantly affected the students in the studios. The owner resolved the matter by adding acoustic isolators to reduce the noise and thereby incurred an additional cost. These deficiencies were actually witnessed because, as mentioned in the interviews, the focus of the decision maker was only directed towards reducing the cost and time without giving any consideration to the contractor's quality of work and implementation of health and safety regulations.

As aforementioned, the insights gathered from the interviews justify the CBA results and the dissatisfaction of both users and professors vis-à-vis the sandwich steel panel adoption in constructing the studio building. However, it was mentioned that this decision would have been more suitable for the users and professors had the decision maker involved the Architecture and Graphic Design department in the decision making process.

4. *Conclusion, Recommendations, and Future Work*

Most construction practitioners consider that opting for any off-site method is risky and needs careful attention. Therefore, this research effort took the initial steps and aimed at providing a decision support tool to aid practitioners in identifying and selecting the optimal off-site component based upon various factors (e.g. cost, time, waste, quality, health, safety etc.). The CBA method was used and results from the case study revealed the benefits of each component with respect to the tested factors. Moreover, the outcome of the CBA case study reveals the need for optimally selecting off-site components to drive more value into the construction process.

In order to deliver a better off-site project, an adjustment in the decision-making process is required and a lean thinking approach should be applied. All stakeholders should be involved in the decision-making process to aid in reducing cost and time, increasing quality and safety, and delivering a sustainable off-site building. A decision support system should be adopted to: (1) explore the differences

among all available off-site options, and (2) narrow down the conflicts arising among off-site stakeholders throughout the decision-making process. The proposed decision support tool is a great attempt at maximizing the value and eliminating the waste whenever utilizing the off-site method. More importantly, applying the proposed decision support system greatly helps the decision makers in focusing on those specific factors instead of concentrating on ill-defined problems. These improvement suggestions are parallel with the lean spirit of incremental improvement while encouraging the use of this technology (i.e. Off-site Construction). Therefore, practitioners adopting off-site construction should align the project objectives with various customer requirements. Finally, the proposed study is not only limited to construction buildings in Lebanon and Syria but can be also applied elsewhere to compare among off-site alternatives.

Further work is needed to study other off-site categories and the effect of other factors on the decision-making process. Moreover, the number of off-site builders in Lebanon and Syria are limited. Therefore, conducting the CBA study and additional interviews with other stakeholders from the region will significantly improve the outcomes of the decision support system.

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Industry Preparedness for Off-Site Construction

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Abstract

Off-site construction/manufacturing is not a recent technological innovation, as it has been around for almost two centuries. However, the adoption of this approach by the industry has been relatively limited. Industry preparedness for the adoption of off-site construction is still at an embryonic stage as it is impacted by many factors, especially the lack of national and international strategies to facilitate its adoption. Nonetheless, the business case for off-site construction/manufacturing is gaining momentum. This is partly because conflict zones across the globe can benefit from the technology and also because the political, economic, social, cultural, legal, technological and environmental issues affecting its adoption are gaining universal understanding and acceptance.

In this paper, industry readiness for adopting off-site construction is addressed. The paper starts with a brief history of off-site manufacturing and construction and its advantages and disadvantages. Industry readiness for using this technological innovation is then described. In addition, some case studies identified from the literature review are highlighted and discussed. The paper concludes with a set of observations and recommendations.

Keywords: off-site construction, industry preparedness.

1. Introduction

Manufactured and assembled buildings are not a new concept in the construction industry. The first recorded example was in the 1830s and many other examples of off-site manufactured buildings during the 19th century were also cited Gibb, A. (1999). Prefabricated houses were used during the colonial periods in many parts of the world due to the colonisers' desire for 'European-style' housing. The Industrial Revolution brought into fashion the 'industrialized building method' which involved using cast-iron in prefabricated buildings Gibb, A. (1999). The recent advancements in technology, especially simulation and modelling tools, will enable the swift planning and erection of these buildings thus paving the way for a new generation of off-site constructed and manufactured structures. The technological revolution combining Artificial Intelligence, Simulation and Building Information Modelling, coupled with the use of robots, will ultimately revive the use of prefabricated buildings.

Off-site construction methods started to be adopted more frequently after the Second World War, and "modular building" achieved popularity when there was a need for quick construction – particularly housing – to restore bombed buildings and to accommodate troops returning from war fronts. These buildings were initially received favourably however, especially as they often continued in use way beyond their design life (e.g. some temporary classrooms are still in use), they began to fall out of favour Gibb, A. (2001). Nevertheless, in the same way, many nations, which are currently facing destruction because of civil wars or other conflict, will be able to benefit and rapidly restore infrastructure and buildings. Therefore, off-site construction is not an emerging trend or development but in fact a recurring phenomenon. Simply put, off-site construction becomes popular during periods when its intrinsic or supposed advantages are useful Gibb, A. (2001)

The way that off-site construction is perceived constitutes the key element to forecast or influence its use throughout history. This perception is usually subject to cultural, social, and economic contexts, which are thought to be the real reasons, why off-site construction is fashionable at some points in time but not others Gibb, A. (1999). Economic downturns, quick construction for conflict zones, and advancements in technology will influence future adoption of off-site construction and overcoming many of the associated cultural, social and economic problems.

Generally, off-site construction is the type of construction in which sub-elements of a construction project are constructed remotely in a shop or a plant then transported to and installed on the project

site. This process distinguishes it from the in-situ method whereby the project components are built directly on site Alazzaz, F. and Whyte, A. (2012).

Off-site construction can be classified into four types Gibb, A. (2001) , Gibb, A. and Isack, F. (2003) :

- 1) Building components, which are manufactured and sub-assembled remotely, for example furniture, light fittings, doors, etc.
- 2) Non-volumetric pre-assembly which is a term describing units such as wall panels not enclosing usable space.
- 3) Volumetric pre-assembly which are units enclosing usable space.
- 4) Modular buildings, which are usable units that require a minimum amount of on-site work

Hybrid construction, which combines off-site and in-situ methods, is now commonly used as it provides pragmatic solutions taking advantage of both methods.

2. A comparative review of the advantages and disadvantages of off-site construction

The literature on off-site construction indicates that the benefits associated with prefabrication are increased speed of construction, quality, on-site health and safety, together with the environmental impact benefits. The disadvantages associated with off-site construction methods are the potential project cost increase, possibly unappealing visual features (aesthetics), and the high set-up costs of any new facilities required.

2.1 The apparent benefits of off-site construction can be summarized as follows:

A. Time Saving

The most important benefit delivered by off-site construction is time saving. The manufacturing of a considerable percentage of the construction elements in an off-site facility will result in reducing the on-site time spent. The major factors favouring this approach are that factory conditions are foreseeable, generating significant economy of scale, and ensuring that construction time schedule deadlines are being effectively met more than they would be in conventional on-site conditions. Gibb, A. and Isack, F. (2003) an interview of senior staff from major construction clients in the United Kingdom on their views about why pre-assembly is one of the principal forms of off-site construction, showed that over 40% of all answers chose time/speed as the main reason for choosing off-site construction. Pre-assembly means that less time is spent on site, thus reducing the commercial risk usually associated with faster project time-frames. Another study of clients in the UK Goodier C. and Gibb A., (2007) , found that time is the greatest advantage associated with off-site construction methods. In this study 87% of designers and clients stated time saving as an advantage, however 38% went so far as to cite it as the greatest advantage. In the same study contractors rated time saving from off-site construction even higher, with 68% of them stating it as their first choice benefit Goodier C. and Gibb A., (2007) . These findings were also supported by another study in the United States Lu, N. and Liska R. (2008) . In this study general contractors and architectural/engineering designers were interviewed. The benefit of off-site construction chosen by contractors most frequently was time related, ie the reduction in the overall project schedule and construction period. These two benefits put together were chosen by 64% of the survey group as being their prime reason for using off-site construction methods. In another study of house building companies in the United Kingdom Pan W., Gibb A., and Dainty A. (2007) , 54% of participants stated that their reason for using off-site construction methods was the guarantee of time certainty regarding the project's construction process and delivery. Venables T., Barlow J., and Gann D., (2004) analysed the views of off-site construction component providers and concluded that reducing the on-site time required for assembly was a major area in which off-site methods had clear benefits over traditional methods. Finally, in Blismas N., Pendlebury M., Gibb A., and Pasquire C., (2005), shorter project time schedules were the major benefit associated with off-site construction methods.

B. Quality Improvement

Another important advantage mentioned by all the groups was product quality improvement. In this regard, the main benefit provided by off-site construction is more stringent control of product quality compared to the on-site environment. Venables T., Barlow J., and Gann D., (2004) found that the produced quality and the resulting finishing were the most important benefits of off-site construction compared to traditional on-site construction. Gibb, A. and Isack, F. (2003) revealed a shared client belief

that products manufactured off-site were more uniform and reliable and underwent a greater degree of quality control than those made on-site. The reduction in time spent on on-site corrective works was also reported as a benefit. As an overall conclusion, the study found that quality ranked as clients' second most important reason for choosing off-site construction. Goodier C. and Gibb A., (2007) also found that increased quality is perceived to be the second most important advantage of off-site construction methods with 28% of clients and designers citing it to be their choice of preference, while 15% of contractors did the same. However in Lu, N. and Liska R. (2008), the quality increase was not ranked as favourably as it was in the earlier references, being only fourth among designers and seventh among contractors. In Pan W., Gibb A., and Dainty A. (2007) , quality was fourth choice among other relevant factors for house building companies, with 50% stating that this was their motive for opting to use off-site methods. Further work needs to be done to clarify whether the apparent inconsistencies between the surveys referred to in Lu, N. and Liska R. (2008) & Pan W., Gibb A., and Dainty A. (2007) and those of Gibb, A. and Isack, F. (2003) & Goodier C. and Gibb A., (2007) are significant or simply attributable to survey variance. Gibb, A. (2001) shows that a key quality advantage of off-site construction is its capacity for continuous improvement and quality management. Due to standardization, off-site constructed modules can be continually improved over time, while such continuous improvement is not a feature of traditional on-site construction.

C. Addresses Shortages in Skills

A third main factor behind the construction industry's support for off-site construction is that it alleviates skills shortages, which are becoming a industry major concern. With off-site construction, processes can be outsourced to a setting requiring a smaller labour force than would be required by traditional on-site processes. Pan W., Gibb A., and Dainty A. (2007) noted this as the most significant reason for implementing off-site construction methods identified by house building companies in Britain, with 61% stating it as a driving force. While not as important as for building companies, general contractors using off-site construction considered alleviating the shortage in skilled craft workers to be one of the top six reasons for this choice. Lu, N. and Liska R. (2008) Western Australia is currently becoming aware of the skills shortage problem and is promoting apprenticeship schemes and recruitment strategies to tackle the issue. By contrast the European developed market seems to show a different picture as Gibb, A. and Isack, F. (2003) found skills shortage to be only a marginal reason in their analysis of client views, where less than 10 out of 117 voluntary responses stated reasons related to shortage of skilled labour and they concluded that off-site construction results in fewer people needed on site. This difference may be related to the fact that clients, in comparison to contracting and building industry companies, have less understanding of the components of the construction industry and the specific skills shortage problems within it. Indeed, Gibb, A. and Isack, F. (2003) shows that the client groups are not expected to understand the benefits and drawbacks of off-site construction methods to the same extent as other groups. They may therefore be more inclined to prefer off-site construction due to shorter time frames and higher quality, which are more tangible reasons from their perspective. Another problem according to the same reference could be that off-site construction also suffers from the same skills shortages. Non-availability of components was the third highest ranked reason why companies in the building industry did not use pre-assembly methods. This line of reasoning is supported in Goodier C. and Gibb A., (2007) , where only about 40% cent of the suppliers of off-site products which were interviewed accept that there is sufficient supply to meet the off-site construction demand.

D. Cost Reduction

Cost saving is the fourth observed benefit of off-site construction. Although cited as a main benefit in several studies, the approach was also listed as being rather high in its initial costs. According to Pan W., Gibb A., and Dainty A. (2007), the high cost coupled with the assurance and certainty provided by off-site construction was the main reason behind its adoption by companies in the house building sector. This can be attributed to the fact that off-site construction less likely to face cost volatility caused by uncontrolled site factors including poor weather conditions. Among engineers and architects, 36% cited the reduction of the overall cost of the project as the second most frequent reason for using off-site techniques. In Gibb, A. and Isack, F. (2003) , cost was cited as the third most significant advantage by clients. Although some responses referred to the increased cost certainty of off-site methods, the main focus was the fact that off-site construction could in the end lead to lower cost. In addition, related factors such as the reduced on-site labour force resulting from the benefits of standardization and pre-assembly are recognized in another activity within the construction process Gibb, A. (2001). A similar conclusion is arrived at in Goodier C. and Gibb A., (2007) when noting that other advantages of off-site

construction, especially enhanced quality and reduced corrective work, are often not listed directly under costing. For instance, Pan W., Gibb A., and Dainty A., (2008) shows that the cost associated with the maintenance of bathroom modules manufactured off-site can sometimes be as low as one-third those constructed on site. This fact related to operating costs is often not noticed in an industry that emphasizes on initial capital costs over lifecycle operating costs measured across the asset's usable life. Blismas N., Pasquire C., and Gibb A., (2006) also notes that the most significant benefits of off-site construction may not be directly seen, but result from indirect savings in costs and non-cost value-adding items. Although higher initial costs may be seen, the actual accumulative costs of the methods adopted in off-site construction over the entire useable life of the project may come to be cheaper than those resulting from the use of traditional methods of on-site construction.

E. Productivity Improvement

Productivity can provide another way to evaluate the benefits of off-site construction methods and components. Certain studies such as Gibb, A. and Isack, F. (2003) , cite the increase in productivity as a clear factor in their study of clients in the construction industry. This study mentions productivity as the fourth cost-important advantage associated with methods of off-site construction. However, only 15% of respondents stated productivity as the key reason for selecting off-site construction. A wider view points out that better productivity is a prevailing advantage of off-site construction. The accumulated benefit associated with reduction in time, improved quality, and low cost of projects indicates that off-site construction has higher productivity per unit of input than on-site construction.

F. Other benefits

Some of the other benefits associated with off-site construction are Taylor S., (2009):

- Environmental benefits from reduction in wasted materials, less noise, dust, and disruptions.
- Social benefits by creation of employment in areas away from construction sites.
- Technology benefits in the sector by incorporating CAD and BIM.
- Health and safety improvement by reducing site-based accidents and ill health.

Figure 1 illustrates the overriding factors related to the decision to use off-site construction.

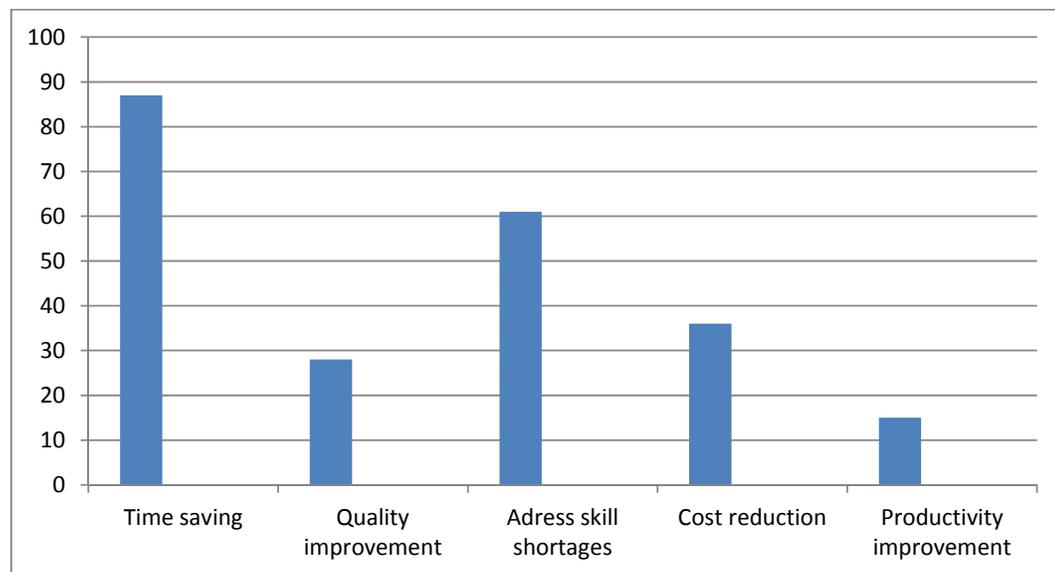


Figure 1 Factors related to the decision to use off-site construction, Taylor S., (2009)

2.2 The main barriers and disadvantages of off-site construction

A. Cost

Although a significant percentage of respondents believed that cost is one of the benefits of off-site construction, the initial capital costs are higher than those of traditional methods GOODIER, C., and GIBB, A.G.F., (2005). In this study 67% of clients/designers and 77% of contractors believed that off-site

construction is more expensive. It is also argued that initial costs in setting up a production line should be factored into the economy of off-site methods Kyjakova L., and Baskova R., (2016) . The considerable investment needed to develop manufacturing processes and designs for modular buildings are another factor cited Smith, R. (2017).

B. Perception problem

Client resistance based on experiences resulting from previous performance can result in lower valuations and difficulty in obtaining financing. A low but significant number of respondents comprising 38% of clients/designers and 31% of contractors believed that this is a disadvantage driving clients away from off-site construction GOODIER, C., and GIBB, A.G.F., (2005).

C. Transportation

The difficulty associated with transporting and handling modules is another cause for concern Smith, R. (2017). The size of prefabricated components may need to be limited due to transportation limitations such as weight limitations, low bridges, road widths, and the resulting disruption to traffic. Another factor to be taken into consideration is the multiple transports to the factory and from the factory to the construction site Kyjakova L., and Baskova R., (2016).

3. Industry readiness for off-site construction

The construction industry’s readiness to adopt and promote off-site construction depends on three major factors. These factors are the demand generated by clients willing to use this method, the infrastructure capable of satisfying the demand, and the regulatory framework within which the projects can be implemented.

The decision to use off-site construction rests with the clients, the designers/architects, and the suppliers/contractors. The drivers, constraints and factors related to the use of off-site construction are shown in Figure 2.

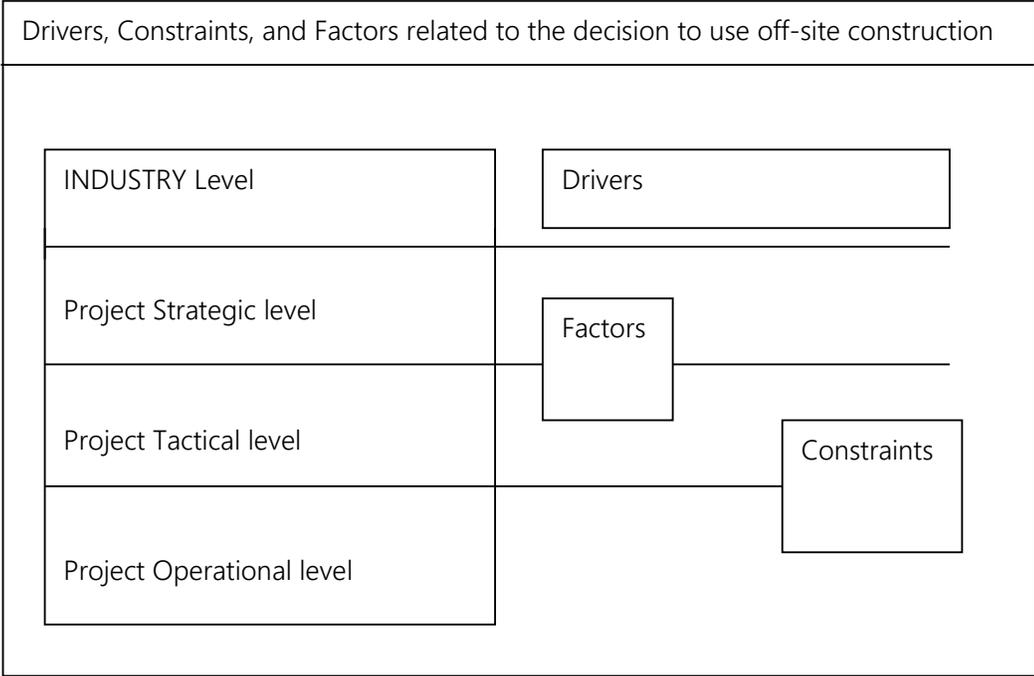


Figure 2 Relationship between Drivers, factors, and constraints Elhisan, E., (2014)

Clients, designers, and architects believe that the client is the driving force behind the choice. However suppliers and contractors believe that they are the drivers GOODIER, C., and GIBB, A.G.F., (2005). Suppliers and contractors need to sell the idea of off-site construction to their clients by educating and convincing them about the method’s advantages and potential. The surveys show that the most effective

argument is that related to price, however other factors such as speed of construction and quality of the product also influenced client choice. The best way to overcome client resistance would be to provide case studies together with increased partnership arrangements and marketing information GOODIER, C., and GIBB, A.G.F., (2005).

There are three fundamental aspects to be considered by the client in making the choice. These are cost, time, and quality and no single aspect can be altered without affecting the other two Gibb, A., (2006). Off-site constructed projects typically have fewer defects and are constructed quickly by mass produced components of better quality and higher standards Velamati, S. (2012). The high initial starting costs of using this method of construction are recovered because the improved quality reduces construction time and snagging time. It is also worth noting that component also design takes into consideration the ease of maintenance and repair, thus savings can also be made in the long term. This cost saving feature leads indirectly to cost recovery that may outweigh the initial high expenditures

The US market for the commercial construction industry totalled \$201 billion in 2010, within which only \$2billion (or 1%) was credited to modular construction Velamati, S. (2012). The UK is an example of a well-established market for modular construction, but it still has only approximately 2% market share.

In a UK based off-site construction industry survey, a questionnaire was sent to 345 companies specializing in complete structures, structural elements and substructures, and pre-assembled civil engineering structures Gibb, A., (2006). In this survey two companies identified themselves as suppliers of complete structures and 51 companies as providers of structural elements and substructures. The majority of the companies surveyed did not assign a category to their product, however it can be concluded that most available components are structural elements and substructures. According to Taylor S., (2009) there are several successful companies but the off-site industry is scattered and therefore the critical mass needed for its take-off has not been achieved. The challenge is to generate systems aiming at increasing awareness and setting standards to enable the off-site industry can make its case more effectively so that the benefits of this industry become widely understood and applied.

The data and information provided by Gibb, A., (2006) and Velamati, S. (2012) indicate low demand for off-site construction, and although Velamati, S. (2012) predicts a rise of 20% per year in this demand even with this expected increase, the number would remain rather low. It also noted that the largest number of suppliers are in the elements and substructures sector which leave assembly to be done at the site. This fact partially eliminates the disadvantages of site construction only.

Two regulatory frameworks which apply equally to all buildings whether constructed off-site or on-site are Building Regulations and Planning Permission. The Building Regulations are legislative tools for enforcing the related legislation that mandates good standards of construction and safety. They are a set of standards for design and construction, applying both to new buildings and to alteration of existing buildings. They are intended to ensure that buildings, including modular buildings, are manufactured and erected to an acceptable approved standard. The Regulations include several parts, such as structural elements, ventilation, fire safety, and the energy consumption of the building. The Building Regulations also set the standard to which new buildings should be built whether in-situ or off-site construction modules. Complying with Building Regulations is a separate matter from obtaining Planning Permission. While Building Regulations set the standards for buildings design and construction, Planning Permissions are used to direct the development methodology regarding the way towns, cities and the countryside are to be developed. Planning also takes into consideration the external appearance and the effect the development will have on its local area.

The Building Codes do not impose any technology limitations on modular manufacturers and early adopters of off-site construction Velamati, S. (2012). Most Codes oblige the manufacturers of modular units to apply an approved quality assurance programme which needs to be monitored by a certified third-party agency, which make inspections both of the building under construction and the modular builder's plant. However if a third-party agency is not a local requirement, then the Building Department certifying engineers and/or officials takes over this inspection role Hardiman, T. (2008).

The Building Code itself defines design guidelines and tolerances, not construction techniques, and therefore any issues related to the Building Code can be addressed effectively during the design process. Consequently, Building Codes do not represent an obstacle for modular construction.

The modular process offers opportunities and challenges for the developer. The specific construction advantages in reduced environmental impact, noise, traffic, and construction schedule are likely to be particularly welcomed by the community and neighbours. Additionally, the reduced construction time schedule will lead to quicker return in development fees and quicker property tax revenue streams. It is also envisaged that more inexpensive and within reach construction techniques could result in lower rents and lower unit sale prices which are additional advantages to the community. However, the

possible reduction in jobs during construction of a modular project compared to a traditional in-situ project might result in criticism from labour supporters and unions Velamati, S. (2012).

The party carrying out the work is responsible for adhering to the Building Regulations and this should be defined at the start of the work. As an example, the Building Regulations state allowable U-values for components to be used in new residences should be as low as possible in order to increase the energy performance of the building as a whole. The Building Regulations also specify the permissible air permeability of new build residences, which is defined as the rate of air leaving the building and the rate of new air entering the building. Buildings are designed to achieve a low air permeability figure so that energy is not wasted because of escaping air. Such values are important and can be easily achieved by use of higher quality products produced in a factory environment for prefabrication and off-site manufacturing techniques KYJAKOVÁ, L. (2015).

It is not intended to say that off-site in general or a particular off-site system is the correct solution to all building problems Smith, R. (2017). Off-site methods performed better on some building types constructed by specific building teams and in certain locations.

General suggested guidelines, which are not definitive, can be drawn relating to the considerations that should be taken into account when making a decision on whether off-site construction is appropriate. These guidelines are Smith, R. (2017):

- Projects that are restricted by a limited time schedule such as schools or student accommodation that need to be ready for the beginning of a new academic year, embassies that need to be built quickly in a foreign country, or retail outlets that must open in a specific season to achieve increased revenues. As a matter of fact almost any building type today can benefit from a shorter construction schedule.
- Modular projects such as classrooms, dormitories, laboratories, office units, communication structures, high-tech facilities, and bathroom pods.
- Projects requiring stringent forms and sustainability specifications or an end product with a higher degree of quality or shape control. In this type of unit, the factory provides space for prototyping, quality control, and complex systems integration capabilities.
- The delivery method chosen by the owner can influence whether off-site is used or not, as some contract types are not suitable for off-site delivery. Examples are design-bid-build contracts, which do not specify methods/means to be used during the design process by the contractor, or construction manager contracts where construction method decisions are made with no need for owner input. This disadvantage can be alleviated by choosing design-build contracts or integrated contracts, which enable early decisions by owners regarding fabrication. Also designer and builder collaboration with off-site product manufacturers during the design phase will help during the planning and schematic development phases.

4. Case studies

The degree of fabrication of prefabricated components relates to their size and complexity. These two factors determine the level of on-site work required to erect and assemble these components and they can be classified as Boafo, F., Jin-Hee, K., and Jun-Tae, K. (2016):

- Components: single fabricated elements such as trusses, wall frames, and precast concrete. They offer flexibility within the design and are especially suited to fabrication using Building Design Modelling (BIM) in which a full scale model can be built to prove fitness and tolerances.
- Panels: 2D structures used to build structural walls, roofs, floors, insulation panels, curtain walls, etc.
- Modular structures: 3D complete volumetric sections in which most of the exterior and interior finishes are placed in the factory and are 80-90% complete when delivered to site. An example is mobile homes and stack-on units.
- Hybrid structures: combine both panels and modular fabrication to construct a whole building.

As discussed earlier, the majority of modular component suppliers identified themselves as component or panel suppliers. The following case studies were selected as examples which relate to these four degrees of prefabrication.

4.1 Van Elle's foundations (UK)

Van Elle's "Smartfoot" package provides a modular pre-cast foundation beam solution system offering all the advantages of quality, speed, and tolerance accuracy Taylor S., (2009). The pre-cast post-tensioned foundation beams are installed on prepared concrete piles. The building is a three storey private dwelling. It was clearly demonstrated that the traditional method would require days if not more depending on the weather while the modular method took 85 minutes only Taylor S., (2009).

4.2 Wallace Building Products (USA)

Wallace Building Products were hired to panel the floor and wall systems of The Woodlands at Harvest Hill, New Hampshire, which is a housing system whose construction schedule did not allow for traditional framing Pre-fab/Modular Construction, (2014). The project started in December 2009 and was completed after few months in the spring of 2010, providing a significant cost saving and reduction of the time schedule of site works.

4.3 Thames Valley University dormitory (UK)

The project developer, Berkeley Homes, contracted the modular manufacturer Caledonian to construct a complex of six buildings (ranging from four to eighteen storeys high) with 1060 accommodation units (839 student rooms together with a 221 studio/one-bed/two-bed apartments) Velamati, S. (2012). The buildings used 825 modular units and the complex was completed in 22 months, which is 12 months less than it would take using traditional construction methods.

4.4 Student housing project at Manchester University (UK)

A hybrid modular design was adopted, taking advantage of a primary steel frame with 2D and 3D modular components. The primary steel frame's purpose was to provide a typical stabilizing structure and offer the designer flexibility when planning internal spaces. 2D modular panels were included to make up open areas and partitions in the floor plan, while the 3D volumetric modules were used in places such as the core use spaces or the highly serviced spaces e.g. bathrooms] Lawson et al., (2005). The 7-storey building for the student housing project for Manchester University was built a primary steel frame and a two-storey podium. The first storey was constructed below ground for parking. The second storey was dedicated as a retail space. The remainder of the storeys each contained 3D modular student housing units. In this building construction a total of 1425 modular units were used Anthony, C., Jellen, P.E., Ali, M. (2013). The Steel Construction Institute (SCI) highlighted that a construction time reduction of 60% was achieved for this project, compared with alternative site-intensive construction methods (SCI 2003a).

5. *A proposed model for the adoption of off-site construction*

A six-stage model is proposed to support the adoption of off-site construction (Figure 3). The readiness of each stage depends on the level of maturity of previous levels. For instance, in order to reach the most mature stage, international adoption and standards have to be defined. The model starts with occasional use through personal interest within an organization. The second stage entails that there are some pockets of excellence, which are achieved within specific projects. The second stage requires strong project management techniques to be in place. The third stage indicates that a process is in place, which can help an organization at stage four to be ready to use this technological innovation at company level. At stage four, strong process management tools and techniques are needed. Stage five and stage six are associated with the developments of guidelines, standards, and strategies for the adoption of off-site construction at national and international levels. It is clear that national strategies are lacking and most important is the lack of international standards.



Figure 3 A six-stage approach for the adoption of off-site construction

6. Conclusions

A greater amount of impartial and unbiased research into the factors that distinguish the methods used in the off-site construction industry from more conventional in-situ supply and installation activities could result in guidance for the off-site construction industry on where and how it can add value to a project. Particular attention should be given to specifically addressing explicit performance variables. Although there is a considerable amount of case studies and observation-based literature related to off-site construction, there is only a modest amount of factual and objective comparison between it and in-situ construction and in particular comparison that objectively explains performance variables measurement and identification off-site work, as pointed out and noted by Blismas, N., and Wakefield R., (2009).

Specifically, more research is needed to evaluate and compare the cost related to off-site construction in comparison with on-site construction, i.e. to assess performance factors Venables T., Barlow J., and Gann D., (2004). Also further research is needed on how other manufacturing principles, such as those in the steel, chemicals, and machinery industries, can be implemented in the construction industry Blismas, N., and Wakefield R., (2009). Insights regarding methods to measure performance through operational management taken from established manufacturing industries would enable the off-site construction industry, being in its early stages, to grow in a productive and efficient manner.

Such academic research would enhance the guidance available on the use of off-site construction. Future studies of off-site construction need to focus on productivity assessment of off-site construction with regard to operational management and empowerment of employees. This focus would result in the identification of factors affecting the productivity of the off-site construction industry and enable the evaluation of current productivity rates of off-site construction industry fabrication methods relative to traditional in-situ methods.

Regardless of the assertions of some champions of off-site construction industry methods, a complete or even a major shift to standardisation and prefabrication is not appropriate Gibb, A. (2001) . Instead, attention should be focused on optimising rather than maximising its use. Similarly, off-site construction is not a complete construction solution for all built assets and is it is unlikely to become so Venables T., Barlow J., and Gann D., (2004). Instead, relevant parties should concentrate on determining suitable uses for off-site construction, identifying projects where the benefits of off-site construction can add the most value, and where there are prospects for continuous improvement. For example: in projects which need a more standardized and uniform design solution, off-site construction may add considerable value due to its more precise nature and faster time frames. Off-site methods are highly suitable for a repetitive design requirement, which is to be completed to a specific deadline, but not so useful in situations where these factors are not important.

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Impact of Stakeholder Management Tools and Techniques on Construction Project Success

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Abstract

Stakeholder management is a relatively new concept; only recognised as an area of project management by the Project Management Institute in 2013. Prior to this, it was an area of communications management, with recent literature suggesting that stakeholder management holds a greater impact than previously thought. In the construction industry, there is a conflicting view of stakeholders, and generally speaking they are seen as an area of an interest that comes second to the iron triangle: cost, time and quality. It has been stated that projects can potentially benefit from comprehensive stakeholder management and engagement, and thus positively influence the level of project success. Therefore, the purpose of this study is to analyse and explore the impact of stakeholder management on construction project success. It further aims to provide expounding context and application of effective tools and techniques involved in applying comprehensive stakeholder management in construction projects.

Keywords: Stakeholder management, tools, techniques and project management

1. Introduction

1.1 Background of Study

Within construction projects, there is the inherent need for two main factors to ensure success: high performance teams and effective stakeholder management (Mohan & Paila 2013). Effective stakeholder management and relationship management can be the difference between success and failure from many aspects, including cost and time overrun (Project Management Institute 2013).

The issues surrounding the success of construction projects due to poor stakeholder management relate to losing stakeholder support and commitment to a project (Bourne, L 2006), resulting in confusion and unclear project goals and thus potential failed delivery of project objectives. It can therefore be said to be a paramount responsibility of the project manager to identify all stakeholders, the power, predictability and interest of the key project stakeholders, and to manage the communication channels by which they relate, interact, and influence the project's execution. According Project Management Institute (2013) the responsibilities of the project manager are extensive with nine main areas:

1. Accountability to the project steering committee for delivery of the project; reporting, to the project steering committee at regular intervals;
2. Ensuring the project is managed in accordance with agreed processes and tolerances;
3. Dealing with the construction/contractors to ensure project progression;
4. Maintaining the project risk register and the integration of risk treatments and control activities into project plans and activities;
5. Approving minor variations to budget, schedule or scope, within agreed tolerances;
6. Managing and monitoring the project activity through detailed plans and schedules and preparation of reports;
7. Managing day to day stakeholder relationships and issues;
8. Managing project sponsor and stakeholder expectations through the formal specification and agreement of goals, objectives, scope, outputs, resources required, budget, schedule, project structure, roles and responsibilities and communication to them on progress; and
9. Inspecting project progress and element completion for quality assurance.

The ways by which these elements are managed by the project manager are dependent on the project environment and project team dynamics (Mok, Shen & Yang 2015).

Traditionally and throughout the twentieth century in construction projects, however, the concept of the client was seen as the main stakeholder, having changed in recent times and replaced with the reality of project stakeholders: contractual and non-contractual (Newcombe 2003). Stakeholders hold different levels and types of investment, power and interest in projects, and therefore can influence and affect the major organisational dynamic and environment. This has in recent years, developed the need for the project manager to introduce stakeholder management, with the aim to eliminate the risk of miscommunication, interference without adequate consultation, insufficient support, and poor delivery of project information (Chinyio & Olomolaiye 2009).

Bourne and Walker (2005) discussed the importance of developing strategies in order to engage project stakeholder support as a process that is unique to each project undertaken; that there is a need to:

"...adopt significantly different strategies to achieve stakeholder engagement, leading to stakeholder satisfaction and a successful project." (Bourne, L & Walker 2006)

The stakeholder theory addresses morals and values in managing an organisation (Freeman 1984, p.46). Due to its expansion, there has been a change on traditional views that the only *important* goals and ambitions were that of the shareholder. Freeman (1984) originally discussed and developed the stakeholder theory, and defined a stakeholder as:

"...any group or individual who can affect or is affected by the achievement of an organisation's objectives."

Through the stakeholder theory arises the need to develop a model, which incorporates the roles and responsibilities of all stakeholders, in order to ensure a culture within an organisation that holds compatible, not competing interests (Collier 2008) – stakeholder relationship management. The issue surrounding the inclusion of all stakeholders is to determine how much emphasis needs to be shown to each party dependent on their influence. Determining the level of stakeholder power may change as a project develops and therefore can become challenging.

1.2 What is stakeholder management?

Stakeholder management is an area of project management that involves many interpersonal aspects and therefore requires constant progressive research and reports of the most current, and successful techniques in order to achieve the best project success possible. Nahyan *et al* (2014), Johansen *et al* (2014), Doloi (2013) and Maier & Branzei (2014) support this idea and discuss the aspects of cost, time and budget blowouts that have been directly correlated to stakeholder influence and power. Project stakeholders are classified by Johansen *et al* (2014) as uncertainty in a project, and that their subjective nature is influenced directly through a project's objectives and effects. This idea supports all literature reviewed, in the respect that stakeholder management and project success are interrelated and if not addressed, can cause detrimental results. The research undertaken by Johansen *et al* (2014) reviews the relationship between the stakeholders and opportunities through four main sections: rationality and methodology, relevant theories, the author's view of the connection between stakeholders and uncertainty, and conclusions of further research required within project management. Stakeholders and uncertainty are explained in relation to uncertainty having two sides – threats and opportunities. Maier & Branzei (2014) support this idea, demonstrating that through the ability to involve stakeholders and managing the individuals, opportunities may be created whilst minimising the threats.

1.3 Stakeholder Theory

Stakeholder theory is an area of stakeholder management that must be acknowledged and analysed in order to grasp a better understanding of the background of stakeholders, and why in the twenty-first century they have become such a crucial aspect of successful project execution and project management. Stakeholder theory can be said to be the basis of the development of stakeholder management, in the sense that it explores the sociological and interpersonal side of managing people. Numerous articles discuss stakeholder theory, including Collier (2008), Jensen (2002), Friedman & Miles (2002) and Freeman (1994). The period of time these articles were published shows that stakeholder theory is a dated concept that true stakeholder management has been developed from in the twenty-first century.

Stakeholder theory, as defined by Freeman (1994), addresses morals and values in managing an organisation. This concept was applied in the study by Collier (2008) where the author explains that stakeholder theory offers the organisation a way of identifying and integrating conflicting, opposing stakeholder interests by determining wider organisational obligations which may be verbalised to all stakeholder groups. Freeman in an earlier paper published in 1984 discusses the concept of stakeholder theory, but his more recent study in 1994 is paradoxical in that he suggests that there is a move away from stakeholder theory, to a more comprehensive, broad way of viewing and integrating stakeholders within a project. As stated previously, stakeholder management requires constant progressive research – and this can be applied to the analysis of stakeholder theory. Jensen (2002) discusses the idea that stakeholder theory has purposely been left incomplete in order to allow for subjective influence to be introduced from project to project. Similarly, the study conducted by Friedman & Miles (2002) identifies the lack of comprehensiveness outlined by stakeholder theory, and therefore it must be applied in conjunction with multiple concepts.

Friedman & Miles (2002) proposed a model to follow that integrates stakeholder theory, as well as a realist theory of social change and differentiation. This identifies the need to develop a better way of specifying the organisation/stakeholder relationship. It is argued that due to the exponential increase in technology, mobile communications and social media there is equally an increase in the ability for people to protest; influencing a projects progress and overall success. This element of impact that stakeholders may have on a project was previously not a consideration in projects and therefore can be said to correlate with the increasing need for stakeholder management in projects (Elmualim 2010).

Similarly in an article by Atkinson (1999) it is proposed that stakeholder influence is a success factor in construction projects. This article proposes the idea that the Iron Triangle (cost, time and quality) only incorporates “two guesses and one phenomenon” (Atkinson 1999) and that there are other success criteria that must be incorporated. Furthermore, this concept is discussed by Karlsen (2002) in an article that focuses on stakeholder management and the impact that all stakeholder groups can have – determining that clients and end users are the most important stakeholders. Karlsen elaborated on the idea that almost all projects are undertaken in a context where stakeholders have a major role and influence on the accomplishment of tasks; that the project is subjective to actions and decisions influenced by the stakeholders (Karlsen 2002).

Eskerod & Huemann (2013) conclude that the approach to stakeholder management outlined in the PMBOK 2008:

“...goes into the direction of selling the project to the most important stakeholders rather than involving them and their interests into the creation of project objectives. It is recommended to concentrate on a limited number of stakeholders, including only those who are relevant for the project success.” (Eskerod & Huemann 2013)

Atkinson (1999), Elmualim (2010) and Karlsen (2002) all follow a similar ideal that stakeholder management is one of the most difficult to manage and one of the most important areas of project management.

1.4 What are project stakeholders?

The concept of the stakeholder throughout the twentieth century was thought to be that of a singular client, however more recent studies have found that this is being replaced by the reality of project stakeholders. This was discussed in studies by Newcombe (2003) and Doloi (2013), exploring and exposing the progress within construction stakeholder management, and the way a pluralistic view of the impact and influence stakeholders hold over a project can enhance the success of projects. This has been supported in the current PMBOK guide (Project Management Institute 2013) stating that:

“...it is critical for project success to identify the stakeholders early in the project...to analyse their levels of interest, their individual expectations, as well as their importance and influence”.

There has been a constant progression of what a project stakeholder is actually defined by. Newcombe (2003) stated that stakeholders were once identified by the traditional concept of shareholders – the clients, consultants and contractors. Now, many authors have defined stakeholders and how they are viewed within the twenty first century.

Mok *et al* (2015) articulated how the concept of the stakeholder is discussed and how this has developed over the past century is explained. Mok *et al* (2015) refer to the Stanford Research Institute whom firstly

defined the concept of the stakeholder in 1963 as “any groups or individuals who are crucial for organisational survival”.

Stakeholder engagement is a concept discussed in the Australian Mining industry by Dobeles *et al* (2014). This article discusses a specific case study exploring the challenges associated with stakeholder management and implementation of Corporate Social Responsibility (CSR) in regards to a project within a controversial industry sector. The idea of stakeholder engagement is similarly discussed in literature by Missonier & Loufrani-Fedida (2014). Dobeles *et al* (2014) discuss the stakeholder management tool of CSR implementation in a new way in order to improve the success of stakeholder engagement within projects. The literature describes the way by which CSR has been proposed in existing literature, and how there is no singular solution due to the dynamic nature of stakeholder relationships and interrelationships (Dobeles *et al*. 2014). By contrast, the study undertaken by Missonier & Loufrani-Fedida (2014) supports the concepts discussed by Dobeles *et al* (2014), but in a more general sense, describing stakeholder analysis and engagement broadly within the field of project management.

Maier & Branzei (2014) investigate the importance of creativity in large scale projects, and how this can be enhanced but still within controls set in place in order to increase the project’s success, but still achieving the original objectives. This can be achieved through implementing limitations on creativity, as there are great risks and dangers with allowing unlimited levels of input from stakeholders, as this can result in a disjointed end result. The article explains that although stakeholder creativity within a project can provide the ability to attain and sustain competitive advantage, there is the risk that if one component of the project is changed or altered, then multiple interdependent aspects of the project will equally need to be changed (Maier & Branzei 2014). This is supported in majority of the literature in review, as it relates to the managing of stakeholders’ influence and power. Creativity is an aspect of every construction project, whether it comes from an architect, designer, or the community at large putting forward their ideas and expectations of the project and therefore at the early stages of conception of a project, these all must be addressed and limitations to their effect on the project must be put into place.

2. Stakeholder management tools and techniques

The baseline of stakeholder management tools and techniques are outlined in the Project Management Institute PMBOK (2013). Depending on the industry and discipline, they may vary due to the context, environment and culture of the respective industry – this has been outlined in an article by Ibrahim and Nissen (2003) where the authors state that ‘there is no such thing as a typical facility development project. No two projects are ever the same’. The literature also explains that the project manager must gain an understanding for the cultural, organisational and social environments surrounding projects (Ibrahim & Nissen 2003) which further assists with implementing stakeholder management whereby the internal stakeholders quickly adapt to working as a coherent unit. Stakeholder management is a new area of project management and is difficult to implement correctly, creating the need for further clarification of a systematic framework for stakeholder management. This is discussed in an article by Yang *et al* (2010b) that expands on the multiple stakeholder management methods a project may adopt, however there is no baseline for the construction industry.

When focussing on stakeholder management in the construction industry – it is important to analyse stakeholder management tools and techniques that have been researched and used within this industry. There are many formulas and techniques that are said to be preferred for the construction environment, and a selection of these are outlined by Bourne & Walker (2008) and Doloi (2012). Bourne & Walker (2008) outline the importance of project relationship management and the Stakeholder Circle. Similarly, Yang *et al* (2010b) discusses context specific tools and techniques that are most commonly used, and the order of processes that must be complete. Cleland and Ireland (2002), Karlsen (2002) and Bourne & Walker (2006) all follow a similar formula but slightly vary, demonstrating the subjectiveness of this area of project management. This is shown below in table 1.

Table 1 Comparison of Stakeholder Management Processes in Methodologies

Academics	Stakeholder management processes
Cleland and Ireland (2002)	Identification of stakeholders; gathering information on stakeholders; identifying stakeholder mission; determining stakeholder strengths and weaknesses; identifying stakeholder strategy; predicting stakeholder behaviour; implementing stakeholder management strategy.
Karlsen (2002)	Identification of stakeholders; analysing the characteristics of stakeholders; communicating and sharing information with stakeholders; developing strategies, following up.
Bourne & Walker (2006)	Identifying stakeholders; prioritising stakeholders; developing a stakeholder engagement strategy.

Source: adapted from Yang et al (2010b)

2.1 The Stakeholder Circle™

The Stakeholder Circle is a methodology developed by Bourne and Walker (2008) that incorporates many of the base elements that make up stakeholder management including identifying a project's stakeholders, their influence, understanding their expectations, and defining appropriate engagement procedures in order to gain beneficial relationships for the project. Figure 1 demonstrates the visual nature of this methodology, incorporating concentric circle lines, size of section, radial depth, colour indicators and patterns all indicating stakeholder elements such as the distance of stakeholders from the project, scale and scope of influence, and degree of impact/power (Bourne, L & Walker 2008).

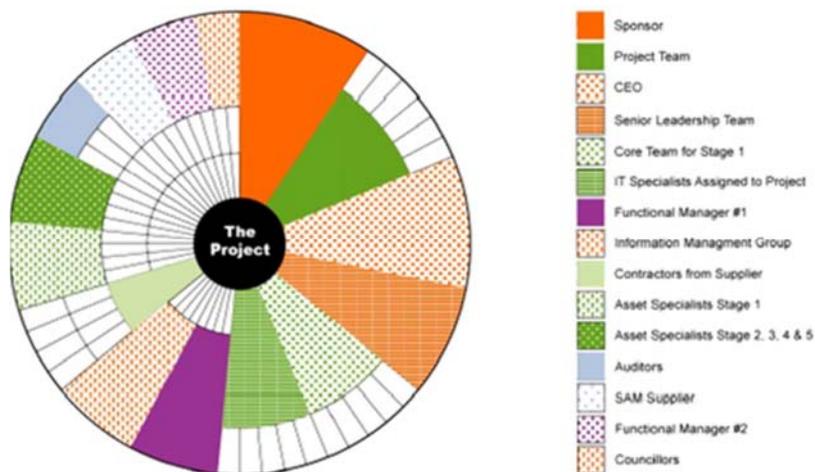


Figure 1: The Stakeholder Circle™ Tool (Bourne, L & Walker 2008)

The Stakeholder Circle methodology is developed through 5 main steps: identify, prioritise, visualise, engage and monitor and has been discussed by Bourne & Walker to be a methodology that can create a correlation between comprehensive stakeholder management and stakeholder assessment of project success. These steps carried out within this methodology are similar to the processes outlined in the PMBOK, but have been further clarified and adapted. This process is not simply a tool or a technique, but a methodology which entails many of the stakeholder management tools and techniques outlined and discussed in the following sections. The aim of the Stakeholder Circle methodology is to improve a project's chances for success by identifying ways to develop effective relationships with key stakeholders (Bourne, L & Walker 2008). This concept is similarly discussed and supported by Chinyio & Olomolaiye (2009), discussing the method as an effective stakeholder mapping method and thus may lead to positive project outcomes and success rates.

2.2 Social Network Analysis

Social network analysis (SNA) is a stakeholder management technique discussed both in studies by Mohan & Paila (2013) and Mok *et al* (2015). Mok *et al* (2015) describes traditional stakeholder management techniques to be affective in small to large scale construction projects, however for mega construction projects many of these methods are constrained due to the individual influences of project managers and incomplete stakeholder boundaries as the project grows in size and complexity. This idea was discussed similarly by Yang *et al* (2009) – that the size and complexity of a project changes the approach and techniques applied in stakeholder management. If this is not considered by organisations delving into the area of mega construction projects, they may expose themselves to the possibility of weak stakeholder management and thus poor project outcomes. Social network analysis allows for the inclusion of stakeholder environment through the consideration of structural characteristics of the stakeholder network/group and the interactions among these stakeholders. Therefore, this technique acknowledges the dynamic nature of not only the project, but the stakeholders alike, and can prevent a project from being unable to assess and resolve conflicts at different stages of the project's lifecycle (Elmualim 2010).

2.3 Stakeholder mapping

Stakeholder mapping is one of the most well-known stakeholder management tools in order to identify all stakeholders involved within a project, and therefore can be said to be one of the most widely used. The PMBOK guide (2013) describes stakeholder mapping or stakeholder analysis as:

“...a technique of systematically gathering and analysing quantitative and qualitative information to determine whose interests should be taken into account throughout the project.”

It further describes the idea that stakeholder mapping aids in the identification of stakeholder relationships – with the project itself, as well as other stakeholders – which can be leveraged in order to build further relationships and potential partnerships, enhancing the project's chance of success.

Newcombe (2003) discusses the idea that stakeholder mapping is the wider overview of further in-depth stakeholder techniques such as the power/predictability matrix and the power/interest matrix. He explains that each stakeholder has expectations that the project is under pressure to fulfil, however these expectations are commonly conflicting between internal and external types of stakeholders. This causes great issues surrounding project execution and stakeholder satisfaction, which brings forward again, the idea that stakeholder management is crucial. Mohan & Paila (2013) refer to Newcombe's article in regards to stakeholder mapping and therefore these studies are inherently linked. Mohan & Paila (2013) uses the concepts described in Newcombe's article, but address stakeholder mapping in a different way. The authors state that stakeholder mapping within construction and infrastructure projects, as a stand-alone tool is not sufficient due to the dynamic nature of the numerous stakeholders. Mohan & Paila (2013) classified stakeholders into different categories in order to develop strategies for managing the relationships. They equally regard setting common goals, objectives, and project priorities in consultation with the stakeholders as a mapping technique that improves stakeholder management significantly.

2.4 Power/predictability matrix vs. power/interest matrix

Power within projects is an area that has been heavily researched within stakeholder management, and Newcombe (2003) outlines the importance of stakeholder mapping of responsibilities and roles of key stakeholders, as without this, there can be the increased chance of an abuse of power. Both the power/predictability matrix and the power/interest matrix identify all stakeholders involved in a project and allow the project team to visualise their biggest concerning stakeholder groups that threaten the success of a project. Stakeholders hold various levels of power and interest and therefore predictability. Newcombe (2003) explains that the power/predictability matrix allows the project manager to assess the size of the stakeholder problem they face.

The power/predictability matrix consists of four zones, whereby the stakeholders are placed through expert judgement and stakeholder analysis. In figure 1 below, it can be seen that stakeholders in zones A and B hold minimal impact over a project and therefore are the most desirable stakeholders as they present few problems and are relatively easy to manage.

In addition, the power/interest matrix stakeholder management tool is usually used in conjunction with the power/predictability matrix, but analyses a slightly different aspect. Mohan & Paila (2013) describe the power/interest matrix as a tool that in order to execute comprehensively, the project manager must have an understanding of context and to have evaluated and ranked the type, source and level of power. Similar to the power/predictability matrix, this tool is executed in a similar manner; by categorising the stakeholders within the project into their respective level of power and interest. Mohan & Paila (2013) classify this tool as effective, but like many other traditional stakeholder management tools, it must be used with other tools in order to encompass all potential risks and opportunities, interests, power, expectations and influence of stakeholders within a project. Much like the power/predictability matrix, Newcombe (2003) discusses the idea that there are groups within this matrix that require different types of management than others which is depicted in figure 2 below.

Zone D again, is a crucial area of stakeholders to consider and focus on. Within this power/interest matrix, Newcombe (2003) describes zone D as the key players within a project and therefore when decision making and formulating project strategy, involving these stakeholders is a must, as they can hold great power on the execution of the project depending on whether they are happy with the decisions and project direction. Zone C stakeholders are described both by Newcombe (2003) and Mohan & Paila (2013) as the most difficult to manage. This can be due to the stakeholders not necessarily having a great interest in the project, but depending on whether they are satisfied with the project strategies and processes they can use their power in order to move into zone D. Within all projects there will always be stakeholders that perceive themselves as powerful, or influential, holding a great interest within the project however the project manager may have grouped these stakeholders within a low level of power zone.

Both matrices can be highly useful within stakeholder management and can aid in decreasing risks involved with stakeholders and increasing opportunities that may become apparent within a stakeholder group or individual – whether that may be due to an idea, or an increased interest and involvement in a project, thus increasing the dedication to the success of the project objectives.

3. Results and Discussion

3.1 Interviews

Five interviews were conducted with project managers, academics and senior project managers. The interviews were of a semi-structured nature whereby the questions outlined were then elaborated on depending on the response of the participant. The aim of the questions was to initiate a conversation about stakeholder management within the environment that the participant was working within and to try to understand the different approaches one could take in adapting stakeholder management, tools and techniques. This was achieved by having 10 baseline questions in order to allow for verification between interviews.

The subjects interviewed were a combination of industry professionals, including project managers, senior project planners, project directors and project management academics. This is shown in the graph below to depict the variation in demographic. There was a variation in the level of experience the participants had which allowed for a wider understanding of different age groups view points on stakeholder management, as well as the effect of experience on the processes employed in projects. The minimum experience of the subjects within the industry was 10 years in project management, with prior experience in project environments and the project management academics was at least five years' industry experience.

3.2 Stakeholder management as a knowledge area

Participant A discussed the recent changes to stakeholder management within project management and how this has had a great impact on the way organisations implement this. In 1995, participant A was involved with a contract that simply had one employee organising and managing stakeholder advice and implementation. This meant that the communication between stakeholders and project managers was informal in nature and thus could have become problematic. Over this 21 year period, there has been a great increase in stakeholder management and Participant A explains that a similar contract now would have a team of approximately 10 stakeholder experts who control communication channels, media releases and to ensure correct information is released to the correct people. Both Participant A and D determined that media has had an impact on the increase in importance of stakeholder management, explaining the

indictment on the maturity of the profession of project management: that from the latest PMBOK guide of 2013 to the previous version of 2008, there is the addition of the tenth knowledge area: stakeholder management. This exposes that stakeholder management has only been seen in its own right for the last 3 years – prior to this it was a subset of Communications Management.

3.3 Project success measures

Participant C determined that stakeholder management could be a factor in the level of project success, however explained that if the scope of work is well defined in a project, then all stakeholder processes that must be completed will have been catered for within the time and budget of the project and thus not impact the execution. They explained that in order to do this successfully, the project team must propose a template that covers the scope of work expected from the internal stakeholders to the project, allow a timeframe, budget and scope to be defined and create a contract from this in order to create accountability within the project; a mini contract within a company. Similarly, participant E held the opinion that stakeholder management should not determine the success of a project, but explained that it is 'all in the eye of the beholder', that projects they had participated in have run over time, or over budget, but still been considered a success due to the end users being satisfied with the deliverable. Participant A simplified this by looking at IT projects; that 87% of IT projects are over time and budget, and therefore they expect this – it is not so heavily focussed on in terms of project success, the project stakeholders are more concerned with whether the deliverable achieves the project's goals and objectives. This can be related to the nature of that particular industry. Opposing to this, both participant B and D related stakeholder management failures to cost, quality and time overruns; that stakeholders have power to disrupt a project, and thus impact elements of the *Iron Triangle* such as an increase in costs that were initially forecast in the project plan. Participant D supported the literature by Karlsen (2002) by indicating that the end users of a project hold a great influence on whether a project is considered a success.

3.4 Stakeholder management practices

All participants agreed that correctly identifying stakeholders within a project and ensuring correct communication are practices imperative in achieving stakeholder management success within construction projects. This was discussed by Participant B and said to be directly related to the culture of the construction industry and the lack of trust experienced between stakeholders, which has been explored within the literature review. However, three participants devised that predicting and assessing stakeholder influence to be the most difficult to manage, with the potential for the greatest detriment to a project and thus requires further research to understand techniques to manage this more effectively. The different stakeholder management practices employed between government and private sector projects were outlined by Participant A, concluding that there is comprehensive stakeholder management within government projects, and a significant lack of stakeholder management within the private sector projects due to the historically adversarial relationship between contractors.

3.5 Tools and techniques employed

Three of the participants elaborated on the idea that depending on the project you are involved with, the tools and techniques employed for stakeholder management will vary. Participant A regarded 'open communication' as one of the most effective and important tools to incorporate in stakeholder management in order to increase project success, while participant D said the 2x2 matrices was a powerful tool. Participant D explained that this tool whilst simple, aids greatly in the ability to best manage the stakeholder groups, and allows the project manager to understand where each stakeholder 'sits' within the project hierarchy. This was also supported by participant E, who discussed stakeholder categorisation as an important tool to identify the type of engagement each stakeholder requires. Other participants also indicated that this tool allows for a self-explanatory visual image to ensure that any individual presented with the image can interpret the information easily.

A lessons learned approach was also discussed, allowing for an environment that is constantly progressing concurrently with the project management industry and learning from past successes and failures. Table 2 below shows the various tools and techniques participants classified to be important and successful in stakeholder management.

Table 2 Tools and techniques employed by interview participants

Interview	Tools and techniques
Participant A	Open communication, update meetings, stakeholder involvement within the project.
Participant B	Stakeholder engagement from inception, communication through media, direct communication, creating positive relationships.
Participant C	Template with stakeholder management baseline, lessons learned approach, update meetings/releases.
Participant D	2x2 matrices, identifying influence, impact, power and interest, open communication, meetings to create positive relationships.
Participant E	Communication, update meetings, stakeholder categorisation [2x2 matrices].

4. Conclusions

Stakeholder management has been seen as an emerging and important area of project management, supported by the participants within this research paper, demonstrating the need for constant improvement and better understanding of the processes involved. The research methods were developed to create an in-depth analysis of the data collected via five unstructured interviews.

The results showed that there are various applied tools and techniques, effective and comprehensive in stakeholder management in construction projects. Project environment was found to be a large contributing factor in determining the tools and techniques implemented, with a new perspective on selecting stakeholder management methodologies. The findings supported the statement by Yang *et al* (2010a) due to the emphasis all participants placed on understanding all aspects of the stakeholder in order to successfully manage them.

"No matter what type of projects and respondents, social responsibilities, comprising economic, legal, environmental, and ethical responsibilities are considered most important for managing stakeholders." (Yang et al. 2010a)

Therefore, by implementing correct stakeholder management processes for the environment and context, determining this on a project by project basis, could contribute to an improved likelihood of project success by minimising the impact of stakeholder management. It can be concluded that there is a definitive correlation between effective stakeholder management implementation and project outcomes, but not conclusively with project success despite the strong linkages identified in the literature review.

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A Study on the Effect of R&D on Bahrain Economy to Achieve its 2030 Vision

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Abstract

Research creates new knowledge that contributes to the development of technology and the solution of problems. Technology development, in turn, underlies much innovation, productivity growth, and economic growth.

Research in Bahrain provides critical solutions to Bahrain's specific needs, local and regional problems for which ready solutions often are not available. These include unique local industrial or business problems, as well as health, environment, economic, or social needs. Sustainability a principle underlying vision 2030 is an example of an area that requires local as well as global research for environment, energy, and economics.

We can compare Bahrain to its peers in research using a key measure gross domestic expenditure on R&D (GERD) as a percent of gross domestic product (GDP).

This include both capital and current expenditures in the four main sectors namely:

- Business enterprise
- Government, Higher education and Private non-profit.
- R&D covers basic research, applied research
- Experimental development.

Some industrial countries have been investing in R&D for decades and OECD countries, GERD/GDP averages about 2.2%. Some newly industrialized countries, such as South Korea and Singapore have rapidly increased their R&D levels to those of the most advanced countries, with current GERD/GDP of 3.6% and 2.65% respectively. So the main question is, Is R&D in Bahrain enough to Achieve 2030 Vision? The aim of this research is to study the Effect of R&D on Bahrain Economy to Achieve 2030 Vision.

Keywords: Research and Development, R&D, Economy, 2030 vision.

1. Introduction

Within the last decades, R&D and Innovation Management practices changed due to upcoming new challenges, societal developments and technological possibilities. R&D and innovation processes are nowadays are more effective, taking into account a wider range of developments in the environment of an organization and more efficient than in previous generations of R&D and innovation management while dealing with a new level of complexity and the challenge of increasing convergences and cross-disciplinarity. A key challenge however remains the early recognition of future developments and trends in R&D and Innovation Management. This track will address foresight activities dealing with the identification and/or analysis of next decade's key topics in R&D and Innovation Management from an industrial and scientific perspective.

Innovation through Research and Development (R&D) is a focus in most developed, as well as developing nations wishing to improve environmental and other socio-economic conditions. To account for the upsurge and growth of technological developments and innovations, countless approaches in the form of policies and strategies have been adopted by governments and policy makers. Ahmad Saleh (2017). The GCC countries have had the vision and objective of transforming their economies traditionally based on petrochemicals to more diversified and sustainable economies with an important component based on R&D, technology, knowledge and innovation. An important part of this vision has been attracting and supporting SMEs who focus on R&D and innovation in the various industrial sectors. This has unfastened a wide arena for investments and technological developments within the region

2. Importance of Study

Research is an essential component of successful knowledge based economies. No country can succeed in a knowledge-based economy without strong higher education institutions, and research is essential to having strong universities. Research is needed to attract top international faculty and to have strong graduate programs. Gulf Cooperation Council (GCC) countries can achieve an economic growth rate of 2.2 per cent by increasing their research and development (R&D) spending by 1 per cent, according to a Strategy& Middle East report. The study reveals that R&D spending (including capital expenditures) is much lower in GCC states when compared to their global peers. For example, R&D spending in the UAE amounts to 0.9 per cent of GDP, and just 0.1 per cent of GDP in Bahrain. By contrast, Organisation for Economic Cooperation and Development (OECD) countries spend, on average, 2.5 per cent of their GDP on R&D. To be in line with OECD average, the report said that Saudi Arabia would have to increase its R&D spending by an additional 1.7 per cent of its GDP, while the figure for the UAE stands at 1.6 per cent, 2.2 per cent for Kuwait, 2.3 per cent for Oman and 2.4 per cent for Bahrain.

3. R&D Challenges: In Bahrain

Definition Research and development (R&D) comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge (including knowledge of man, culture and society) and the use of this knowledge to devise new applications. R&D covers three activities: basic research, applied research, and experimental development. Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view. Applied research is also original investigation undertaken in order to acquire new knowledge; it is, however, directed primarily towards a specific practical aim or objective. Experimental development is systematic work, drawing on existing knowledge gained from research and/or practical experience, which is directed to producing new materials, products or devices, to installing new processes, systems and services, or to improving substantially those already produced or installed. The main aggregate used for international comparisons is gross domestic expenditure on R&D (GERD). This consists of the total expenditure (current and capital) on R&D carried out by all resident companies, research institutes, university and government laboratories, etc. It includes R&D funded from abroad but excludes domestic funds for R&D performed outside the domestic economy. GERD is here expressed in constant 2005 dollars (adjusted for purchasing power parity) and as a share of GDP (R&D intensity).

Now, private-sector-led and academic research is limited. Local universities have few channels for collaboration with international universities, the private sector, or the government, while the region's legal system does not effectively protect researchers' intellectual property and provide them with commercialization support. This means that GCC countries pay a high price to import knowledge, an unsustainable solution that does not always answer their specific needs. Gulf countries are investing heavily in state-of-the-art labs, university buildings and research facilities. "Their total capital expenditure from 2010 to 2030 will reach \$38.4 billion (Dh141.04 billion). However, so far, they have not put similar efforts into high quality research and development, Consequently, GCC countries require importing knowledge, which is often difficult to adapt to the specific context of Gulf States, or may not even be available. As GCC governments allocating large shares of their budgets to state-of-the-art facilities, there are still major obstacles behind the lack of research coming out of the GCC. These include structural limitations within academia, scarce partnerships with international researchers and the private sector, a limited contribution to the public-sector agenda, as well as insufficient intellectual property (IP) regulations.

GCC countries have made admirable investments in research facilities, but must now turn their focus to fostering the research ecosystem. By encouraging the output and quality of academic and corporate research, they can enable innovation and the development of new products and solutions, enhance workforce skills, and inform public policy. As a result, these advances will contribute to adaptability and increased productivity. Bahrain is at the very early stages of establishing a research system and it is clear from that there are many institutions and processes that need to be established or improved to create an effective research system.

Bahrain needs an effective national research system. While such systems vary widely among States in their structure, they accommodate the unique circumstances, needs, resources, capacities, history and cultures of the States that serve them. Despite this diversity, the key elements of all national research systems are research, finance, behavior, and agenda governance.

3.1 Comparing Bahrain with its peers in research

A major measure of GERD is GDP as a percentage of GDP. Many industrialized countries have been investing in R & D for decades and for OECD countries, average GDP per country averages about 2.2%. Some modern industrialized countries, such as South Korea and Singapore, have rapidly increased their R & D levels to the levels of the most advanced countries, with current GDP at 3.6% and 2.65 respectively. Compared to the GCC countries, Bahrain's GDP growth rate is 0.04%. In addition to R & D spending, other international indicators of Bahrain's research status in the innovation system are competition and university rankings. Bahrain ranked 43 out of 148 countries on the GCI (2013/2014), which is lower than the other GCC countries. Bahrain ranked lowest among its regional peers in the classification of quality of scientific institutions and cooperation between universities and industry.

Based on scientific publication as a measure of research output, Bahraini universities did not appear in the SIR rankings in 2013. In 2009, the last year when a Bahraini university at the University of Bahrain was ranked 2252. Although the total increased the number of Bahraini publications since 2000 (about 300 publications annually), and the Kingdom's share of the total regional publications has declined. The authors of the University of Bahrain and the Arab Gulf University are in the majority of Bahrain publications.

3.2 R&D Weaknesses: In Bahrain

Open environment conducive to successful research
Increasing competition from neighboring countries with immense resources
Due pressing national priorities, research may not fall on the top of priorities list
Science agencies, funding, infrastructure, and research culture largely absent
Collaboration, linkages to global networks, data, strategic direction are weak
Research funding has been modest
Opportunities
Strong & vibrant financial and banking sector
Opportunities for regional research leadership in targeted areas
Bahrain R&D current strengths
Leadership recognizes the need to invest in research
Resources can be leveraged from both public and private actors
Well-developed human capital
Eagerness across individual and institutions to improve Kingdom's research capacity and impact

4. Objectives of the Study

The objectives of this study is to:

1. Decrease Bahrain's dependence on natural resources
2. Ensure the long-term social, environmental, and cultural well-being of the Kingdom
3. Improve the application of global health research to the unique medical needs of Bahraini citizens
4. Transform the Bahraini economy into a Knowledge Economy
5. Advance the prestige of the Kingdom within the region and globally
6. Give local opportunities for Bahraini citizens for world-class education and research
7. Establish a national research governance infrastructure SO –
8. Strengthen university research capacity SO –
9. Strengthen the integration of academic institutions with international research institutions & with entities focused on Bahrain's economic & social priorities.
10. Improve public awareness and understanding of research and innovation Research Focus.
11. Address national research priorities.

5. Bahrain Economic Review

Perhaps the most interesting innovation of 2017, however, is the new regulatory framework for SME crowdfunding released by the Central Bank of Bahrain (CBB). The regulator has long been aware of the

difficulties small businesses experience in securing bank loans, and it therefore hopes that crowdfunding platforms will provide a viable alternative source of funds. The CBB's framework uses a person-to-business financing model with conventional and sharia-compliant options, and allows crowdfunding platform operators to establish with BD50, 000 (\$133,000) minimum capital. Foreign and domestic SMEs with paid-up capital not exceeding BD250, 000 (\$663,000) are eligible to showcase themselves to potential investors. If the SME is unable to raise at least 80% of its offer size, the attempt is considered unsuccessful and the monies raised return to investors, a regulatory hurdle that helps narrow down the field of candidates to those that the investment community considers most promising. Successful candidates can raise a maximum of BD100, 000 (\$265,000) in a single year, with the financing tenor capped at five years.

Table 1 The Economic Indexes for the Kingdom of Bahrain

The Index	The Value
The gross domestic product in current prices	31.1 Billion US Dollars (2015)
The gross domestic product in fixed prices	30.8 Billion US Dollars (2015)
The growth in the gross domestic product the percentage growth for one year after the other	2.9% (2015)
The inflation in the consumer price index (100= 2006) annual change	3.3% (June 2013)
Population	1,423,726 (2016)
Employment rate (the workforce as a percentage of the population between 20 and 64 years of age)	79.0% (2010)
Bahrainis	58.4% (2010)
Non-Bahrainis	89.7% (2010)
Unemployment rate	4.3% (2016)
Public sector debt (% of the gross domestic product)	37.6% (2015)
Current account	8.9% (2015)

Source: The Economic Development Board and the Information & eGovernment Authority

6. *The 2030 Economic Vision*

The 2030 Economic Vision focuses on crystallizing an integrated socio-economic government vision and focuses on three basic principles which are competitiveness, integrity and sustainability. After the launch of the vision, the Kingdom of Bahrain began an institutional economic reform program that is in line with the objective of the 2030 Economic Vision. This led to the preparation of a National Economic Strategy that represents a roadmap to achieve the vision. This strategy is continuously revised to adapt to the international changes and the government's work program. The Economic Vision 2030 for Bahrain recognizes that research is essential for shifting the Bahrain economy from one built on oil wealth to a productive globally competitive economy. Bahrain will excel in key fields of research of importance to the Kingdom's economy and social welfare, and possess the broad research capacity needed to access and use global knowledge'.

The Government of Bahrain identified in its Vision 2030 industries and priority areas. The National Strategy for Bahrain and the Higher Education Strategy of the Economic Development Board have identified sectoral priorities, which will feed into the priority areas of the national research strategy. The priority areas of research are based on the relevant human resources of the Kingdom and recognize the need to promote applied research in areas relevant to Bahrain's economic and social needs.

The three priority areas of focus are:

- Financial services, Islamic and financial banking, insurance
- Health and Public Health Services, Gulf Health and Journalism
- Information and Communications Technology (ICT)

It calls on the Kingdom to "encourage research and development in universities to create the platform for a knowledge-based economy." To help achieve this vision, the Bahrain Higher Education Council has developed the National Research Strategy for the Kingdom of Bahrain.

7. R&D In Bahrain

7.1 Research and Development

Research

Research is the systematic investigation into existing or new knowledge. Research may be undertaken primarily to acquire new fundamental knowledge (basic research) or to acquire new knowledge for a specific practical objective (applied research).

One of the leading entities in fostering innovation in the Kingdom of Bahrain is Tamkeen, a national authority established in August 2006, tasked with developing Bahrain's private sector as part of Bahrain's economic vision. In 2008, Vision 2030 for the economic development of the country was initiated and involved participation by government and the private sector.

Vision 2030 is based on three principles:

1. sustainability,
2. fairness
3. And competitiveness.

Tamkeen has two primary objectives; fostering the creation and development of enterprises and providing support to enhance the productivity and growth of enterprises and individuals. To achieve these objectives, Tamkeen provides a number of programmes including training, consulting, financing and entrepreneurship support. Tamkeen launched "Mashrooi" youth business awards, which gives youth a chance to build their own businesses, bearing all expenses related to the Business Plan and Prototype creation through the competition phases, without imposing any registration fees. Another significant step supporting start-up and technopreneurs is the introduction of the virtual commercial registrations by the Ministry of Industry and Commerce, which allows a registration of a company without the requirement of a physical premises. This type of commercial registration is allowed for 39 commercial activities including computer programming activities, graphic design, interior design consulting, photographic activities, software publishing, sound recording and music publishing activities, motion picture and video and television program activities.

Development is systematic work directed to producing new or improved materials, products or devices, processes, systems and services.

Research and development or "R&D" covers both work to create new knowledge and use it to improve technologies. R&D is closely linked to innovation, which can be defined as the introduction of new ideas, devices, or methods into use.

Research creates new knowledge that contributes to the development of technology and the solution of problems. Technology development, in turn, underlies much innovation, productivity growth, and economic growth.

More broadly, research is an essential component of successful knowledge based economies. No country can succeed in a knowledge-based economy without strong higher education institutions, and research is essential to having strong universities. Research is needed to attract top international faculty and to have strong graduate programs. Research is also necessary to be able to acquire and use knowledge and technology produced in other parts of the world. Companies, universities and medical centers, which are active in research, tend to remain at the forefront of their fields and are more aware of developments around the world. Researchers who produce knowledge are invited to participate in forums and networks where new knowledge and technology emerge. Research and development is needed to test technologies from around the world for use in Bahrain. Research in Bahrain is critical to providing solutions to Bahrain's specific needs - local and regional problems that often have no ready solutions. These include unique local industrial or commercial problems, as well as health, environmental, economic or social needs. Sustainability - a fundamental principle of Vision 2030 - is an example of an area that requires local and global research in the environment, energy and economy.

GERD Gross domestic expenditure on R&D (GERD) is the total intramural expenditure on R&D performed on the national territory during a given period; typically normalized by expressing it as a percentage of GDP, and this measure is highly positively correlated with the level of economic development of a country.

8. *Bahrain National Research Strategy*

The Bahrain Research Strategy reflects extensive input from the Kingdom's leadership, universities, industry practitioners, civil society associations and other stakeholders. Considering the needs and current state of research in Bahrain, as well as the likely available resources.

The consensus vision, goals, and strategic objectives are presented below.

'Vision: Bahrain will excel in key fields of research of importance to the Kingdom's economy and social welfare, and possess the broad research capacity needed to access and use global knowledge'.

The main goal of the Research Strategy is to contribute directly to the realization of the goals of Bahrain 2030. The National Research Strategy aims to help:

1. Transform the Bahraini economy into a Knowledge Economy
2. Reduce Bahrain's dependence on natural resources
3. Ensure the long-term social, environmental, and cultural well-being of the Kingdom
4. Improve the application of global health research to the unique medical needs of Bahraini citizens
5. Advance the prestige of the Kingdom within the region and globally
6. Provide local opportunities for Bahraini citizens for world-class education and research

To achieve these goals, Bahrain needs an effective national research system. While such systems vary widely among States in their structure, they accommodate the unique circumstances, needs resources, history and cultures of the States that serve them. Despite this diversity, the key elements of all national research systems are research, finance, behavior, and agenda governance

Research Governance

- Provided by professional research administrators
- Makes use of data and evaluation to manage overall research enterprise
- Facilitates technology transfer and associated IP issues
- Able to convene local, and as necessary international scientific expertise for the purposes of advising government

Research Funding

- Provided at sufficient level that critical mass is reached in the areas that are funded
- Basic science funding provided without interference from the source of funds; applied research projects allow for appropriate influence of funders
- Overall level is relatively stable over time
- Individual grants/contracts are time limited
- Is awarded on a peer- or merit-reviewed basis

Research Conduct

- Led by trained and credentialed science investigators
- Provides a platform for the training of the next generation of science investigators
- Contributes to national human capital development, beyond the training of new scientists
- Proposed research is evaluated for impacts of research on human and animal subjects, the environment, and other societal concerns including ethical conduct of researchers

Research Agenda

- Focused broadly on the economic, social, and health needs of the country
- In general, connected to the needs of industry
- Includes a component focused on long-term, high-risk basic research
- Acknowledges local assets/areas of strength in research
- Evolves over time to meet the evolving needs of the country

Priority Research Areas

The Government of Bahrain identified in its Vision 2030 industries and priority areas. The National Strategy for Bahrain and the Higher Education Strategy of the Economic Development Board have identified sectoral priorities, which will feed into the priority areas of the national research strategy. The priority areas of research are based on the relevant human resources of the Kingdom and recognize the need to promote applied research in areas relevant to Bahrain's economic and social needs.

The three priority areas of focus are:

Financial services, Islamic and financial banking, insurance:

The finance and banking sector is significant in terms of the number of companies, contribution to the economy, and number of employees.

More than 400 financial institutions: banking, insurance, investment business firms, capital market, specialized licensees and funds, contributes more than 17% of GDP, employs roughly 2.5% of Bahrain workforce, with spillover effects. Emergence of the Middle East as a banking center & the rise of Islamic Banking globally. Finance that complies with Islamic law has been one of the fastest growing segment of the global financial system and sales of Islamic bonds have risen considerably. More than 300 Islamic Banking institutions exist in more than 50 countries.

There is opportunity to develop regionally as a key research hub and repository of knowledge and skills, conduct research on the financial sector locally and regionally and opportunity to establish research and standard setting institutions for Islamic banking & finance.

Health and Public Health Services, Gulf Health and Journalism:

Supportive Condition in Bahrain:

- Largely dominated by public sector: Salmaniya Medical Complex, King Hamad Hospital, Arabian Gulf University, & Ministry of Health
- Private: Royal College of Surgeons of Ireland, American Mission Hospital
- Non-communicable diseases such as cardiovascular disease, diabetes, and cancer are leading cause of death – Translational Medicine is very relevant in this area
- Strength in internal medicine, reproductive biology, peripheral vascular disease, hematology, immunology especially at AGU
- Shortage in technical skills, management, administration & evaluation
- There is opportunity to invest in research in niche areas within the sector, internally or through collaborative research programs with academic institutions, domestically and abroad.

Information and Communications Technology (ICT)

Supportive Condition in Bahrain:

- Tech-savvy & connected Bahraini youth
- Quality technical programs at local universities and qualified graduates
- Availability of startup/venture & training funding especially through the variety of support programs by Tamkeen
- Strong growth potential across many industries given the enabling platform nature of ICT
- Strong banking and finance sector which is dependent on agile and robust ICT solutions
- Growth potential in neighboring economies in need of technical and IT consultancy services
- There is opportunity to develop a strong ICT sector that could drive growth across the economy and via entrepreneurship; to build capacity in high value added IT consulting services that serves both local and regional markets and likely immediate opportunity in ICT in developing applications software (apps) for local/regional use.

9. Result and Conclusion

History shows that when nations such as Bahrain dedicate themselves to building a research-based economy, significant and enduring economic and social benefits can result. The Research Strategy will help take Bahrain on path towards its vision of becoming a diversified, sustainable, knowledge-based society.

The reforms, institutions, and activities in the Research Strategy are intended to be realistic – recognizing the current level of research and funding – and are also intended to establish the foundation for future advances. Over the long-run research funding levels should expand to be comparable to other knowledge economy countries, which invest about 2-3% of their GDP in R&D including 0.5 to 1% of GDP in universities. The benefits of expanding research will not all occur immediately but will accrue over time. Growing investments in research will help to attract and develop qualified human capital, attract investments in technology, improve the Kingdom's capacity to make use of existing global knowledge, and help solve the Kingdom's social and economic needs.

10. Recommendations

- Strengthen University Research Capacity by Strengthen administrative structures to support and manage research, Increase admissions to and funding for master's and PhD programs at universities, Establish stable and sufficient source of merit-based research funding for universities, Create conducive environment for faculty members to perform research (reducing teaching load, rewarding researchers), Enhance knowledge transfer through schemes for creation of scientific incubators or science parks, Introduce compulsory and regular international evaluation of institutions funding and conducting research, increase in number of researchers at universities & private enterprises, increase in number of persons with doctorate degrees. Increase in the share of students with natural sciences and engineering majors. increase in journal publication output from universities, including review articles, increase in number of patents & industrial designs filed in Bahrain & internationally, improvement in ranking of Bahraini universities in Global University rankings, increase in number of enterprises with R&D departments and personnel.
- Establish a national research governance infrastructure by Establish the public research funding infrastructure, fund the establishment of new scientific teams/labs, provide access to scientific and testing equipment and installations to avoid duplication given the small size of the country, introduce scientific research best practice: peer review, evaluation, program evaluation, introduction of financing model stimulating competition, development and application of problem-based research. increase in available funds for R&D both for academia and private sector, increase in national R&D expenditure from current 0.04% to 1% by 2020 (2/3 of expenditure by Business enterprises), Increase in number of properly equipped research labs conducting research.
- Strengthen the integration of Bahrain academic institutions with international research institutions and with entities focused on Bahrain's economic & social priorities by stimulate private sector involvement in academic research activities, introduce schemes for providing matching funds for university-industry collaborative research, integrate Bahraini science activities into regional & global research by expanding travel funds, participation in international conferences, facilitate access to regional & international organization's research infrastructure, maintain, optimize, and expand access to databases of reference scientific publications and information/communication infrastructure, create a national forum for linking academia, industry, and government, introduce targeted programs supporting scientific activities at private firms and SMEs, such as seed funding in universities for small business creation/proof of concept Key Performance Indicators. increase in number of collaborative research projects between universities and private enterprises, increase in number of joint research projects with regional or international universities, increase in number of research projects funded by regional or international resources, increase in number of national research networks.
- Improve public awareness and understanding of research and innovation by carry out public dialogue, through conventional & social media, on the role of science and research, introduction of programs for promotion of scientific activities, competitions, and fairs at schools and universities, introduction of scientific research awards to raise the prestige of scientists and researchers, emphasize science, technology, engineering, and mathematics (STEM) education at the primary and secondary levels, universities to develop bridging programmes to improve student preparation during the summer before starting on a STEM programme, exploit social media to improve public awareness Key Performance Indicators, improved public understanding of science as measured in international surveys, outstanding researchers, scientists, & students are recognized and awarded at the highest levels.
- Address national research priorities by introduce targeted national thematic & sectoral programs relevant to Bahrain's economic & social needs, support the development of thematic research centers or centers of excellence for concentration of critical mass of scientific potential aimed at implementation of the national priorities, be a leader in establishing regional networks in priority areas, increase in resources available for scientific research in priority areas (increase in Demand), improvement in the quality of performed scientific research in priority areas, improvement in the human capital potential: increase in number of highly qualified & motivated researchers working in priority areas, increase in the number of highly qualified Bahraini scientists who studied or conducted research abroad in priority areas, increase in number of participants in regional/international research networks in the, priority areas.

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Section 7
Education

Using Problem-based Learning in Innovation Management: The Case of Social Innovation at Arabian Gulf University

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Abstract

This paper explores the merits and opportunities for applying Problem-based Learning (PBL) in Innovation Management. PBL was applied in medical education to enhance models of experiential learning across disciplines and professions. However, PBL offers new avenues for learning in innovation management through navigating the innovation journey from ideation to commercialization. AGU embarks on innovative ways of teaching and learning in higher education by mainstreaming PBL in technology and innovation studies. PBL methods enable both professionals and students to deal with complexity and uncertainty by focusing on deep understanding of socio-technical context and technology cycle. PBL pedagogy makes learning possible and meaningful by addressing and understanding the process of knowledge acquisition, learning context and learner identity. Besides, PBL proves to be a useful pedagogy for experiential learning that contribute to enhanced research skills, team learning and critical thinking.

A case study on teaching social innovation at Arabian Gulf University in Bahrain is presented by identifying and solving a set of social issues in the Gulf region. Design thinking is combined with PBL to explore the barriers and enablers for innovation. Induction is applied to devise themes and a framework for understanding the process of innovation. The study recommends that PBL is to be located centrally within higher education system in the Arabian Gulf region.

Keywords: Problem-based learning (PBL), innovation management, social innovation, GCC, Bahrain.

1. Introduction

During the last few decades, higher education institutions (HEI) had experienced major shifts in business model and paradigm due to globalization and open innovation (Gibb et al., 2012). Open sources for learning are enabling learners to have access to immense amount of knowledge. However, it is imperative that HEI responds to market needs to ensure relevance (Gibb et al., 2012, Thorp & Goldstein, 2013, Wilson, 2012; Guerrero et al. 2016). This resulted in the emergence of new paradigms that enhances internationalization of education and emphasized action learning (Etzkowitz, 2008; Harrison & Leitch, 2010).

The GCC is undergoing deep socio-economic transformations to enhance competitiveness and productivity in a post oil era (Al-Jayyousi, 2016, El-Kholei & Al-Jayyousi, 2018, Akhonbay, 2018). The concept of entrepreneurial university emerged as a response to market demand and policy shifts to ensure relevancy and legitimacy of HEI (Clark, 1998; Guerrero & Urbano, 2012). The entrepreneurial university is an innovative model of HEI which is underpinned by economic efficiency and characterized by putting emphasis on new models of financing, teaching, branding, knowledge management processes, and partnerships. The imperative for entrepreneurial university was developed to deal with uncertainty and complexity (Casson, 1982). For example, the budget cuts of public funds to publicly funded HEI in many countries (like UK, Egypt and Jordan) led to market-oriented education policy and resulted in massification of HEI (Mason et al., 2009). In essence, changes in factors of production, technology systems, funding constraints, and new business models are likely to induce creative destruction in HEI. Specifically, on-line learning, social media, and Massive On-line Courses (MOOCs) are posing challenges to traditional models of HEI (Vaira, 2004). This paper outlines a case study as an example of AGU to show case the use of PBL in teaching social innovation.

This paper is organized as follows. First, the higher education landscape in the Gulf Cooperation Council (GCC) countries is outlined. Then, a literature review on social innovation is presented to show its social value and impact. In this context, a framework for PBL model is presented. Finally, the case of AGU as an example of entrepreneurial university that promotes PBL in innovation management is discussed to link theory to practice.

2. The Background—Higher Education in GCC

Higher education institutions (HEI) in Gulf Countries Council (GCC) face various challenges due to internationalization and disruptive technologies. In addition, producing high quality research and meeting the market labor demands for high quality education outputs pose key challenges (Alyahmadi, 2006; McGlennon, 2015; Vardhan, 2015; and Buqawa, 2016). Understanding these issues and challenges in higher education, especially in the GCC region, is of prime interest for policy makers, educators, and political leaders. It is crucial for HEI to develop their capacity to respond to the above challenges in an agile manner. HEI also have to be more competitive to be able to survive, especially after the commoditization of education and opening the sector to private investors and international institutions.

The GCC includes Saudi Arabia, Bahrain, Kuwait, United Arab Emirates, and Oman. These countries have recorded an exponential growth in the HEI, as manifested in high number of GCC students studying abroad and the adoption of a model of hosting international branch campus model like Dubai Academic City. Youth under the age of 25 represent about 60% of the population in GCC and in Middle East and North Africa (MENA). This in turn created a high demand for education, jobs, and reform of education along with the social contract (Masri & Wilkens, 2011).

Despite the fact that policy makers realize that higher education plays a critical role in socio-economic transformation, there is limited innovation in the delivery of education. The key challenges for HEI in GCC and MENA region include the limited capacity to cope with change, the inability of the HEI to meet the needs of the job market and to balance local identity and culture with globalism. Also, majority of students lack key practical skills in research (Gee, 2000; Elyas & Picard, 2013).

With the emergence of the knowledge economy' concept, countries realized the need to reform their higher education strategies and to develop smart education models by harnessing global networks and ICT (Visvizi et al., 2018). Recently, Higher Education Institutions are perceived as the basis of innovation that enhance the economic growth as enabler. All GCC countries innovated in higher education strategies that aim to advance knowledge economy capabilities and develop models of entrepreneurial university.

3. Framework for PBL in innovation management and social innovation

There are many models of PBL based on context, objectives and audience (Lennon et al., 2019; Terry, 2017; Clark et al., 2006; Brush et al., 1993). However, each model has its own merits depending on the target audience and learning objectives and outcomes. Figure 1 below outlines the process envisioned and applied at AGU in the Innovation Management program. The framework of PBL includes three distinct components; i.e., ideation, implementation and learning. The piloting of the PBL was based on case study approach based on real case problems in industry or community. Students are exposed to a social problem using mind mapping and brainstorming. Then, students are guided to refer to key references or policy documents to understand the initial and boundary condition. The next phase includes one-to-one mentoring and synthesis of documents and research papers. This step is followed by designing a solution to address an un-met social needs using design-thinking approach (Glen et al., 2014; Bason, 2013, Durose, & Richardson, 2016). The final step includes feedback and learning along with the review of the process.

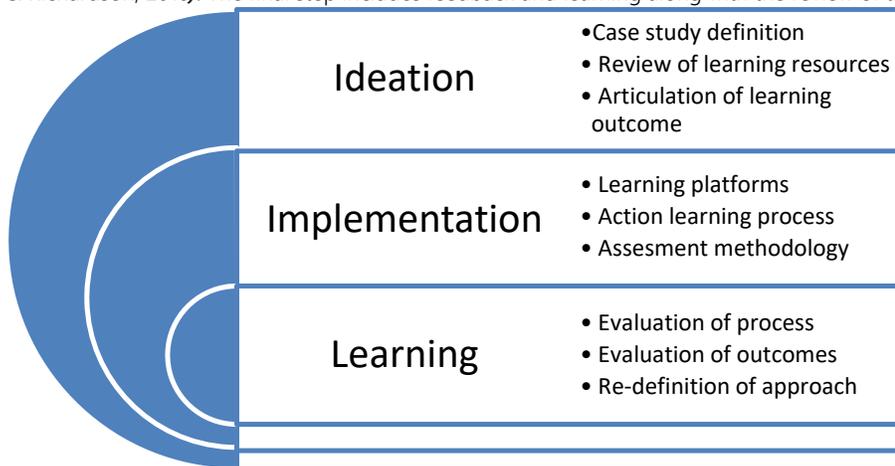


Figure 1: A Model for PBL in Innovation Management at AGU

The business model for PBL consists of four elements, including value proposition, resources, processes, and learning (Al-Jayyousi, 2017). From a different angle, innovation in learning in HEI may be characterized as sustaining or disruptive innovation (Christensen & Armstrong, 1998). The determinants for assessing the performance of PBL include definition of strategy, knowledge management process and business model.

In the GCC context, Arabian Gulf University (AGU) was founded in the early 1980s with a mission to promote a model of regional innovation system for HEI (Bugawa, Al-Jayyousi, AlSultanny, Bhandari & Mirzal, 2018). AGU was initiated to compliment the NIS (National Innovation Science) in GCC countries and to harness the innovative capability by investing in human capital and by promoting organization innovation and a regional model of an entrepreneurial university. The following is a case study about AGU as a model of entrepreneurial university using PBL to teach social innovation and innovation management.

4. The Case of the Arabian Gulf University: PBL in social innovation and innovation management

4.1 Background

Technology plays a critical role in transforming societies and economies through enhancing efficiency, connectivity and access to resources and services. The challenge remains of how universities can build the capacity for a new generation of professionals to enable them to localize technology and innovation (Al-Jayyousi, 2017). The quality of university education is critical for transforming societies to knowledge economy. This requires system thinking, team learning and shifts in mental models. Investing in the human, intellectual, and institutional capitals are crucial to provide the enabling environment for science, technology and innovation (STI). AGU is keen to harness utilize its core competences in technological innovation in R&D by transforming to a learning organization. Its graduate programs in technology management, biotechnology, water and environment are unique academic programs that have sound international reputation.

The vision of AGU is to become one of the leading academic innovation hubs in the GCC countries, by providing transformative educational services that catalyze the creation of a social environment with innovation embedded in the local culture. The graduate program in TM is intended to prepare graduate students in Technology Management and Business Sciences specializations for successful research and managerial careers that combine depth in research methodologies with broad knowledge of the socio-economic implications associated with major technology innovations. Besides, it aims to prepare graduates to assume leading roles in managing new approaches to effectively lead and manage change and to bridge the gap between academic institutions and the corporate world.

AGU had undergone salient transformation in the philosophy and strategy of teaching the graduate program in Technology Management (TM). The Program was established in 1990 with a pioneering vision to link science, business and technology in the GCC. AGU mission is to be a model for higher education in the GCC region. AGU strives to address the regional priorities of the Gulf Cooperation Council in health, human development, environment, science and technology and aims to contribute effectively to spreading the culture of excellence in knowledge creation and education.

AGU is a unique model of a regional research university that aspires to instill a culture of innovation in technology education. Problem-based and technology-based learning is vital for harnessing technological innovation as manifested in universities in Asia and Europe (Harryson, et al., 2008, Lawson & Samson, 2001). The GCC is at threshold to leapfrog and catch up with emerging technological innovations. This macro shift in education paradigm requires holistic management of technology and resources (Bower & Christensen, 1995). Investing in the human, institutional and manufactured capitals (technology) is a key for creating wealth and prosperity for both firms and nations (Khalil, 2000).

Envisioning AGU as part of an organizational ecology that passes through stages of pioneering, growth, innovation and renewal requires a vision of sustainability of the program delivery to ensure that the TM product is undergoing constant review and development. Instilling the notion of sustainability and reviewing the program strategy and value proposition is critical for a resilient and innovative institution (Goffin, 2012).

AGU is pioneering innovative research in biotechnology, water, agriculture, environment and medicine and was granted several funds from regional and international agencies, which enabled it to build a sound networks and knowledge and innovation. The linkages with key industries like oil and gas, telecom and the public sector were strengthened through the graduate research and consultations. Besides, there is a purposeful learning, reflection and knowledge co-creation which crucial for continuous improvement in

the modes of learning and delivery in technology management (Haour, 1992, Koners, et al., 2007, Goffin, 2010, and Nonaka, 1994).

The Arabian Gulf University which aims to “look forward to undertaking its role as a regional university in addressing the developmental issues of the Gulf Cooperation Council countries through its innovative and effective educational and research programs with relevance to Arabian Gulf regional issues and aspires to gain an eminent international reputation” (AGU 2015). Among other, the Technology Management and Innovative program (TM&I) tries to equip its students and faculty to cope with the modern technological world through research, innovation and implementation of acquired knowledge for the social empowerment.

The Technology Management (TM) Program at AGU had witnessed a number of developments in strategy, curricula and modes of deliver to respond to market and industry needs. The ecology of the program had undergone various phases of development during the period 1990-2015. These phases include i.e., *pioneering, growth, maturity, and renewal*. Since its inception in 1990, the TM program had experienced a number of paradigms shifts in the focus of content, strategy and methodology of teaching. AGU is keen to develop as a learning organization, which nurtures system thinking, team learning, mental models and self-mastery, which are crucial for creating new knowledge, value and a sense of purpose (Senge 1997, Senge, et al., 1992, and Kofman and Senge 1993).

As part of the periodic strategic reviews of the TM program at AGU a new business model was developed in the early 2000 that emphasizes the need for strategic partnerships with key industries and research institutions were formed like ARAMCO (officially the Saudi Arabian Oil Company). SABEC (a Saudi diversified manufacturing company, active in chemicals and intermediates, industrial polymers, fertilizers, and metals) and ALBA (Aluminum Bahrain). The AGU linkages with key industries helped it to define its core competencies in technology education. Moreover, these formations of alliances, and networks and advances in technological innovations are driving a new business models (Johnson, et al., 2008, and Christensen, et al., 1995). A rigorous process has been carried in 2000, which resulted in a shift from Programs to Departments with some modified program focus, niche, and study plans. In addition, in 2016, AGU developed an inter-disciplinary PhD Program in Innovation & Technology Management.

The program explored the use of PBL in teaching social innovation by using design thinking and action learning. Social innovation emphasizes the practical application to address social problems to induce social change and public value. The Program emphasized four attributes as indicated in the Figure 2 below. These include research skills along with alliances with the industry and community.

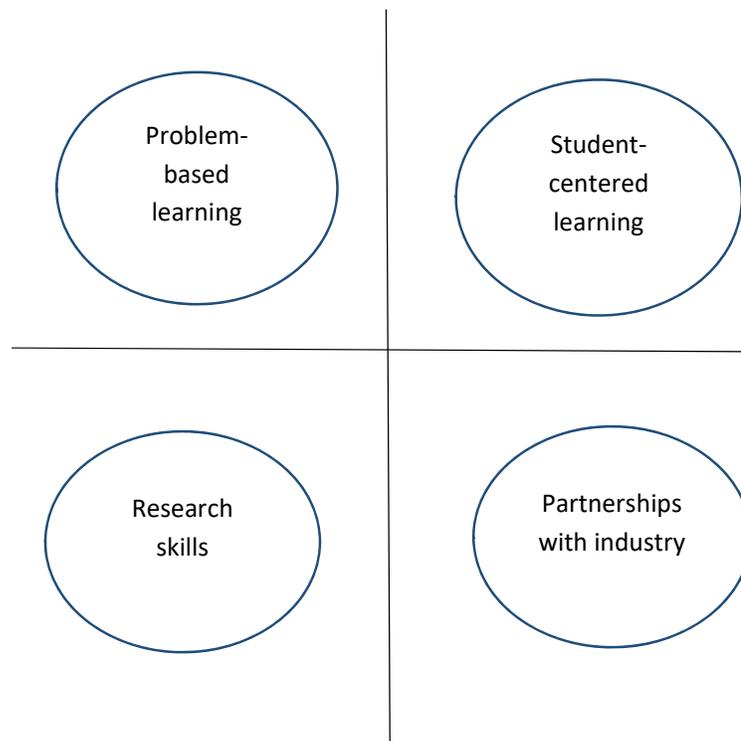


Figure 2: Key features of teaching innovation management

5. Conclusions

The Arab region needs to strengthen its ability to reform education for social change and impact. A key reform is to harness PBL to generate to address real world problems. It is imperative to develop a *culture for action learning in innovation management and to combine technology and social innovation to promote new modes of learning*. This can be achieved through rethinking the traditional models of learning and reflection. What is needed in the Arab region is to develop a critical mass of learners and teachers that apply PBL in HEI in the domain of social innovation. This requires the co-creation of an ecosystem that cross-institutional boundaries and promotes people-centered development. Higher education plays a critical role in socio-economic transformation. The GCC is responding to market globalization and fluctuation of oil prices by investing in human capital and quality education. The new paradigm of development aims to enhance user-driven innovation and action learning in social d innovation.

The pilot model of applying PBL at AGU in innovation management was informed by context, objectives and audience. However, each model has its own merits depending on the target audience and learning objectives and outcomes. The explored model consists of three distinct components; i.e., ideation, implementation and learning. The piloting of the PBL was based on case study approach based on real case problems in industry or community. Students are exposed to a social problem using mind mapping and brainstorming. Then, students are guided to refer to key references or policy documents to understand the initial and boundary condition. The next phase includes one-to-one mentoring and synthesis of documents and research papers. This step is followed by designing a solution to address an un-met social needs using design-thinking approach. The final step includes feedback and learning along with the review of the process.

It is recommended to apply more pilot studies on other modules in innovation management to validate the PBL model.

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Online Educational Gaming System for Children with Autism

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Abstract

The Ministry of Education in the Kingdom of Bahrain has taken serious steps to integrate students with disability and special needs into public schools. There are around 175 schools that have implemented the special education programme in different levels of education set by the Ministry (e-government website, 2019). The Ministry is proving the facilities and environment needed to achieve such integration and it should be commended for the excellent work in taking the lead in preparing students with special needs for a promising learning environment. The tool introduced in this paper which is of learning/educational nature can be embraced as an approach to provide a computerised learning environment for students with autism. This is in with the Ministry's aspirations to support students with disability and special needs. Educational gaming techniques are supporting people to enhance their skills and abilities in education and self-development. Moreover, information technology and computer systems have contributed significantly to the development of many issues through better practice that offers effective procedures and facilitates the use of modern techniques and skills. This has influenced researchers in education to create the edutainment field. This study focuses on educational games that is directed to students with disabilities who are facing learning difficulties. It is based on new science that provides a stereotyped image, and modern educational tools that help students improve their skills with gaming such as numerical activities as well as pictures that make them have fun and learn at the same time. The use of simulated activities in education is widely becoming recognized as an important tool in schools. This study aims to develop an online educational gaming system platform for students with learning difficulties. The system will contain several sections and stages that are useful for students who have learning difficulties. It is used to provide a fertile learning environment for students.

Keywords: Online educational gaming, Autism, disabilities, education game

1. Introduction

Information technology has contributed significantly to the development of many issues through better practice that offers effective procedures and facilitates the use of modern techniques and skills. The gaming model is a new practice that has been used extensively with the development of information and communications technologies (ICTs), which has helped to improve the quality of training that make the trainee imitate reality by using technology and visual tools similar to those of reality. Therefore, in this study, simulated students' education is based on new science that provides a stereotyped image and modern educational tools that help children improve their skills with gaming such as numerical activities as well as pictures that make them have fun and learn at the same time. Gaming-based education is used extensively in aviation science to train pilots via virtual flight, and it is also used in meteorology, weather and military matters (Scope, 2003). Recently, visual gaming techniques have been introduced to train disabled children with autism through modern optical techniques to help them learn faster. These techniques have contributed significantly to increasing the effectiveness of education and training for children with autism and learning difficulties, which has made more centers of study and universities shed light on further research and development in this field.

This study focuses on building and developing a gaming system with some new technical methods that help children with special needs to learn more easily through visual electronic techniques that simulate sports and educational processes as well as science and social situations through simple images and techniques.

Moreover, the purpose of the study is to develop a gaming system specifically meant for children with learning difficulties and disabilities. Gaming-based education can be a very good platform that provides valuable tools in learning and resolves pressures and tensions that occur due to a low capacity in grasping educational concepts. Gaming is the imitation of the operation of a real-world process or system. Gaming can be used to show the eventual real effects of alternative conditions and courses of actions.

In Bahrain, there are few dedicated centers for children with learning difficulties and autism, where the use of electronic instruments to develop their skills and help them integrate into society may be increased, especially for children with learning disabilities such as autism. Therefore, the research aims to examine the rationale for providing online educational gaming system (OEGS) based techniques to children with learning disabilities such as autism and to describe the benefits and limits of using online gaming systems in the education of children, especially those suffering from autism.

2. *Theoretical Background*

2.1 Types of illness

Temporary illness: According to Smart (2002) the definition of a temporary illness is the temporary effect of the natural practices of the normal human being, which can be cured within a certain period of time through medical intervention, and requires special treatment during the temporary illness. The interpretation of the temporary illness is the inability to perform normal functions during a temporary period of time, which makes the patient unable to study or work or achieve normal movement.

Types of temporary illness: According to the Social Exclusion Unit (2004), the types of temporary illness are: bone fractures; dysfunction of the body; mental illnesses such as anxiety, sleep disorders and chronic fear; hysterical blindness; obesity diseases; and diseases caused by smoking and alcohol.

Permanent illness: Permanent illness is classified as a chronic disease that does not transmit infection and has no relation to viruses and bacteria, and is slow to occur and grow, which is linked to the behavior and daily practices of the patient, and may affect his/her ability to move or their mental or physical perception and make the patient unable partially or completely to perform some or all of the normal tasks of the natural person, as well as make them live their life with the disease in addition to the lack of a specific period of treatment or lack of any kind of effective treatment (Wai & Man, 2006). The types of permanent illness include: autism and permanent disability, cancer diseases, cardiovascular disease, asthma and respiratory diseases, diabetes, high blood pressure, and cerebral palsy.

2.2 Disabilities

The definition of disability differs from one country to another. Disability is the inability of the individual due to the total or partial loss of some sensory, physical and mental abilities, which prevents the performance of some functions and may affect the levels of thinking, intelligence, movement, and sight. Disability can be the result of diseases that cause the loss of some motor, audio, visual or even sensory advantages, but with the development of the twenty-first century a movement began to integrate many groups of disability into communities and take advantage of them in many things in addition to the development of information technology, which has contributed to facilitate movement and hearing and vision and has also contributed to finding many solutions for people with disabilities (Halfon et al, 2012).

2.3 Autism

As stated by Gillberg and Coleman (2000), autism is a disease that was discovered in recent years. It is a disorder of the autoimmune spectrum, which appears in infancy, before the child is usually three years of age. According to the APA (2000) there are different degrees of autism. It affects the social relations and language and behavior, which makes the child isolated most of the time and different from the rest of the children. They do not respond to calls and prefer to avoid direct visual contact or look at others and reject hugs. They are not aware of their feelings and the feelings of others.

Examples of autism:

(Fombonne, 2003) Autism is isolationism and reflects disorders that make people isolated from the ocean with a dysfunction in the nervous growth that affects communication and causes psychological and behavioral problems as well as fluctuations in their behaviors. (Sanders et al, 2012) some cases of autism make the patients arrange the pieces or cans in a horizontal manner which is sometimes associated with autism. Moreover, autistic patients have severe isolation, lack of integration with groups, and some aggressive behaviors. However, autistic patients do not have mental problems but consider their main problem to be behavioral rather than mental. (Kinshuk & Patel, 2006)

3. Literature Review

3.1 Gaming in education

(Ulicsak & Wright, 2010) stated that games attract all age groups because of the integration of people into a fun activity that stimulates more participation, concentration, motivation, and challenge. (Pivec & Pivec, 2009) The principle of playing has become one of the most modern techniques used recently to change a certain style and replace it in a modern way that raises the focus of people and makes them more integrated with the traditional methods that increase the daily routine and make children completely integrated. (Reese, 2007) The term Gamification is one of the modern terminologies that started using the techniques of playing in different areas of education and apply certain elements that attract attention and interaction, which produces the hormone gaming and activity. (Gee, 2007).

Examples of Gaming

Gaming teaching could be one of the most powerful means of preparing teacher education students for a solid field teaching experience. (MenatAlla et al, 2016) Gaming is a new term derived from the word "game", also known as unification. Commercial marketing begins using the promotion using the gaming which uses the non-game context to make the customers happy while using their products and compete to get rewards and loyalty points. The same concept can be used in the educational sector which uses the gaming in the educational purposes to make the children with special needs is more affected and gain more knowledge.

Many studies and research confirms that the special needs children's often tell us what they think and what they feel through their free play and use of cubes, dolls, clay, colors and others, and play is a mediator educational work to a large extent to shape the child's personality in different dimensions; Therefore, the educational games when well-planned and organized and supervised it will affect the children knowledge.

Educational studies have proved the great value of playing in the acquisition of knowledge to enhance the children's skills using the game concept to make the child use the thinking techniques more than mental preservation only. The skills in classroom management, lesson planning and communication skills are behavioral skills that cannot be totally developed through knowledge-based training methods alone. (Smith & Ashcroft, 2015)

3.2 Gaming methods

Using the gaming techniques and methods in education categories defined in international organizations definitions of disability indicate that the use of play strategies useful for all specified in the definitions of disability groups, even blind people (blind) can play and enjoy the atmosphere of its sense of the surrounding.

In the gaming, an artificial environment is created to manage an individual's experiences in order to acquire behaviors, notions, knowledge, and dexterities for purposes of meliorating performance (Janet, 2014).

The teacher sets the parameters used to obtain the desired outcomes; hence, a gaming can only be efficient if it engages students in the behavior or skill being developed. Therefore, students experience the reality of the scenario, make decisions within its context and get meaning from it. Gaming is concentrated in making the child touch the reality and use more tactile look, thinking and touch instead of using the traditional paper methods that were used in the past. Children with special needs need a pleasant atmosphere to make them more focused. Education by play creates an atmosphere of enthusiasm and increases the love and attachment of the child to the place of education (Anagnostou , Taylor, 2011).

3.3 Edutainment and Technotainment

For at least the past twenty years, concepts such as edutainment and technotainment have been radically transforming the relationship between learning and play (Veltman, 2004). The difficulty of creating great products to entertain and educate is a main concern of developers and other stakeholders in the education games industry. (Shuler, 2012). The importance of using technology in education is taking high discussion these days (Oksana V. et al 2015). And some researches try to explore the role of edutainment in the student achievement (Mat Zin and Mohd Zain, 2010)

4. Proposed Method

The primary objective of the study is to highlight the importance of building an educational gaming system within the vision of the edutainment field to help students with autism.

4.1 Data Collection

In this study, the data has been collected by using two main ways : by conducting a literature review study to explore the ideas about autism, education, gaming, and edutainment. To get more information about the autistic patients, the study used some interviews.

4.2 The Interview Survey

For this study, a series of interviews with supervisors in autism centers in Bahrain have been conducted in order to achieve the main goals to develop the educational gaming system.

4.3 Need for the New System

The need for such advanced systems has become very necessary as autistic patients need to exploit information technology in the development of their integration into society by improving their language, scientific and social skills, where studies have shown that autistic patients suffer from isolation and inability to learn in regular classes such as other students. Currently, most educational institutions in Bahrain use traditional methods that do not commensurate with current developments and requirements. Most educational institutions rely on YouTube and video in education, while preprogrammed content can be used to suit every category of special needs.

4.4 The Proposed System Architecture

The proposed website map for the new website is shown in the following figures



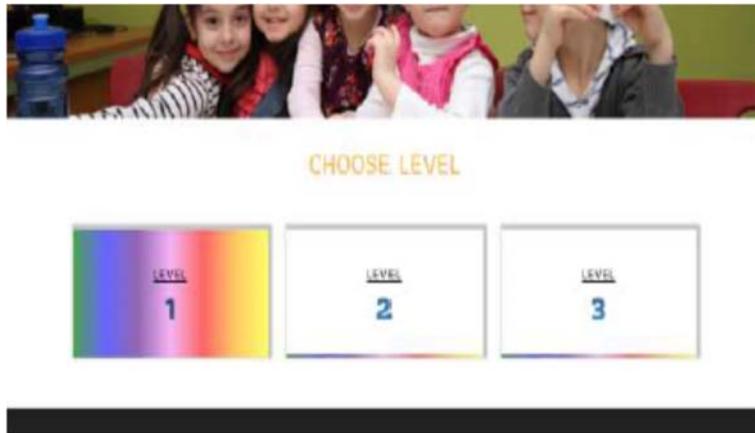
a) Home page



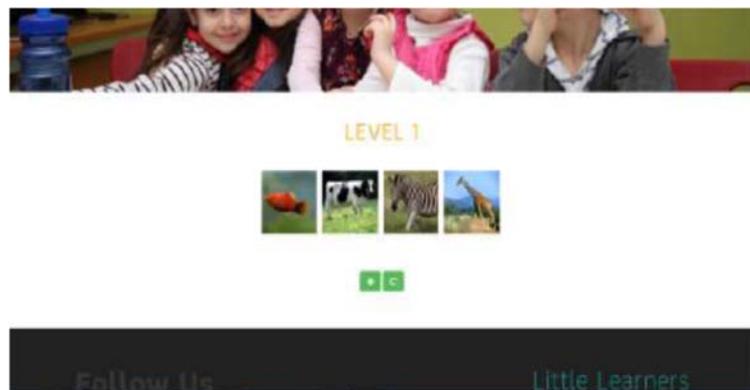
b) Login & Registration

Figure 1: Home page and Login in

Figure 1 shows the home page which contains main components that can be selected in this website and user login option where the user can login to the system simply by inserting the user name and password provided to him/her or if the users are new they can register to the website.



a) Learning levels



b) Level one



c) Level Two



c) Level Three

Figure 2: a) Learning levels b) Level one c) Level two d) Level three

Figure 2 shows where the member can choose one of the levels of education. Figure 2 a shows the learning three levels, where each level has different type of questions. Figure 2 b, c, d represent levels one, two and three respectively.

5. Conclusion

Online educational gaming system for students can be a platform, which provides a valuable tool in learning to mitigate ethical tensions and resolve practical dilemmas. In the design of structured learning experiences, online educational gaming systems training techniques, tools and strategies can be used as a measuring tools linked to targeted teamwork skills and learning goals. This study focuses on educational games directed to those who are facing learning difficulties with disabilities. The system will focus on improvisation to improve skills such as reading, mathematics, science and how to deal with the community. Online educational gaming system techniques can be a very good platform which can provide a valuable tool for learning and to resolve pressure and tensions occurred due to ill grasping capacity. The proposed system will intend to be very beneficial for students with disabilities to improve their learning capabilities and ease their understanding of the subject field. In the future, this system can be used in many ways by encouraging educational institutions to further develop it in order to provide users with a wide range educational courses in different subjects.

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Using Technology in Legal Education: Urgency, Benefits, Risks, and Challenges

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Abstract

Legal Education' touches multi-dimensional streams of education all around the world .so it is not a subject that covers the scope of the law alone but, it extends its arms to social, political, historical and economic arena. The term 'legal education' cannot be understood with a determinate set of definitions, as the law cannot be understood without imbibing the social segments in its ambit. Legal education is a human science which furnishes relationship of law with the society. Education in law equips the future lawyers, judges, administrators, counselor and legal scientists to fashion and refashion ways of peace and ordered attainment of the ideals of human governance.

Legal education as a skill has a strong relation with information technology. Nowadays, Information technology is important to protect the rights of its users'. This is achieved through enforcing privacy, data protection, validity of online contracts, electronic procurement, data integrity and authenticity, outlining intellectual property rights (IPRs) and providing confidence and trust in open systems.

Electronic information resources will play an increasing role in legal education in terms of both teaching and research. Therefore law students, legal academics and practitioners must, as a matter of urgency obtain the necessary ICT skills to navigate, retrieve and utilize these resources. An Online legal resource centre will therefore offer law students and legal scholars an opportunity to harness developments in ICT to revitalize legal education and practice. It is imperative that they embrace this technology if they have to remain competitive in the new global order.

Communication Technology (ICT) plays an important role in legal practice and education. It is becoming increasingly clear in the majority of countries as well as a reality that technology is a prerequisite for effective and efficient legal education and practice.

This paper will shed light on the importance role which technology plays in legal education and practice. Focus is placed on how much technology has impacted legal education and practice also I will discuss the challenges facing colleges of law in Arab world for the use of IT in legal education.

Keywords: Legal education, Information technology.

1. Introduction

The Irish playwright and thinker, George Bernard Shaw, once stated that "Progress is impossible without change, and those who cannot change their minds cannot change anything." This statement is both truthful and powerful, especially if we are to apply it to the condition of legal education in today's world. When we look back in history at inventions, new ways of thinking, and progress, people had to be willing to take risks and look at things from different perspectives to evolve and improve on their old ways or find new ways to get things done. Scholars and educators alike have had many moments throughout time were resistance to change and progress almost stopped their march towards evolution. For example, creative innovations such as printing press was met with such disdain and opposition that we could still today be carving manuscripts into slate and stone if not for the previous generations who were eager for change, improvement, and progress. For example, as Deborah J. Merritt in " Legal Education in the Age of Cognitive Science and Advanced Classroom Technology," states: in reaction to the invention of printing "One scholar famously declared that the world has got along perfectly well for six thousand years without printing and has no need to change now" (2008, p. 3). Having that invention has allowed millions of people to not only contribute in learning and scholarly discussions but to make educators work and research available to all so that there can be a discourse on countless arrays of topics.

Today in education, the common theme used to teach students is still largely textbooks, discussions, and the good old chalk and board. These tools have stood the test of time from the beginning of the nineteenth century. As students become more aware of their environments and that technology is

progressing and taking over, we, educators, need to take into consideration other methods of acquiring information in the classroom by expanding the traditional educational classroom experience. The switch may be difficult for Law professors because this may be new to them. Some of the professors probably didn't have access to these technologies when growing up; for example, computers, Microsoft, or a smart board, podcasts, or even the internet. So, there is a learning curve with the new techniques and let's face it, it is much easier to stay where we are comfortable. Challenging oneself to acquire new skills or competencies when you're a tenured educator can be problematic. Among legal educators, such resistance to new educational tools is particularly troublesome because, as Merritt puts it: Lawyers are thinkers and communicators; law students will succeed in the new, highly competitive global economy only if they analyze and articulate ideas better than other professionals worldwide. Communication and information technologies are not just instruments of learning in law school; they are the tools of the lawyer's trade. If law faculties neglect to master new forms of gathering, organizing, and disseminating information, they risk failing students both in the classroom and after graduation. (Merritt 2008, p. 4).

The success of any given higher education program can be measured through the success of its students in the workforce after they graduate. Therefore, law schools must prepare their students for what the workforce domains require, which is something—in general—legal educators fail to meet. In his article, "Law Schools and Technology: Where We Are and Where We Are Heading," Michele Pistone expresses his disappointment with the slow adoption of technology in classes of legal education. Pistone says, using technology in legal education "has been a minor concern of the legal academy" (2015, p. 586). His frustration with the indifference towards the use of technology in schools of law purely comes from his concerns that the field is declining: "Law schools are facing such a host of difficulties—declining enrollments, declining job prospects for graduates, reduced public funding, and understandable concerns about cost and debt" (586). Therefore, Pistone calls upon legal educators to employ technology as an efficient and effective tool that has a positive potential impact on reviving the field and boosting student enrollment. Pistone argues that in today's legal education students are mostly from the millennial generations which means that they were born with technology or are "digital natives"; their lives most of the time revolves around the use of technology. As Pistone explains, these generations use technology and the internet to study, for entertainment, socializing, and for many other aspects of their daily lives and activities. Hence, law schools, as Pistone makes the case, need to quickly move in the direction of utilizing technology, represented by the internet and the devices that are necessary for accessing the internet, if they want to appeal and attract more students to save the field from likely death. Also, law schools need to be able to meet the expectations of freshmen students coming to law schools as these students most likely have experienced the benefits of online education during high school (591). In other words, online education and the use of technology in education nowadays is more engaging for the younger generations than the traditional ways of teaching.

When we think about legal education, we think of long hours of reading law, research of cases, and many rigorous hours of studying, we don't necessarily think of how the information is absorbed or how the student can recall it and put it into practice. Cognitive science has found links in learning that employing technology can help the law educators produce a student that is clever, sharp, and worldly. There have been great leaps made in the cognitive sciences and learning. Taking these into consideration could help the educators teach methods in ways that the "brain can work harder and smarter," as Deborah J Merritt states (2008, p. 4). Technology, then, educators achieve their goals in the sense that its use will be positively reflected on the student's ability to absorb more material, interact, and respond creatively. Which in the end, produces an abundantly more well-rounded individual ready to go into his/her legal career (s). I want to make a case for using technology in the legal education through some brief discussion of the recent cognitive sciences research. Cognitive science is a blueprint on how the brain works. If we know how the brain works and stores information, we can then implement productive learning methods into the classroom to help the students obtain and retain information which is something in the core of the educational experience. We know that the brain is made of two hemispheres—the left-brain and the right-brain. "The left hemisphere of the brain is responsible for rational, logical, sequential, linear, and abstract thinking" (Berko 1994, p. 103), while the "right-brain concentrates on patterns and connections" (Merritt 2008, p. 5). As someone takes in information, these two brain hemispheres work in tandem. The left-brain side takes in information that may be useful and the right-brain works to make sense of it, putting the puzzle pieces together to see the bigger picture.

One of the fortes to the right-side of the brain is the ability to make sense of illustrations, graphs, images, designs. With pictures, the brain can draw relationship conclusions and frame a background effortlessly than when the brain takes in texts. As a result, most “[p]eople learn more deeply from words and pictures than from words alone” (Merritt 2008, p. 6). There may be the inclination to perceive graphic or picture learning with kindergarten; however, it has been found valuable to the more advanced spectrum of learning. Since the right and left hemispheres of the brain store information separately, there is a greater probability of recollection if illustration and text that’s being used. Law education requires the amalgamation of thought that the right-brain regulates. Although law students must absorb prodigious amounts of data, they must also relate those pieces to the whole, synthesize principles, and apply concepts to new problems. The amount of information conveyed, in the law studies, has massively increased over “the last 3 decades, requiring increased left-brain focus, faculty may have drifted further than realized from right-brain training” (Merritt 2008, p. 7).

Today’s students are inundated every day with images, technology, and immediate results. Social media, internet, and digitized documents are the way the world operates in this age. So, the question now is why not teach in the modern times of how students maneuver through the world. By using technology, that they are well versed in, gives them a better opportunity to absorb information in a way they are used to. An old lectern and textbook versus a smart board or PowerPoint that can use images to help make connections. This debate in law education is happening right now. Which is the more appropriate way to teach, and are we willing to change and accept new ways?

Technology in the classroom can give meaning to the theories that the students learn. The images that are available in PowerPoint can help the right side of the brain creates connections between the material that is being presented and the rigid theories in law books which in turn will help the individual retain the information: “PowerPoint’s capacity to display images is especially important in creating anchor points for classroom learning” (Merritt 2008, p. 15). In cognitive science, research has shown that when the material is “chunked,” or “clustered” comprehension levels are higher (15). Law instruction has the habit of using traditional methods of teaching. Textbooks and traditional classroom lectures only provide the student with heavy linear forms of information. This type of teaching is strictly left-brain learning. In other words, depending on the traditional method of delivering educative legal material and verbal communications can be enhanced via employing technological devices in the classroom experience. In conclusion, the advancement in cognitive science is a much-needed attribute for teaching law. Law is in constant change and is now something that is a global evolution. These new findings can help scholars and professors overcome this ever-changing pedagogy. Law education needs to implement these new research findings to prepare the new generation of lawyers and legal workers better, help them to be exposed to challenge, and develop sophisticated critical thinking strategies.

2. *Risks of Using Technology in legal education*

Some may argue that technology can be a distraction from the classroom. Internet and smartphone addiction in our society is not only being increasingly documented but is also on display in almost every facet of our day-to-day lives (Harris 2018, p. 6). For example, families sitting at the dinner table tapping away on their phones and not engaging with each other, students sitting in the classroom scrolling through the internet or checking their emails during a lecture. A recent study found that people “tapped, swiped and clicked” their phones an average of 2,617 times a day, with the top 10% of the group doing so over 5000 times (6). The first of many risks of laptop use in the law classroom is that they are routinely, and sometimes almost entirely, used for noncourse activities. Harris states, “Laptops not only provide instant access to the Internet but also bombard the user with instant notifications of new messages or comments on social media to further tempt a resisting note taker” (6). So, is classroom performance in jeopardy because of technology?

Susan Rivizza conducted a study to explore the frequent use of technology in higher education classrooms. In the study, Rivizza examines college students who were attending a psychology class, and she finds that the students “voluntarily logged into a server which tracked their laptop use during the class. Students spent a median of 37 out of every 100 minutes of class time using the Internet for noncourse purposes, spending the most time using social media, followed by reading e-mail, shopping, watching videos, chatting, reading news, and playing games” (qtd in Harris 2018, p. 5). The detriment of using the laptop other than for classroom work, notes, or research can affect the student immensely. While surfing the internet, answering emails, checking showtimes, or going on Facebook distracts the

learner from absorbing the information and storing it in the short-term memory so it can be called up while studying or taking an exam. This is a critical first step in the learning process. Multitasking in classrooms only creates disruption and an inability to absorb the material effectively to recall it.

There is another risk that is spoken about among educators, where the technology may influence the learners' experience negatively, which has to do with the skill of note taking. Note taking can be a comprehensive way in which information is received and stored in the brain. When Note taking is done manually, that has shown evidence in retention, and better performance on exams and overall grades. Harris states, "In order for information to be stored in the brain long term, it needs to be captured into 'short-term memory' and then transferred into longer-term memory, where it can be used for analytical purposes such as problem-solving and comparison." He continues, "note taking by hand has been linked to better comprehension and deeper encoding of lecture material because the hand writer cannot write quickly enough to make verbatim notes." The note taker is "forced to use their own words and translation in real time to actively learn the material in real time" (11). The Information must first be solidified in the brains short-term memory for deeper encoding to happen, which in turn leads to long-term memory recall. This can all be done by the handwritten note taking the student performs. They have to pick out the most valid points of the lecture and make sense of it. Doing this is forcing short-term memory to begin the encoding process. On the other hand, notetaking by typing on a laptop can make precise notes on the topic being discussed. This produces minimal encoding of the information, resulting in lower comprehension and recall of the material as compared to hand writers.

In conclusion, Today's technology can be helpful in law education, but it can also be a hindrance if not used correctly. The attitude to view the machines as the center of the universe, not people is not an attractive idea. Updated classrooms with all the fancy bells and whistles of technology can be, as Craig T. Smith puts it, more of an "ego boosting and career enhancing to show off a law school's expensive" classrooms (2002, p. 248). So, we must be careful when using technology in the classroom, and we must make sure the student is the priority and not the equipment. By limiting the technological distractions in the classroom, it can help boost the student's absorption of legal material and also increase their test scores and overall performance in the class. Having the students work through problems with critical thinking and hands-on problem-solving helps to promote a learning environment that stimulates the long-term recall of ideas and theories. There are risks in having technology in the classroom, but it isn't avoidable altogether. Law educators need to find a balance between the use of technology and traditional teaching methods. There can be a wide array of learners within a classroom, and as an educator, the challenge is meeting all of them. Trying to keep students engage will not work with long drawn out lectures with black and white handouts. However, incorporating new technology with the lecture or discussion can help to bring context to the topic. The professor that uses all the tools available to them creates an environment of success. Technology can be utilized in research, writing, problem-solving, gauging students in their writing and comprehension of topics. Technological tools can help advance learning, but there has to be a healthy balance for the instructors and the students.

3. Challenges of Using Technology in Legal Education

We need to be aware that using technology in the legal education is not going to be an easy transition since both educators and higher education institutions, for a long time, have depended on the traditional face-to-face method as their primary—sometimes, only—form of education. In other words, once an instructor or an institution makes the decision to employ technology in the classroom or programs, that requires intensive preparation on all levels; the work sometimes can seem intimidating and frustrating. However, integrating technology in the legal education is something law schools, and programs must adapt if they want to attract more body of students because students of law nowadays come to the program with the expectation that they'll see technology fused into the curricula because technology is their way of life in this high-tech age. To meet the expectations of these generations, or technology "natives," as many scholars prefer to use, has proven to be challenging for many reasons that I will discuss in the next paragraphs.

According to Noel Lawson (2007) in "Questions Students Ask About Distance Education," technology overspill has changed higher education experience through removing restrictions imposed by the physical spaces and time on the traditional educational experience. This change to the familiar aspects of space and time is not usually painless as several known practices need to change. In the traditional way of teaching a professor comes to the classroom ready to lecture and discuss some of the topics on her agenda. This form of teaching is very familiar to the point it has become to be anticipated as the second

nature of the instructor's experience. Nevertheless, when switching into using technology in the classroom, it will turn around the space as the classroom setting and layout might look different from the traditional layout (think of a classroom full of computers). Also, the traditional way of teaching has been instructor-centered for so long, but when using technological devices, the instructor might occupy a secondary role, which is a change not many instructors are ready to embrace. In other words, one of the challenges that face the process of transition has to do with old practices and beliefs vs. the new trends. Of course, some educators may resist the change because it might make them less of the center of the educational experience. If this happens, then we need to remind them that the sought purpose is to help the students become more engaged in the process and acquire more knowledge, especially that massive amount of recent research has shown that utilizing technology in the classroom has become to be a necessity of today's age.

One of the challenges that the transition might bring forward is the amount of time, and effort instructors will spend on designing their courses. As Subhashni Appana (2008) shows in "A Review of Benefiting and Limitations of Online Learning in the Context of the Student, the instructor, and Tenured Faculty," putting together a curriculum in which its deliverance is fully or partially dependent on technology—including the internet—can be consuming when it comes to the time the instructors spend on them and the effort. The traditional face-to-face mode of teaching has been practiced for such a long time that instructors, most of the time, have mastered the practices and know what to expect in terms of time and efforts. However, throwing technology in the mix will more likely mess with the old expectations; in fact, this brings in an abundance of a new set of expectations. Instructors tend to appreciate environments in which they have a sense of control over their materials, but when this premise becomes negotiable, it might shake the instructor's confidence in their courses. This is true especially in the first few blended courses the instructor designs.

Also, we need to be aware that not all instructors are comfortable dealing with technology in and out of classrooms. To solve this issue, those instructors—though some might not need instruction on using technology since they use it already in their classrooms—need to be trained to use technology purposefully as Charlene A. Dykman and Charles K. Davis (2008) recommend in "Online Education Forum: Part Three- A Quality Online Educational Experience." Training educators is another obstacle that might complicate utilizing technology in classrooms because this needs to designate a budget and time to accomplish it. A well-trained instructor is a pre-requirement for a successful and purposeful education as the tools are meant to boost the educational experience and outcomes. In "The Role and Impact of Technology in Legal Education," Kennedy M. Maranga suggests that showing mastery of the basic of technological literacy is no longer enough for "effective legal education," because, nowadays in higher education "Technological skills are required in analyzing legal problems, performing legal research, collecting, sorting facts, and writing effectively. Such may include the use of quantitative and qualitative software's like statistical package for social sciences...for data analysis" (2010, p. 1-2). This is true if law schools want to grow through expanding their interdisciplinary domains, which, in return, will create more research opportunity desired by the varied body of students.

Through the extensive research that links use of technology with successful higher education experience, it is now established that students coming to higher education institutions demand more use of technology in their programs. However, we should not forget that not all these students have the same experience with educational and technological tools. This being said, as Galyon C. Keramidis (2007) et al., suggest, in "Saving Your Sanity When Teaching in an Online Environment," there should be an effort by educators and institutions of higher education to unify the technological experience of students across courses and programs. The aim of using technology to make the process more fruitful but, at the same time, we need to remember that diverse exposure to varied technological environments may overwhelm and complicate the students' experiences which is something that might work as the antithesis of the original purpose. This is not an easy task as establishing a unified experience requires a collaborative effort among the educators and administrations.

One of the most disruptive challenges to implementing technology in higher education is, probably, that students are assumed to have the required skills to thrive in a digital environment and respond creatively. Creativity and utilizing the available technological tools is expected in an institution that has integrated these tools in its programs, but there is no guarantee that students coming from diverse geographical or socioeconomic backgrounds will utilize or react to the digital environment the same way, or that its outcomes will similarly influence their intake. Let's also not forget that not all today's students come from fortunate societies in which they have been introduced to experiencing education through technological tools. Hence, to guarantee that all students have the tools they need to navigate their way around in a digital environment, higher education institutions ought to put these students through

intensive training programs and workshops for healthy exposure and smooth introduction to the new environments. Several problems arise from this proposal because this will lead to an increase in expenses to make such training available for students. Who will be responsible for paying the bill? If students are to be billed the cost of these workshops, then this adds more burden to the burdens that already exists of tuition and living expenses. Let's remember that one of the purposes of using technology in higher education is to lower tuition expense in hopes for more enrollment; however, adding more expenses to the ones already exist won't be very attractive. If the law schools are to pay for the training, this also will complicate their experiences since they already struggle with budgeting. For some, this issue may seem exaggerated because we know from research and experience that the millennials are technologically oriented; nonetheless, their orientation might be geared towards non-classroom technology.

4. *Legal Education, Technology, and the World*

It is proven that technology can enhance education, and it is more engaging for the younger generations. In order to meet the expectations of the "digital native" students, Michele Pistone overviews several teaching methods that employ technology and the internet in delivering legal education, which has proven to resuscitate the discipline. For example, law schools can use the synchronous model to deliver legal education and reach to more students. In this form of teaching, professors and students participate in the process as if they were in a traditional classroom; however, they do not need to be in the same physical building or geography. In other words, as Pistone puts it, "Under a synchronous model, all the participants in the course" everybody engages "in the course at the same time, albeit from different locations. Thus, the participants are together in time, but not together in space" (2015, p. 593). This model can be more convenient for students who, due to financial or other challenges, cannot have time or capabilities to travel to the main campus of instruction. In this model, all the distant classrooms need to be equipped with the needed technological devices to make teaching and learning possible. When life obligations make it hard for some law students to be present at a given time to participate in live distant learning, the "Asynchronous Models of Distance Learning" is the solution to this problem. All the parties that are involved in the process are separate in time and space. In this style of teaching, instead of engaging in live teaching, the professor records his lectures and posts them on the online website for the course, and then the students enrolled in that class can watch these videos whenever they want from wherever. The "asynchronous model encourages a geographically dispersed student body, for it does not place students in faraway time zones at a disadvantage" (594-5). This model has the potential of relieving the stress on the students of feeling that they need to be physically present in a physical place in a definite time frame to be part of a learning experience. This way of teaching will attract students who have full-time jobs, or those who cannot commute to classes daily.

The use of technology in legal education does not have to cancel the traditional form of teaching, which requires face-to-face classes. Pistone suggests a hybrid model he calls "Blended Learning: Flipping the Law School Classroom." In this model, professors dedicate their lectures to essential or backbone information while the "instruction in foundational or background information is delivered online through short videos that students review outside of class" (2015, p. 597). This model allows professors to assign more time in the classroom to encourage their students to work on "for active learning, including Socratic dialogue, drafting exercises, problem solving, simulations, small group discussions and role plays. These in-class activities can be designed to reinforce what students learn through readings and video" (597).

Peter W. Martin notices that technology is changing the processes of legal education, as well as the way law is performed. Martin explains that nowadays, there is no escape of the impact of technology on all "law-related function." He notices that the human use of technological tools in the legal field is very visible: "The sights of a judge bringing a notebook computer to the bench, a lawyer searching for documents relevant to a case or other transcripts of its proceedings in digital form, lawyers situated in scattered offices of a firm collaborating online, or a client consulting with a lawyer via computer network" have become a wide and common practices in the recent decades (507). All these common situations indicate that technology will be an important part of law graduates after they leave their institutions which means that legal educators might as well prepare their students to the real-world-work environment for a smooth transition

5. Conclusion

Technology can help promote legal education and make it more reachable and affordable. However, alongside the benefits of technology in the field, employing it in legal education has its risks, challenges, and drawbacks. Several scholars have voiced their excitement for digitalizing the field of legal education while others call for cautious use of technology in the law schools. We need to be wise about using technology: We should embrace it because the world will be ever changing and evolving; nevertheless, we need to be aware of possible setbacks and anticipate solutions for them. As the case in any new enterprises, we should expect problems and complications when we transit from the traditional mode into embracing technology in our classrooms. However, we should not let likely future issues stop us from seeking progress and improvement.

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Soft Skills that Improve Distributed Teams and E-learning Efficiency: A Theoretical Proposal

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Abstract

The main line of the work presented within this paper is about how technology can support innovation management and the role of technology in the transformation of firms and educational entities.

A review of the existing status of educational environments is presented with a focus on e-learning education, academic performance, motivation and participation. On the other hand, the efficiency of distributed teams within professional environments is analyzed, highlighting the importance of their performance, communication and collaboration between team members and their biggest struggles.

After an extensive fieldwork, results showed that through monitoring soft and interpersonal skills, interactions produced throughout IT tools in these environments might help to improve their outcomes. Finally, a theoretical proposal is presented in order to monitor and improve the efficiency of distributed teams and online education environments.

Keywords: Human Resources, Distributed Teams, Communication, Participation, Collaboration, Leadership, Education, Business Performance, Education, Efficiency

1. Introduction

“Distributed teams” mode is growing globally. In this paper, two points of view are considered, the educational and the professional. Soft skills such as communication, participation, motivation and leadership are keys to distributed team performance as will be shown during this paper.

Professionals and Educators around the world agree that motivation and engagement directly and positively influence performance. And this experience is shown at different levels. With the eruption of Information Technologies (IT), new opportunities and challenges appear. One of the goals of this research is to analyze IT impact on motivation, engagement and performance within educational (section 2) and professional environments (section 3).

After the review of these two important industries, section 4 presents the fieldwork data and the theoretical proposal to overcome the issues related to distributed teamwork and online education. Finalizing the paper with the conclusions and the future work.

2. Educational Environments

As education has a huge range of aspects where IT can influence, this research focuses on motivation, engagement and performance. Academic performance indicates whether students’ learning process has been successful or not. Meanwhile, engagement and motivation help to have a better educational environment with better academic performance. These three fields have been selected due to their importance within education. Their definitions are presented in the following sections.

Since 2004, Horizon Report has been releasing data about the most promising technologies and their impact on education based on three items: short term (1 year), mid-term (2 years) and long term (4 years), this data is analyzed in (Martin 2011). Is important to look at this research because it helps decide which IT platforms should be selected during this overview. The evolution of technology trends from 2004 to 2014 is summarized. The success of the predictions is based on the use of bibliographic analysis. It is also important to highlight that this research points out that the maturity of some technologies increases the expectations for other related technologies. This study has helped to decide about some of the analyzed content within this research. Elements as social networks, user-created content, games and mobile devices have impact on our educational systems.

In a world where blogs and social media are tools that some teachers use to decide about which IT tools they should integrate into their teaching processes, it is important to clarify and point out the impact of these tools based on academic research. For that, in this paper, this impact is analyzed and discussed for a better use and implementation of these new technologies.

2.1 Academic Performance

Academic achievement or (academic) performance is a term used to measure whether a student, teacher or institution has achieved their educational goals. It is commonly measured by several types of assessments, but there is no consensus on how it is best tested or which aspects are most important.

Another important concept regarding academic performance is Grade Point Average (GPA), which is defined as follows: GPA is a number that represents the average of a students' grades during their academic life within an institution.

In the following paragraphs, several research works are analyzed regarding IT impact on academic performance using e-learning as the most similar work methodology to distributed teams in business.

The intention of the study conducted by Paechter, Maier, and Macher (2010) was to obtain a general view about expectations and experiences that students had while using e-learning platforms, which looks as if they are distributed teams while studying. In 60% of the subjects, students interviewed claimed to use e-learning platforms sometimes or frequently. "Which aspects of e-learning do students consider important for their learning achievements and course satisfaction?" Expectations and students' achievement goals were positive predictors for success. Instructor's expertise and involvement were the best predictor for course satisfaction and learning achievement. This research points out that the main characteristics of an e-learning course and learning behaviors are important for performance, achievements and satisfaction. In students' perceptions, the instructor was a key factor. Counseling and support were especially important in order to facilitate the construction of knowledge, media competence and satisfaction.

Reynol, Heiberger, and Loken (2011) describe a semester experimental study to determine if Twitter can have a positive impact on college student grades and engagement. A sample of 125 students was considered: 70 of them were part of the experimental group and 55 were in the control group. The experimental group participants use twitter for academic and co-curricular discussions. These discussions can be considered as distributed team talks. An interesting data is that no students in the control group were reported using Twitter during the study period. The percentage of students sending tweets and the number of tweets sent by using the Twitter Application Programming Interface were collected to be analyzed, where each student sent an average of 48.20 messages during the study. Data analysis shows that the experimental group had better grades and had more experience and higher engagement than the control group, which means that Twitter can have a positive impact on educational environments. Twitter is used as an educational tool that can help engage students and push teachers into a more participative role.

IM (Instant Messaging) negative impact on students' performance is pointed out in (Reynol and Cotton 2011). It means that IM, while working on distributed teams, may have a negative impact. Although several studies were conducted before about the relation between technologies, multitasking and performance, in this research they try to validate them with a larger sample. A total of 38,345 person were emailed in this survey. The final number of participants who answered was 4.491. A web-based survey to college students, about technology usage, was conducted in order to analyze how IM and multitasking affect educational outcomes. Information overload was one of the main focuses of this research. Results show that students use instant messaging frequently in several platforms and multitask while using IM. Over half of them reported that IM had negative effects on their educational outcomes. As main conclusion, authors highlight the negative relationship between IM and the academic performance.

The relation between online participation and e-learning performance is analyzed by Huang (2011). Learning style is one of the predictors considered when analyzing learning performance. A model is proposed and tested about the relationship between learning style and e-learning performance and the moderating effects of prior knowledge. Data about online participation was extracted from students' records (a function offered by the e-learning platform that was used). It was evaluated using several indicators such as: number of discussion board posts, number of file views, session duration and total number of pages read. This participation was segregated into two classes: active participation and passive participation. Results show that learning style predicts performance through online participation.

Based on a 36 questions questionnaire about motivation in e-learning, Gutierrez and Garcia (2013) try to identify the success items within e-learning. Two of the most important barriers found during e-learning are: the progressive discouragement process and the lack of real commitment to the formative process. The most interesting outcomes of this research are, contents presentation will improve grades and levels of satisfaction, integrating a motivational system (equalitarian) will increase engagement and retention, and finally, accessibility is a key point.

In (Romero et al, 2013), a data mining approach for improving prediction of student's final academic performance is proposed. They use participation indicators, quantitative, qualitative and social ones for this prediction. The three different types of analytic data based on forum activity are: (1) Quantitative information, statistical information, (2) Qualitative information, evaluation or score of the content given by the teacher, and (3) Social networks information, relationships between students. The main finding of this research is that two quantitative measures, the number of messages sent, and the number of words written, are the most important to predict the result of the students, and the two social network measures were the most important to predict students' final performance.

All these researches prove that the IT impact on academic performance can sometimes be positive and other times negative. It has helped to create the proposal that is presented in section 4. The analysis of the use of IT and student performance based on students' GPAs is interesting. Once all research related to performance has been exposed, it has been noticed that one of the words that has been repeated during several analyzed research is, participation. This tells that a relation exists between participation and academic performance.

An interesting fact is that almost half of the papers exposed within this paper (and related to education) is experimental research, and the other half is questionnaire-based research. This number was not intentional, but it highlights that questionnaires are a tool that is widely used for measuring elements on educational environments.

3. Professional Environments

Distributed teams are composed of team members who fulfill their work remotely and do not share a central office or common working hours and can be in different shapes and sizes. Figure 1 shows organizations' major shift towards utilizing virtual distributed teams which pushed "Distributed Teams" to become a global phenomenon and terminology that is highly supported by the globalization and advanced open communications as well as the increasing demand of employees globally. In a survey that was conducted with 1,900 global remote workers from 90 countries (Buffer 2018), 90% of them plan on working remotely for the rest of their careers and 94% encourage others to work remotely for different reasons mainly being flexible working hours, more family time, convenient locations, healthier life, and so on

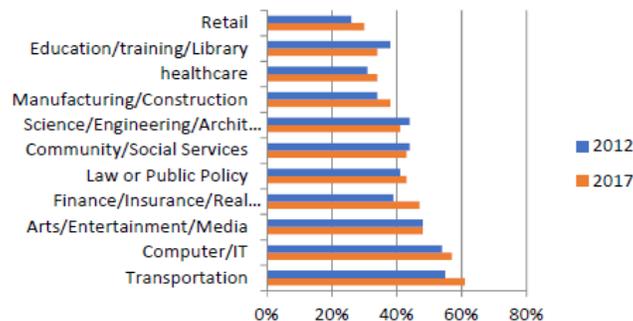


Figure 1: Share of workers performing some work remotely

This trend is getting globally acquired by industries seeking decreased real estate costs and overhead, greener environments, high employee loyalty, and other reasons, but at the same time, it puts organizations and team leaders in front of tough challenges related to teamwork collaboration and communications.

3.1 Communication and Collaboration

Establishing an efficient distributed team is not an easy job because an operational methodology for a collocated team may not necessarily work for a distributed team, and what fits a specific distributed team may not necessarily fit another. For instance, the management could face challenges to manage teams where both permanent and temporary employees work together, as controlling these two groups of employees within the same team demands unique communication strategies (Chakraborty and Chakravarti 2019). Project managers and team leaders are responsible for the project coordination activities like planning, scheduling, allocating and integrating & monitoring. For a specific project/program, the lack of a leader who can have a full visibility and control over the project flow will surely fail any distributed team.

The critical role of leadership is necessary to assure the flow of information and communication between the team members is smooth and clear. Project leaders spend 70% of their time communicating which highlights the importance and criticality of collaboration, communication and leadership and their direct effect on the efficiency rate of distributed teams' structures. The leader in distributed teams is the central hub and the center of gravity of the whole team. If this role is not fulfilled as supposed, the other two important pillars, i.e. collaboration and communication, will be negatively and promptly affected, thus, reducing the efficiency of the whole team. This is expected because the leader is the one who is responsible for building the communication channels, communication structure, and communication hierarchy. A conducted survey (Buffer 2018) shows that the top two biggest struggles for working remotely are Loneliness (21%) and Collaboration/Communication (21%) as shown in Figure 2.

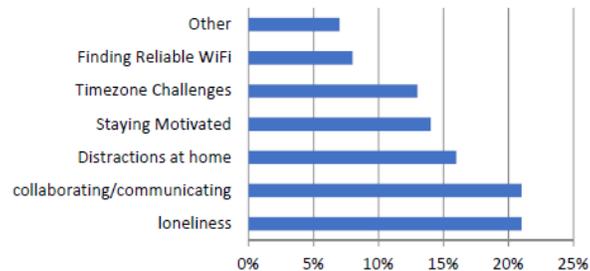


Figure 2: What's the biggest struggle with working remotely?

On the other hand, another survey, CosoCloud (2019), shows that when it comes to collaboration, 42% of remote workers do not feel any collaboration difference between being distributed or collocated, and 10% feel even more connected when working in the "distributed team" mode. The discrepancy, in both surveys' results, highlights the lack of consensus on distributed teams' impact on collaboration and communication, and hence, the efficiency level of distributed teams. This is well expected since these two pillars are closely attached to and reliable on leadership. Therefore, if the leadership is being executed properly, collaboration and communication are highly probable to be smooth, effective and productive; while if any weakness appears in leadership, collaboration and communication will be weak, interrupted, and less efficient, thus reducing the team's efficiency and disengaging employees from each other and from the organization. Andrew Filev, writing in 2017, that employees rate bad communication as one of the key reasons they feel disengaged with employers, (Personnel Today 2017). As time goes by, the ongoing advancement in sophisticated mobile devices and advanced communication tools as well as the wide availability and enhanced internet connectivity, will enhance employees' relationships and reduce communication frictions, hence, highly empower collaboration and communication among distributed team members and consequently raise the efficiency rate of the distributed teamwork.

As per CosoCloud (2019), 30% of remote workers reported an annual saving range of 1 to 2 months when working remotely, and 50% claim that remote work feasibility increases their loyalty to their employers. Personal satisfaction and higher quality of life are strong motives for remote workers where 45% say they are getting more sleep, 42% are eating healthier, and 53% report reduced stress.

To finish this section, the following clarifying words are quoted from Michael Fitzpatrick, CEO of ConnectSolutions: "Our Remote Collaborative Worker Survey suggests there are significant benefits to be gained by both remote workers and their employers with off-site employees motivated to work harder and more efficiently to protect both the personal and professional benefits of working remotely. Even the personal benefits workers experience can be viewed as employer benefits since workers tend to be happier,

less stressed out, and healthier, thereby bringing down the costs of turnover, absenteeism, lower productivity, and other issues." (Computer Business Review 2019).

4. Monitoring and Measure Interaction

In this section, several kinds of interactions are analyzed in the "Fieldwork" sub-section, while sub-section 4.2 presents the main outcome of this paper.

4.1 Fieldwork

Since long ago, as the work presented in (Fardoun et al, 2012) shows the big use of the new technologies and social networks by high school students, this encourages us to follow our social networks research at high schools. This research work says that 88% of the high school students use Social Network Sites. Also, it highlights a set of advantages for their application in teaching, where the field study focuses on Tuenti and Facebook social networks. First, it presents the results obtained through an anonymous questionnaire given at three centers of the community Castilla La Mancha, Spain (two secondary and one primary education centers). Next, it discusses the main findings of this field study conducted during the last two academic years and applied over 425 students (381 secondary education and 64 of primary one).

Another previous research done about SNS (Social Network Sites) impact in secondary education, by Romero, Fardoun, Penichet, and Gallud (2013), points out some issues related to these new technologies such as: the time spent by secondary education students (12-16 years old) on these platforms is too high, 17.2% of participants spend more than 3 hours per day and 44.8% between 1 and 3 hours per day. A positive outcome is that nowadays students spend a lot of time online, which should be redirected into platforms that have a positive impact on students' academic life. Therefore, based on results presented by Fardoun et al, (2012) and Romero, Fardoun, Penichet, and Gallud (2013), the time spent online is one key and the high use of SNS is the second.

In the domain of higher education, improving distributed teams' efficiency will focus on e-learning platforms such as Moodle. On the other hand, i.e. business domain, the focus will be on the tools that are used by the distributed teams. But one important question shows up here: what skills are the most important? A set of questionnaires were conducted, on educators, for the sake of answering this question.

Below, the data collected from anonymous questionnaires, conducted on educators from different levels and countries, is presented and analyzed. On a 30 question-questionnaire about soft and interpersonal skills regarding their students, around 50 educators from several educational levels gave clues about which skill are the most important to them. These are the skills that their students either already have or need to improve, in order to face the new challenges of the teamwork styles, such as working within distributed teams.

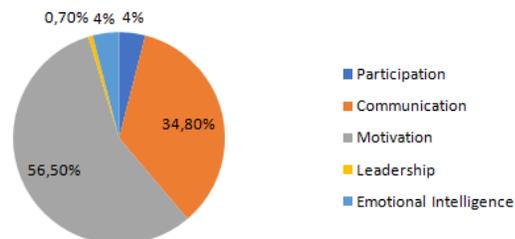


Figure 3: Which soft skill is the most important for your students to have?

As seen in Figure 3, motivation is very important because it increases students' self-confidence and will consequently increase their participation. It is strange and maybe conflicting that participation is only 4%. Probably it is because participation and motivation are directly and closely inter-related, but motivation is wider, so voters choose Motivation. In other words, if a student's participation is initially high due to some reasons like self-confidence, curiosity, etc., and this is not very common among students, educators can still motivate the student to further raise the level of both, motivation and participation. While if initial participation is not high, and this is common, then motivation is highly needed in order to encourage students' participation and motivation as well.

If we compare the importance and volume of communication among students in educational environments, and communication between workers in “distributed teams” organizations, it is very weird to have such a big impact of communication (34.8%). Maybe this is communication is the communication between the teacher and the student, which is important but only if it positively influences motivation and participation.

Finally, it is important to highlight that leadership is almost negligible, probably because, unlike the case of employees, leadership in educational organizations does not play an important role in the relationship between a student and an educator, or between the educator and the rest of the students.

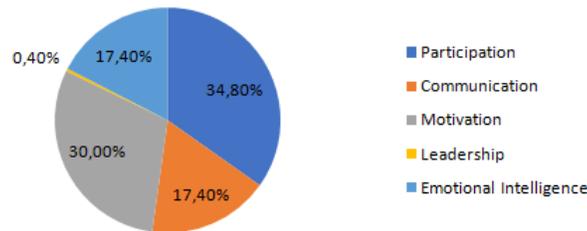


Figure 4: Which soft skill of our students do we need the most improvement?

Results showed in Figure 4 vary from the ones in Figure 3. This is because Figure 4 is related to skills improvement, which can be depicted from the results where participation and motivation are almost even, in terms of improvement needed.

Moreover, these results give more importance to communication and participation versus motivation. This is logical because communication, participation and motivation are closely inter-related and should be equally improved. Another important result showed in Figure 4 is the noticeable increment of emotional intelligence importance. This can be seen as an indicator of the lack of emotional intelligence in some students’ current skills and therefore in future workers, while it is predicted to be crucial to nowadays success.

Important results were shown by the following question: “Do you think that the scores regarding skills given to the rest of the questions have the same importance for educators?” where more than 90% of the educators answered “Yes”. Regarding the other questions, results were as expected and logical.

Even though leadership is not that important from the point of view of educators, as can be seen from the results shown in Figures 3 and 4, it is highly important in the business field. And it is important to improve leaders from the early stages of our educative systems, as it is highlighted in previous works “Looking for Leaders” (Fardoun et al, 2012) and “Being Example” (Romero, Fardoun and Mashat 2013).

4.2 Next Step

In many researches, the use of questionnaires and data analysis in order to validate hypotheses or results has been used. But after or before that measurement, an element for a daily monitoring or measurement is missing. An element for daily measurement could be an important source of data and information and can help complement studies or analysis done using questionnaires. As it has been shown in this paper, IT may have a positive or negative impact on education and business, as IT importance in these fields (and human beings’ daily lives) is growing with time and becoming essential. In order to control it, maximize the positive or minimize the negative effects, it would be interesting to measure and monitor these elements.

Based on the research exposed, there is an element that has been proven to positively affect performance, motivation and engagement; this element is participation. Therefore, it should be chosen as a primary measure along with other elements that should be explored. For example, the results in (Vos, Van der Meijden, and Denessen 2011) suggest that constructing is a better way to improve student motivation than just playing; playing could be considered as participation, while construction could be considered as a type of leadership or initiative. Therefore, in addition to participation, initiative and leadership could be candidate elements to consider for monitoring IT impact.

As well, an important part of the learning process is student’s motivation to learn. Thoonen et al (2011) proved that teacher’s sense of self-efficacy impacts teaching and motivation to learn. It could be

interpreted as teacher leadership producing an impact and it could be extrapolated to team leader/s when speaking about distributed teams.

Before selecting a final set of soft and interpersonal skills, elements or predictors to measure IT impact, a rigorous study must be conducted. After that, it will be possible to create a concrete monitoring and measurement system for IT impact on education. This system should consider traditional elements such as performance, attendance, engagement, motivation, etc. in addition to a set of soft and interpersonal skills or characteristics that may be found in IT platforms.

To end this section a summary with the main research open questions or assertions found are exposed below:

1. How could educators, team leaders or administrators measure platforms impact on their students/workers if they do not have enough research capacity within their own environments?
2. Where is the line that separate positive and negative impact?
3. Could educative or/and business systems be evaluated before or quicker than questionnaires-based studies' results?
4. Which elements will better predict IT impact on these fields: participation, initiative, leadership, time spent online, etc.? Will it vary depending on the field?
5. **A method for monitoring and measuring IT impact on performance is needed.** This last assertion could be considered as one possible answer or an element that will help to answer some of the previous questions.

One option is to create a new platform where specific indicators could be placed as features. However, there are issues regarding new platforms as mentioned in (Romero, Fardoun and Mashat 2013): "Many social networks, many passwords sometimes this is messy". Another option is to create new systems that measure what we want or need to measure, as is the case in (Fardoun et al 2012). Again, this option implies more work and new elements within systems (education and business) that are already overloaded.

On the other hand, we have the option of measuring and collecting data logs of the platforms that are already in use, such as Moodle, which is our recommended path. Using this data wisely, with respect to soft and interpersonal skills, will allow educational and business distributed (or not) environments to improve their outcomes. This path may require software changes, but without a major effect on the final user.

In addition to measuring and monitoring interactions on IT platforms, a reward structure/process could be put in place in order to reward those who are providing the best performance. Each entity should decide whether to integrate a reward system or not. There are several approaches to implement this, where the one we recommend is "Positive Reinforcement Social Networks" (Fardoun et al 2012).

5. Conclusions

The utilization of effective distributed teams and online education is becoming a global hot trend that is being adopted by multinational companies and educational entities for the sake of reducing overhead cost, rental cost, greener environments, etc. Enabling these teams with the proper tools, skills and support will be the key for these entities' success and efficiency.

Future work comes out to perform a similar questionnaire to the one presented in section 4.1 but should be directed to businesspersons. Besides, a practical implementation of the recommendations presented in this paper will help guide the complicate process of improving performance when working or studying in none face-to-face environments.

Different surveys sometimes provide different or conflicting results, which is due to the numerous factors that could affect the remote worker satisfaction and loyalty. So, further research and continuous data collection should be done while involving several affecting factors in order to have a higher precision feedback and results, mainly about the top three biggest struggles of working or studying remotely: distractions at home, communication/collaboration and loneliness.

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Analysis and Design of a Curriculum Management Information System

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Abstract

Nowadays, due to National and International quality and accreditation bodies' requirements to enforce curricular standards, higher education faces many challenges that require a sharper concentration on the development, assessment and review of its curriculum. Therefore, this paper presents the design process of an Information System for curriculum management based on data integrity as well as constructive alignment of course-level learning outcomes with assessments, teaching and learning activities, besides how these learning outcomes fit within the context of the program outcomes. This system also supports academic and administrative efforts to enforce the accuracy and consistency of the curricular facts, monitoring program outcomes, and enhance communications to its stakeholders. Moreover, prevent a lot of burden on resident quality in any educational institution. This solution will thus contribute to the improvement of the curriculum management, can also replicate by other higher institutions that have similar needs in Bahrain.

Keywords: Curriculum Management, Assessment, Quality, Course Alignment

1. Introduction

Curriculum is considered to be the foundation of a given educational institution. In higher education, the process of coming up with, analysing, revising, as well as evaluating this curriculum tends to be a bit challenging. A possible justification to this challenging is the shortage of the available systems, techniques and tools to help in supporting such determinations. In its widest sense, A Curriculum Management System (CMS) is a computerized system that supports the whole curriculum process all the way from planning, to execution to assessment. Authors in (Yuen et al. 2009) consider the system of curriculum management, as "an evolving tool and innovation, is increasingly used to promote the quality, efficiency and flexibility of teaching and learning in higher education."

Regardless of the application area, an info system is composed of seven components (Kendall and Kendall 2011). These components include process, hardware, people, software, and data, people. For developing software component, there is a Software Development Life Cycle (SDLC), which is an outline that defines tasks that are carried out at every step in the process of software development. The SDLC structure followed by a development team and made up of five phases. These phases include:

Identifying Problems, Opportunities, and Objectives

The first phase requires that the analyst together with other organizational members identify problems and estimate their scope.

Determining human information requirements

The next phase is to determine the human requirements of the participating users with various instruments (sampling, interviewing, questionnaires, and prototyping) to identify those who are likely to use the information system as well as how they are likely to be using it.

Analyzing System Needs

In this phase the system analyser uses distinct tools and techniques to analyse system requirements (data flow diagrams (DFD), activity diagrams, sequence diagrams).

Designing the Recommended System

Here, the system analyst utilizes the data gathered previously to logically model the data system (user interface and databases design).

Developing and Documenting Software

In this stage, the analyst is working with programmers to develop original software based on the design specifications. Furthermore, the analyst is working with customers to create helpful software documentation.

Testing and Maintaining the System

Before using the information system, it must be tested. Some testing is done by programmers alone; some by the testing group include system analysts with programmers and a Quality Assurance specialist.

Implementing and Evaluating the System

This stage includes training system users. The analyst must also plan for a smooth transformation from the old to the new system.

This work proposed is a Web-based relational database management system that stores and displays the content of the program's curriculum and integrated from various courses. This work only comprises the four phases. In this context the produced analytical and design models assume an imperative role, helping in the implementation of the proposed Curriculum Management System (CMS). The CMS analysis and design framework is shown in figure 1. In which, at each step, a well-known supportive study, approach or model is used.

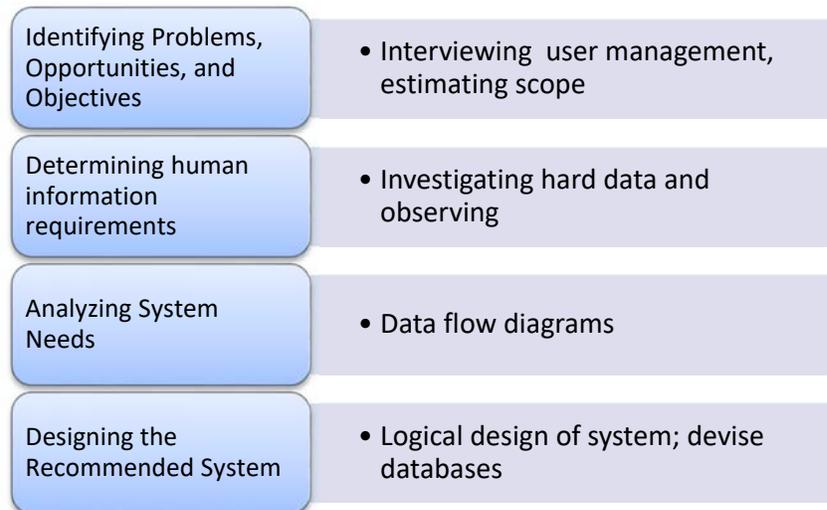


Figure 1: CMS analysis and design framework

The remainder of this paper is structured as follows: Section 1, Identifies problems, opportunities, and objectives that lead to the proposed system. Next, Section 2 outlines the human information requirements. While, Section 3 presents analyses of the system needs. Section 4, presents the design of the proposed system and, lastly, the work conclusions are drawn in Section 5.

2. Related Work

Most of the papers about **CMS** have been presented for specific programs internationally (Chalaris et al. 2011); (Li and Yu 2018); (Britton et al. 2008); (Lopez et al. 2011) or regionally (El_Rahman and Al-Twaim 2015); (Alkhafaji and Sriram 2012) and according to their quality assurance bodies' requirement as shown in Table 1. Unfortunately, none of them address The Education and Training Quality Authority (BQA) in Bahrain. There are some commercial CMS, which are very expensive and no acceptable system was traced in the market to support the requirement of (BQA) in Bahrain. Therefore, this study represents the first work that introduces curriculum management information system according to BQA.

Table 1 Institution addressed by CMS methods.

Publications	Institution
(Chalaris et al. 2011)	Institute of Athens
(Li and Yu 2018)	Guang'an Vocational Technical College
(Britton et al. 2008)	College of Pharmacy, University of Oklahoma
(Lopez et al. 2011)	Feik School of Pharmacy, University of the Incarnate Word
(El_Rahman and Al-Twaim 2015)	Princess Nourah Bint Abdulrahman University, KSA
(Alkhafaji and Sriram 2012)	Sur University College, Oman

2.1 Identifying Problems, Opportunities, and Objectives

In line with National and International quality and accreditation bodies' requirements and to bridge the gap with market needs, higher education institutions are seeking for improving the learning outcomes for their offered academic programs. Furthermore, quality assurance (QA) units and faculty members in these institutions are facing difficulties with the existing paper-based system to ensure constructive course alignment, Alignment of learning outcomes at the course level with assessments, teaching and learning activities, and how these outcomes fit within the program context.

Typically, College of Arts and Science, At Applied Science University (ASU), Bahrain, implement its curriculum management process using a printed files and photocopies of course materials, exams, moderation reports, observation reports, samples of students' woks and course evaluation report. Number of the restrictions of this static, paper-based systems were apparent from quality assurance reports, for example: notes on the alignments of course-level learning outcomes with assessments, teaching and learning activities, notes on accuracy and consistency of curricular data available for different stakeholders and decision makers. Besides, lack of automatic reporting and monitoring system for better management.

2.2 Determining human information requirements

Due to of the restrictions of this static, paper-based systems, which were apparent from quality assurance reports, the college recognized the need to come up with an Information System (IS) for curriculum management. This system to ensure both course alignment and data integrity, as well as dynamically provide curriculum reports and materials for different users (instructor, program leader, QA, Administrative). Use Case diagram in Figures 1 identifies functional requirements by these users.

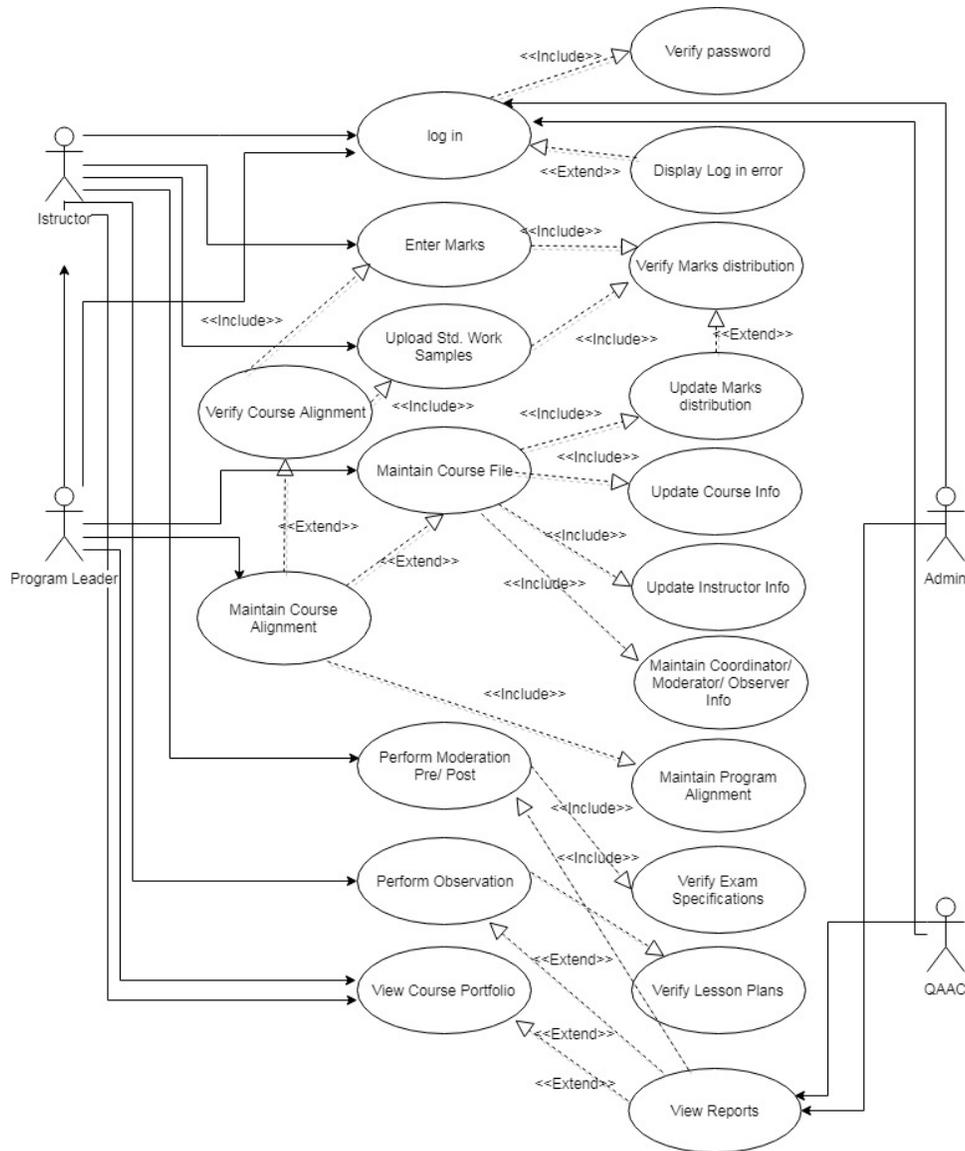


Figure 1: The Use Case Diagram of the proposed CMS

From the functional requirement downs, there will be four main modules of the proposed CMS as:

Program leader module – this act as the main mechanism for data update and maintenance of the Curriculum database.

Instructor module – the purpose of this module is to offer different views as well as grade, moderation, observation, and student work samples data entry to the Curriculum database.

Curriculum Analysis module –provides more query and reporting abilities permitting use to examine and analyse the curriculum for both completeness and consistency.

Administrative module– This feature enables the Admin to make curriculum assessment instruments visible, that demonstrate the degree to which its graduating students have achieved the program outcomes. All assessed program outcomes are linked to one or more course. Consequently, the CMS enables any assessment tactics to be quantified and linked to its course and the skills. The outcomes then can be related to particular courses in which skills are learned and the required changes to the curriculum are made.

The system also involves multiple tools to support its tasks. A search and browsing tool allows users to discover needed curriculum content by keywords, course names, learning objectives and program outcomes

Also, the curriculum analysis module provides numerous reports, such as course evaluation reports, instructor observation reports, program outcomes reports, and course portfolio reports after instructor upload student's assessment samples. Additionally, student assessments of the course are encompassed for analysis by the authorized individuals. The pre/post moderation report is composed by the responsible course moderator through the use of data that is stored in the system.

2.3 Analyzing System Needs

Because this type of Information Systems is very expensive and no acceptable system was traced in the market to support the requirement of The Education and Training Quality Authority (BQA) in Bahrain, the college decide to develop CMS In-House. This system suggests replacing the existing paper - based system into a web - based system as shown in figure 2. The context diagram in figures 3 shows what the specific software is likely to be used for, and who is likely to use it.

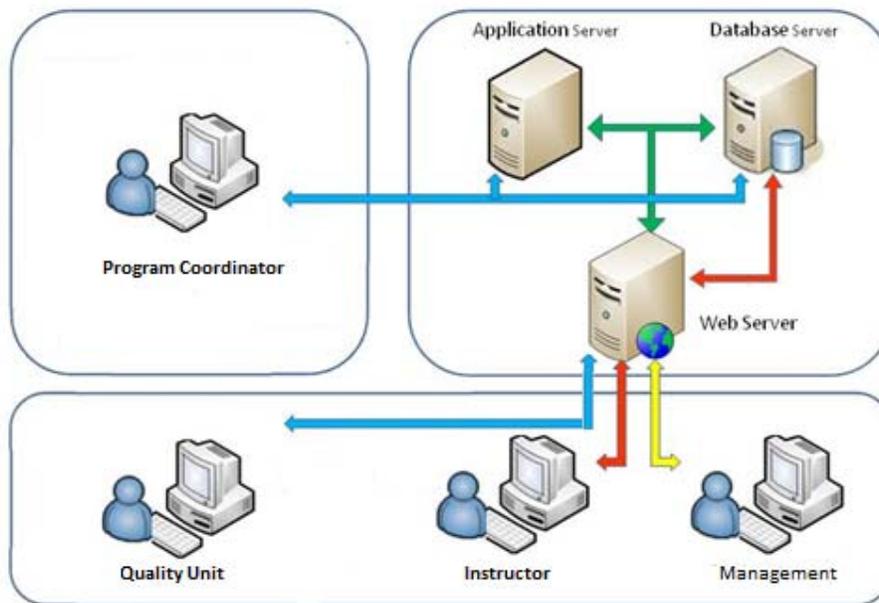


Figure 2: A high-level hardware needs of the proposed CMS

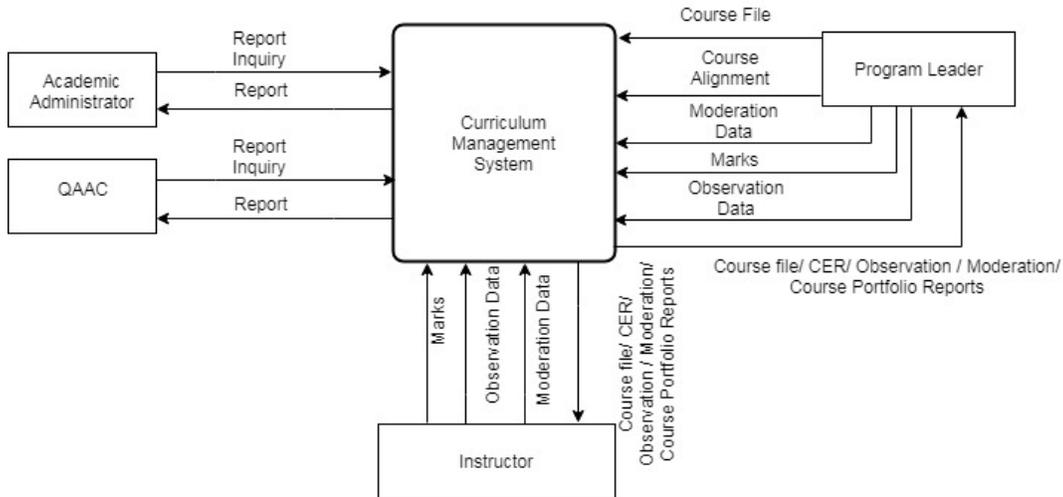


Figure 3: The context Diagram of the proposed CMS

2.4 Designing the Recommended System

To address user and system requirements and analysis, Curriculum Management Information systems should be designed to integrate constructive course alignment and how course level learning outcomes fit in the program's context as well as ensures the accuracy and consistency of data stored in different course files that formulate certain program.

Firstly, course alignment: "requires a strong link between outcomes and assessments, between outcomes and instructional strategies, and between assessments and instructional strategies" (Anderson 2002). Which can be represented graphically (Biggs and Tang 2009), 2003) as in figure 4 below.

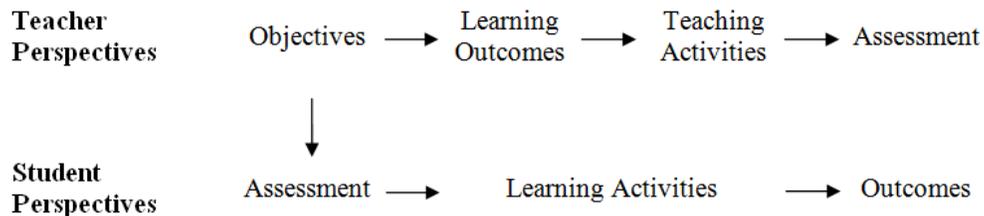


Figure 4: Course Alignment

Secondly, the database approach is an enhancement on the shared file system approach as the database management system (DBMS) offers amenities for querying, data security and integrity, and permits concurrent access to data through the use of various users (Elmasri and Navathe 2011). Data integrity is defined as the accuracy and consistency of data stored in a database; a sample of required integrity between course file and some of course portfolio parts are shown in figure 5

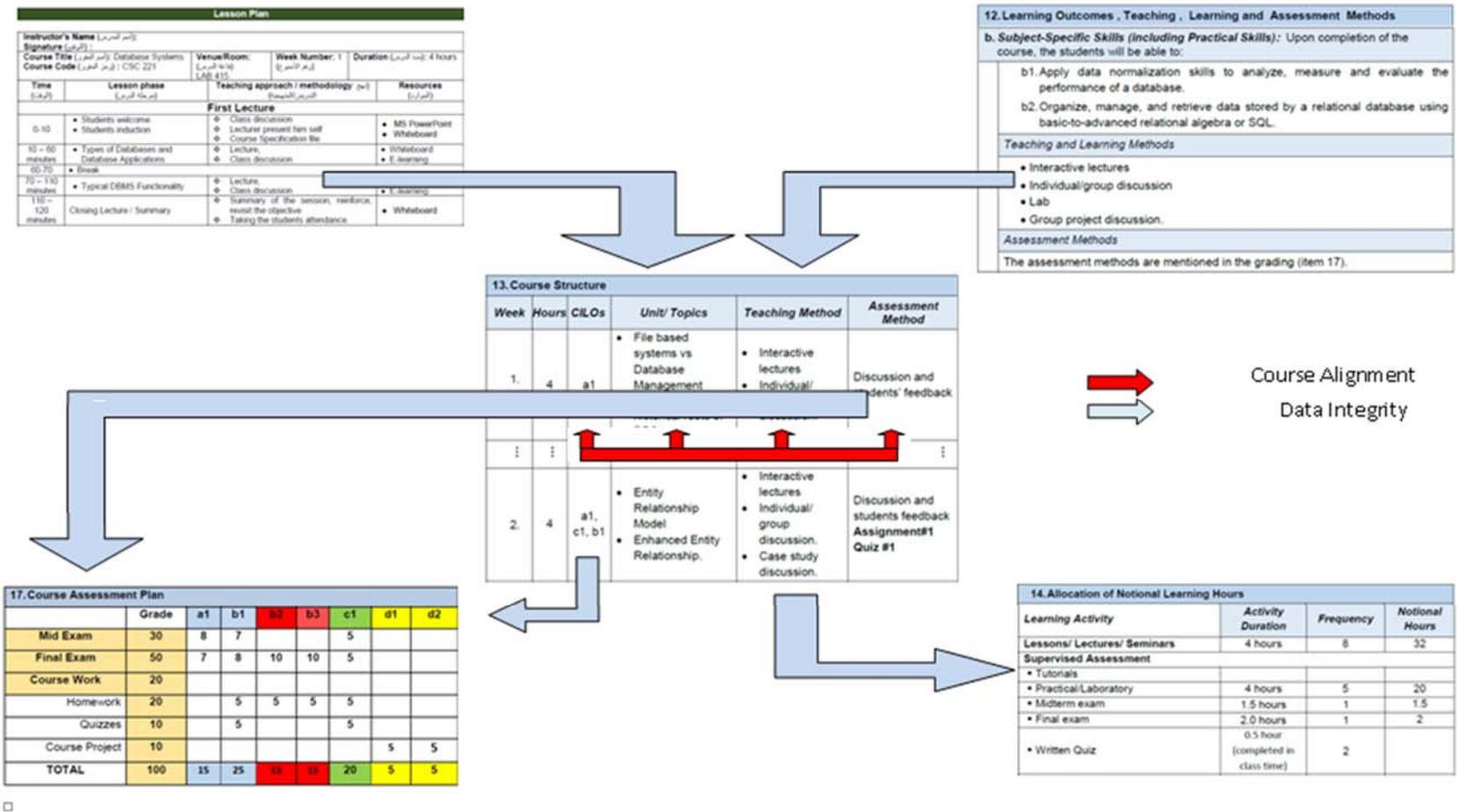


Figure 5: A sample of integrity between course file parts along with course portfolio parts

The design of the software database to be able to deliver each requirement is shown in figure (6). These produced analytical and design models assume an imperative role, helping in the implementation of the proposed system in the next step.

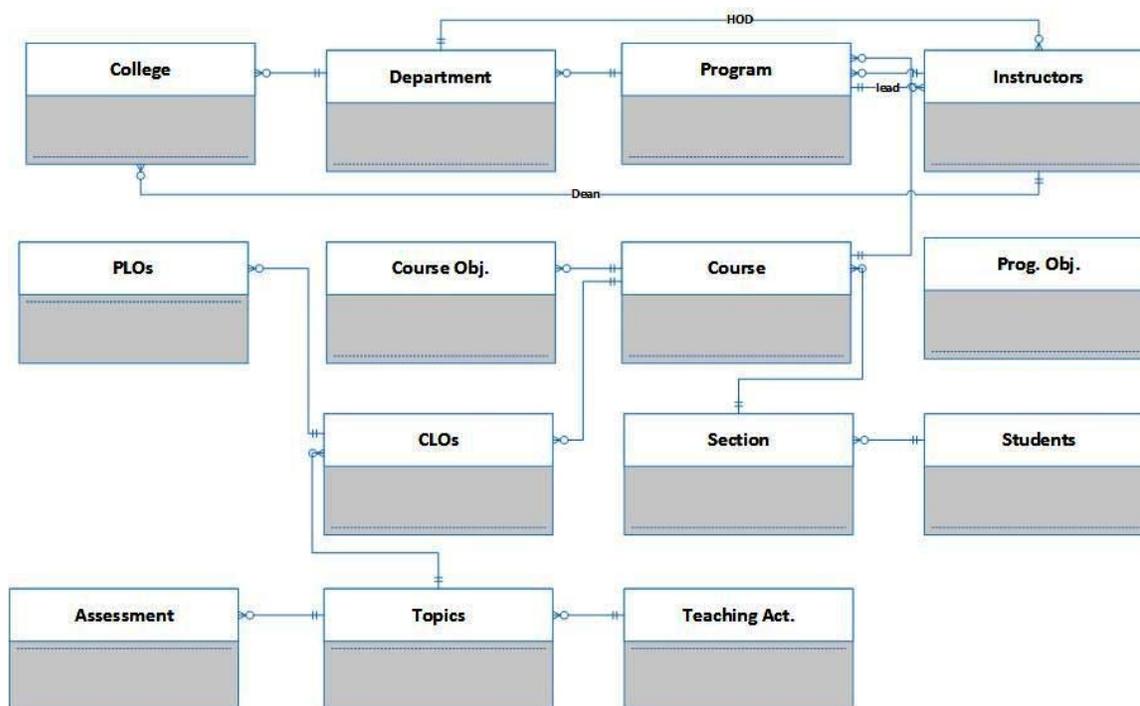


Figure 6: Proposed CMS Class Diagram

3. Conclusion

In line with Bahrain Education & Training Quality Authority (BQA) requirements, the purpose of this paper is to present the design process of an Information System for curriculum management based on data integrity and constructive course alignment. This study forms the basic framework of a CMS composed of four main modules; instructor, program leader, Quality Assurance and Administrative.

The design process included the problem identification, the analytical models for the users and system needs and the main outcomes were presented through the design of the database. As a future work, the implementation and test of this information system will be proposed to validate the solution. This paper can be valuable for researchers on CMS and for higher education institutes in Bahrain.

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The Role of Internationalisation in Innovation in Higher Education in Kazakhstan: The KSTU Approach

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Abstract

Internationalisation at first glance appears to be simply about mobility programmes and academic collaborations. On further examination, it involves these elements and more to meet the needs of a growing global workforce, including: curriculum and content, networking, global and inter-cultural awareness.

Karaganda State Technical University (KSTU) has embarked on an internationalisation agenda to meet the requirements of the government of the Republic of Kazakhstan in increasing international student numbers to 50,000 by 2020 and becoming one of the top thirty countries in the world, all included in the Kazakhstan 2050 strategic plan.

This paper examines the concept of internationalisation and presents the approach being taken by Kazakhstan and the university to internationalise. It explores literature on internationalisation and relates this to the methods being adopted at KSTU through its internationalisation strategic plan.

Keywords: Internationalisation, innovation, sustainability, Kazakhstan

1. Introduction

The role of internationalisation in higher education in the 21st century is crucial, but sometimes misunderstood and under-developed. A quick survey of staff in the International Office at the university, which has been labelled 'International Centre', highlighted this, as they unanimously responded that internationalisation was about developing collaborations and student and staff mobilities.

In this paper, we explore the concept of internationalisation in higher education and its impact on innovation in higher education institutions in Kazakhstan, and in particular, the Karaganda State Technical University. The study conducts a literature review of internationalisation in higher education and presents the findings of a strategic review of internationalisation at the Karaganda State Technical University (KSTU) in Kazakhstan. The strategic review involved a review of the university's strategic plan and interviews with the Deans and Heads of Departments. This review forms the basis of the development of a strategic plan for internationalisation at the university.

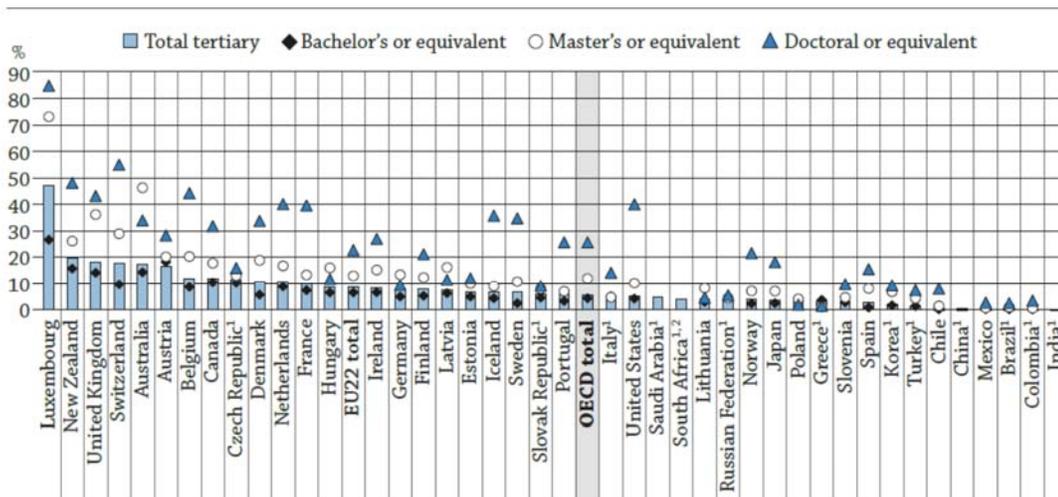
The national report on the state and development of educational system of the Republic of Kazakhstan (Ministry of Education and Science of the Republic of Kazakhstan, 2016) stated that "*higher education institutions are rapidly transforming from academic knowledge sources into the centres of innovations and technological progress*". The report amongst other things, sought to investigate how Higher Education institutions (HEIs) in Kazakhstan could contribute towards the country's aim of "*entering the list of the 30 most competitive countries of the world*". The internationalisation agenda in Kazakhstan is therefore being driven by the third modernization programme of the Republic of Kazakhstan, the strategic development plan 2025 and Kazakhstan 2050, and the adoption of the programme for a 'Digital Kazakhstan' as set out by First President Nazarbayev in his national address of the 10th of January 2018 "New Development Opportunities in the Conditions of the Fourth Industrial Revolution". This set out a new challenge to higher education institutions in Kazakhstan to "innovate or perish." Internationalisation is one way of introducing innovation into education and industrial practice.

2. Internationalisation

Internationalisation is about “ensuring graduates are better prepared as global citizens – capable of living and working successfully in the global economy, making an effective and meaningful contribution to society, and harnessing discovery and innovation to help solve societal challenges at home and abroad” (BH Associates, 2017). In addition to mobility therefore, internationalisation also needs to include: “greater collaboration in teaching and research, study programmes shaped by internationalisation-at-home, foreign language proficiency, participation in international networks, and developing a heightened and deeper understanding and global awareness of issues and cultures” (BH Associates, 2017). Teichler (2004) suggested that the trend was moving away from internationalisation, which he described as the “border-crossing activities between national systems of higher education”, towards “globalisation”, described as “border-crossing activities of blurred national systems, which is often employed to depict world-wide trends and growing global competition”. Cantwell and Maldonado-Maldonado (2009) stated that “Globalisation is seen as an over-arching social and economic process whereas internationalisation is understood as the ways in which institutions of higher education respond to globalization”. For this study, the focus was on internationalisation.

Vinther and Slethaug (2013) cited in Byram (2018) identified three types of approaches to internationalisation: unification or diversification, convergence or divergence, and symbolic or transformative. The first is about the recruitment of international students, diversification, slowing leading to becoming transformative, which could lead to changes in the curriculum.

Hénard et al (2012) attribute the modern growth in internationalisation to the “age of global knowledge and technology,” where “an interconnected network and global awareness are increasingly viewed as major and sought-after assets”. This requires graduates to be able to interact in a global work market, and to have developed skills in international and inter-cultural awareness; and preferably speak a foreign language. This has further encouraged students to travel internationally in search of education, with the number of students enrolled in higher education outside their country of citizenship doubling between 2000 to 2010 (OECD 2012).



1. Share of foreign rather than international students.

2. Year of reference 2015.

Figure 1: International and Foreign Student Enrolment as a percentage of total tertiary education. Source: OCED (2018)

A further study in 2018 (OECD, 2018) identified that although international students only accounted for 6% of total student enrolment in Higher Education, they represent just over a quarter (26%) of enrolment on doctoral programmes (fig.1). In 2017, they accounted for 5.6% of total student enrolment, but still representing over a quarter at doctoral level (OECD, 2017). A third of these students favoured Science, Technology, Engineering and Mathematics (STEM) subjects followed by Business, Administration and Law at 28% (OECD, 2017). At doctoral level however, STEM subjects accounted for 59% of international student

enrolments. The study explained this through the central role played by these disciplines in innovation and opportunities for work.

The Qazak Times (2018) reported that 14,000 international students were enrolled in Kazakhstan higher education institutions, the majority of whom are from Uzbekistan (26.3%), followed by India (23.5%), Turkmenistan (9.4%), China (9.2%) and Kyrgyzstan (7.3%). The Government of the Republic of Kazakhstan (RK) has set a target of increasing this number to 50,000 by 2020 (The Pie News, 2018). This, it was identified, is a part of a wider large-scale programme to strengthen partnerships between domestic and foreign universities. The aims are to *“improve the quality of higher education in Kazakhstan”* and *“create an educational hub of higher education in Kazakhstan”* for the Central Asia region. As a result, in 2015 for example, 24 new collaborative programmes with foreign institutions were instituted under the State Program for Industrial and Innovative Development (SPIID); KSTU being one of the SPIID programme institutions.

To aid the development of internationalisation, there is also the provision by the Government of the Republic of Kazakhstan that all educational institutions at all levels should be tri-lingual, namely: Kazakh, Russian and English. This is particularly challenged by the English language skills and competencies of those currently in academic roles who are mainly Kazakh and Russian speakers. There are several programmes in place to support the development of English Language skills amongst current academic staff, one of which is the World Bank funded *“Training of Scientists and Employees of OCT in English”* project, under the grant of *‘Offices of Commercialisation/Technology Transfer*, of which KSTU is a participant.

Another challenge for Kazakh universities in delivering the requirements of the Republic’s strategic development plans 2025 and 2050, is student recruitment. Whilst student numbers enrolled in Kazakh universities fell from 53.1% to 48.4% between 2011 and 2015, with the largest decrease of 33% amongst fee-paying students, the number of Kazakh students studying in foreign universities increased by 36% between 2009 and 2013 (Ministry of Education and Science of the Republic of Kazakhstan, 2016, pg.76). This figure excludes the number of Kazakh students in Chinese universities. It was also noted that Kazakh students make up 23% of the total HEI student population in Russia. About a third of all Kazakh students in HEIs receive scholarships based on the state education order (pg.76). The educational grant programme was previously open to students from a select number of countries. However, in a drive to boost international student recruitment in Kazakhstan to meet its targets, this programme has been opened to all international students with effect from the 2019/20 academic year.

There is also the challenge of the language difficulties. Russian is widely spoken in Kazakhstan, a legacy of the Soviet era. The older generation speak Kazakh and Russian, but little or no English, whilst the younger generation (Generation Z) speak Russian, limited English, but little or no Kazakh (hence the popularity of study in Russia). There is currently a national drive to improve the English language skills of teachers across all levels of education, and KSTU is currently undertaking an English Language training programme for over 100 staff funded by the World Bank.

Current statistics on the number of Kazakh students in foreign institutions, and international students in Kazakh institutions was not available. However, the trend for international student enrolment in Kazakh universities appeared to be modestly increasing from 1.9% in 2014 to 2.3% in 2015 (Ministry of Education and Science of the Republic of Kazakhstan, 2016 pg.79). This growth is not enough to meet the set target of 50,000 international students by 2020.

3. *World University Rankings*

Although a fairly recent development (2003) on the world stage (Rauhvargers, 2011), there is currently a focus on the attainment of world university rankings by Kazakh HEIs as part of the strategy of the National Development Plans. Increasing competitiveness for attracting international students across the globe has also led to an increase in the number of *‘World University Rankings’* available, with HEIs being driven by the criteria for assessment, which include: the reputation of the institution amongst its peers and employers, number of internationals partnership and collaborations, number of international students, number of staff and students engaged in mobility programmes, and graduate employability; amongst others.

The positive impact of this focus on international rankings on HEIs is that there is greater accountability and increased pressure to improve management practices; and in some countries, it has been used to argue for more investment in Higher Education (Rauhvargers, 2011). It has also driven the HEI agenda to become more research intensive, with the emphasis on research outputs as a measurement of international competitiveness. The danger however, is that academics may become more focussed on the outputs rather than the innovation.

A recent survey by education.com however indicated that rankings are becoming less important in determining student choices of HEI, with students making "study abroad decisions based on a changing list of priorities and influencers" (ICEF, 2019). These include: cost of living, the ability to work after studying, quality of teaching, and a destination's reputation for being welcoming and friendly. Kazakhstan has a much lower cost of living relative to the main players in the provision of international education highlighted in figure 1. The survey concluded that:

- University rankings are decreasing in influence in terms of where students choose to study
- Peer reviews, virtual tours, videos, and cost of tuition and living are becoming much more influential
- Students may have a list of "dream destinations," but they will consider other options if a compelling offer is available
- Post-graduation work opportunities (graduate employability) are increasingly important to students across the globe

This would suggest that HEIs in Kazakhstan should focus more on improving the quality of teaching and graduate employability and promoting their international reputation, to attract talented students and graduates. Recent conversations by the author with current students and graduates of the university however identified that students were not just interested in employment opportunities in their local regions; but were also seeking an education that would make them competitive on the international job market.

4. Internationalisation and Innovation

Internationalisation includes activities related to mobility, collaboration (teaching and research), content, foreign language proficiency, networking, and global awareness of issues and cultures. These all contribute to a culture of innovation and sustainable development, as follows:

Mobility

International mobility is the most common form of activity under internationalisation undertaken by students and staff. This could take several forms and be undertaken either as an individually arranged programme, group activity or as part of an established mobility programme such as the EU funded Erasmus+ programme. It also involves learning and/or training. The ERASMUS impact study (EU, 2014) undertaken by the European Union identified that:

- more than 85% of ERASMUS students undertook the programme to enhance their employability abroad;
- ERASMUS participants are half as likely to face long term unemployment;
- 5 years after graduation, the unemployment rate for ERASMUS participants was 23% lower than for non-participants; and
- ERASMUS students increased their graduate employment advantage by an average of 42%.

The 2019 impact study (European Commission 2019) found that:

- Although motivations for undertaking Erasmus+ mobilities remained similar, 70% wanted to experience life abroad, 62% wanted to improve their language skills, 49% wanted to improve their soft skills and another 49% wanted to improve their career chances
- 80% of first cycle Erasmus+ students found their first jobs less than three months after graduation
- 40% of Erasmus+ traineeship participants were offered a job by their host employers
- Almost 50% of Erasmus+ graduates got their first jobs in the countries where they undertook their mobility programme
- 10% of Erasmus+ graduates start their own companies after graduation, with 75% planning to do so in the future. The evidence suggests that the mobility programme develops entrepreneurial skills.
- Two thirds of Erasmus+ graduates compared to 58% of non-Erasmus graduates characterised their jobs as high income

Student mobility presents the opportunity for countries to attract the best talent to study and work. Such talents required to not only be innovative, but to get ahead of the competition, in an increasingly globally competitive world.

Staff undertaking Erasmus+ mobilities were also found to be more innovative in their teaching methods, with 43% of participants reporting to have started using an innovative teaching method during their mobility programme (European Commission, 2019).

A study by the Observatory on Borderless Higher Education [OBHE] (2018) cited in ICEF (2018) examined the scale of what they termed “virtual international mobility.” Over the last ten years, the study found that online/distance learning showed very little growth in the market for international students. Instead the market witnessed a growth in the volume and variety of transnational education through more conventional routes like international branch campuses and joint or dual degree programmes. It was not clear however if this study included the development and growth of Massive Open Online Courses (MOOCs).

The growth of MOOCs and the development of new and innovative alternative methods of delivering Higher Education are opening up new markets for international education. HEIs can now open their courses to a global audience in a variety of ways, offering a wide variety of certificated and non-certificated learning. This need to compete on the open digital market, enabled by leaps in technological advances, is driving innovation in online and remote delivery. In countries such as the USA and China, where there is actual growth in the development of online and hybrid models of learning, the need to deliver to changes in student demand and technology enabled learning is driving such growth. A recent report by Georgia Tech (2018) proposes a ‘reimagination’ of the higher education model. The report acknowledges that the focus will still be on the traditional offerings, but that there is required a redefinition of the fundamental approach to educational delivery. The influence of Artificial Intelligence (AI) on internationalization cannot be underestimated, but is not examined in this paper, as it will be addressed separately.

A study by the International Education Association of Australia (IEAA) cited in ICEF (2019a) highlighted the appeal of the opportunities for work in host countries post-graduation for many international students. This is influenced by government policies, and countries which have an immigration system that allows international graduates from local universities to take up employment, are found to be more attractive by students. This way such host countries can retain the best international talents and harness these talents in their economic growth and development. The study noted that the host countries “*recognise the value of retaining the highly qualified graduates in their labour market and periodically revise their immigration policy settings to align with changing market conditions*” (ICEF 2019a). ICEF (2019b) further noted that the qualities that make international students happy include: good networking, graduate employability, course administration and management, the student experience and the environment. These are all contributory factors in innovation and entrepreneurship.

Collaboration and Partnerships

International collaborations and partnerships not only open new markets to HEIs, but also enable them to build capacity for innovative cross border research activities. 93% of all staff who undertook an Erasmus+ mobility indicated developing new collaborations and networking as one of the main reasons (European Commission, 2019). This is also one of the key criteria in the assessment of various world university ranking tables.

Several models can be adopted for collaboration and partnerships. The regional education hubs support cooperation and competition between HEIs in geographical regions. Kazakhstan is part of the East Europe and Central Asia regional hub (Eurasia). Cooperative Transnational Education (CTE) is seen as a way for governments to “enhance the effectiveness and efficiency of their higher education systems”, i.e. “reduce the costs and maximise the benefits of higher education” (Craciun and Orosz, 2018). They found that at Macro level, CTEs offer economic benefits of more and better patents and economies of scale in the provision of higher education. They also provide socio-cultural benefits in terms of positive attitudes towards borders and democracy. At meso level, Craciun and Orosz (2018) identified economic benefit in form of increased institutional efficiency, and academic benefits of strengthened research and teaching capabilities, more and better scientific outputs, and greater attractiveness to foreign academics. At micro level, they suggest the economic benefits are better prospects for graduate employment (local and international) and more employability skills. The academic benefits were seen to be increased foreign language proficiency, gains in content knowledge, increased mobility, and more and better research publications.

International branch campuses (IBC) is another model of internationalisation that has gained popularity in recent times. C-Bert (nd) define this as “*An entity that is owned, at least in part, by a foreign higher education provider; operated in the name of the foreign education provider; and provides an entire academic program, substantially on site, leading to a degree awarded by the foreign education provider.*” This has

proven to be a popular model adopted by 'Western' universities to set up base in primarily Asia and the Middle East. 'Eastern' countries are catching on with Russia leading the charge into new territories.

Content

Educational content increasing needs to be reflective of global awareness and graduate employability agendas. The need for high quality curriculum development to serve the international community is reflected in the creation of the International Bureau of Education (IBE), a UNESCO initiative. There are six areas of excellence in curriculum development that work on.

Educational content also needs to be reflective of the requirements of incoming international students, which may form one of the influencing factors for international student recruitment. The proliferation of 'international' badged courses is one method of meeting these needs.

The content developers (academics) require new knowledge and skill sets to meet these growing needs. New knowledge is being sought through internationalisation, with 93% of Erasmus+ staff mobility participants indicating the acquisition of new knowledge and skills as a motivating factor for the mobility, whilst 89% reported the opportunity to learn new learning and teaching methods (European Commission, 2019).

Foreign Language Proficiency

Foreign language proficiency is seen as an attractive skillset by employers, and an asset to organisations. The drive for a share of the internationalisation market has seen the development of undergraduate courses delivered in English (international) by non-English speaking countries. It could of course be argued that simply teaching in English does not make a programme international, except the curriculum contains international content, and vice versa. That is however a debate for another paper.

Hughes (2008) reported that anglophone countries have the largest share of the international student market. As they attract the 'best brains', it gives them an edge over non-anglophone countries with regards to retention and innovation. In recognition that Latin graphics are used by over 75% of the countries of the world, and to fully support the internationalisation drive in Kazakhstan, the Government has introduced a change in the Kazakh language to the use of Latin graphics. This is expected to "*accelerate the integration*" of the country "*into the global information, digital, scientific and cultural space*" (Ruhani Zhaңғыру, nd).

Networking

Networks are essential for the development of internationalisation. Mobilities, collaborative partnerships, etc. all depend on how good your networks are. It is also one of the main motivations for students and staff undertaking Erasmus+ mobilities as shown below.

Global Awareness of Issues and Cultures

The EU ERASMUS impact study (2014) found that employers were seeking transversal skills and international experience when recruiting. Other studies (Rizvi, 2000) showed that employers held more valuable, education that could offer exposure to different people and cultures, ideas and attitudes, and different ways of learning and working. Furthermore, employers were seen to require more than graduates' achievements in relation to the subject discipline for recruitment (Yorke, 2006).

The 2019 Erasmus+ impact study (European Commission, 2019) identified that 23% of Erasmus students (compared to 15% of non-Erasmus students) worked abroad or had jobs with an international dimension. The study also identified that Erasmus+ students are exposed to new teaching methods and experiences, which help them to define a clearer career pathway. It also improves their "*competence for effective learning*". Travelling to non-neighbouring countries also led to higher gains in inter-cultural openness. Staff undertaking Erasmus+ mobilities also improved their inter-cultural understanding, transversal and social skills.

5. The KSTU Approach

The internationalisation agenda in Kazakhstan is mainly driven by the Government agenda. Based on this at KSTU, the focus is on:

- The provision of innovative educational processes and becoming the lead institution in the country for training specialists for the "main sectors of the economy"
- Improvements in the quality and impact of research, and the commercialisation of research outputs
- Staff development and the creation of an enabling environment

This requires effort on capacity building, network development, language proficiency and global awareness. The university is adopting the Uppsala Internationalisation Stage Model approach (Johanson & Vahlne, 2009), for a managed gradual increase in internationalisation activities. For this purpose, partnerships and collaborations have been defined at local (Karaganda), national (Kazakhstan), regional (Eurasian Economic Union [EEU] and neighbouring countries) and international levels. Strategic partnerships are to be formed with key partners in the first instance in Mining, Mechanical, Electrical and Computer Engineering. Research activities in these key areas will also be developed in collaboration with all levels of partners. This approach adopts the diversification approach to improve the recruitment of international students in order to meet set government targets. The development of research collaborations in tandem with the recruitment drive would be transformative in terms of influencing the curriculum and providing more opportunities for students to undertake mobilities and internships.

This transformation is leading to the development of new international programmes and the conversion of existing programmes for an international non-Russian speaking audience. As most of its international students are from Russian speaking countries, KSTU seeks to become the leading Technical university in the sub-region for international technical courses.

The next phase of the transformation would be to attract more students from outside of the sub-region, which is now enabled by the opening of the grant system to all international students, effective from the next academic year.

There is also a drive to bring in more foreign 'experts' into the research and teaching activities of the universities. A new programme for visiting academics has been developed which will see the appointment of foreign experts as Visiting Professors, Visiting Fellows, Visiting Lecturers and Visiting Scholars.

6. Conclusion

From initial discussions of internationalisation as simply mobility and exchange programmes and seeking the signing of collaborative agreements (mainly without any activities following on), the university has developed a strategy for internationalisation using the Uppsala Internationalisation Stage Model approach. Though much of the agenda for internationalisation and innovation in Kazakhstan is being driven by the government, institutions can be innovative about how they meet government requirements.

The importance of world university rankings driven by the government of the Republic of Kazakhstan has helped focus the university's activities on the areas in need of improvement. There is also recognised a need to improve on areas where the university is already performing well so as not to be overtaken by competitors.

In doing this, the university is addressing the full spectrum of internationalisation activities, i.e. mobility, collaborations and partnership, international content, improved English proficiency, better networking, and improved global awareness, especially outside of the Russian speaking block. The creation of the office of Vice Rector for Internationalisation under the government's top managers' programme is one of the means in which the university is seeking to achieve its agenda.

The transformation journey has already been started and the supporting infrastructure to deliver this programme is being put in place to achieve the University's mission of integrating education, science, innovation, production and business as an innovative, entrepreneurial university, to meet the diverse needs of the 21st century global specialist and technical workforce.

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Innovation in the Education of Architectural Schools to Improve Awareness of Architecture Conservation

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Abstract

Cultural built heritage around the world decreases day after day due to many factors. Among the most important is the weakness of the role of architectural schools in increasing public awareness. Some universities have started to include in their architectural curriculum courses about architectural conservation at different inclusion and levels. This research will evaluate the role of architectural programs' curriculum and activities of architectural schools in strengthening public awareness towards built heritage. A group of academics and specialists has been consulted through a short questionnaire to specify the possible innovation in architectural programs to increase public awareness towards architectural conservation. The research concludes that, university architectural programs must have an innovation not only in their content and the way of teaching of architectural conservation courses, but also in practicing different conservation activities to the students and the public in order to play a major role in improving architectural conservation awareness.

Keywords: Architecture conservation; Architectural education; conservation awareness; built heritage; innovation.

1. Introduction

Protecting and conserving the built heritage of communities present a real challenge for developers, architects and professional education programs which are responsible for preparing the courses of architecture conservation. Most of architectural schools around the world offer one or more courses, or a full degree programme on architectural conservation aiming not only to improve awareness of their students, but also to play a role in the community's conservation initiatives.

This paper highlights the innovation in the education of architectural schools to improve awareness of architecture conservation. Public awareness and education are essential to change social and cultural norms which perpetuate harmful practices (UN Women, 2010). The main concept of conservation education is to foster clear awareness of, and concern about cultural, economic, social, technical and legal interdependence; to provide students with opportunity to acquire values, knowledge and skills needed to protect and improve the built heritage, and to improve the behaviour of individuals, groups and society as a whole towards architectural conservation.

Problem Statement: The main problem of the research is identifying characteristics and innovation in architectural programs to improve public awareness towards architectural conservation.

Methodology: Research methodology will be based on a descriptive analytical method involving investigating the written literature, a short questionnaire for a number of academics and specialists teaching at different architectural schools around the world. At the end, conclusions will be juxtaposed, compared and defined to achieve final conclusions.

2. Architectural Conservation Education

Over the past decades, the approaches of architectural conservation have tended to merge, and the principles of teaching architectural conservation have been given an international backing through the recommendations of UNESCO and its institutions ICOMOS and ICCROM. Those conservation supporting institutions are promoting the importance of formulating new methodologies of teaching heritage conservation. The Amsterdam Declaration in 1975, item "i" concluded that: "The architectural heritage will survive only if it is appreciated by the public and in particular by the younger generation. Educational

programs for all ages should, therefore, give increased attention to this subject.” (ICOMOS, 2011). From this time on, an increasing number of training programs have been organized at universities and technical training institutions.

- **Introducing Architecture conservation into architectural programs:** Architecture programs differ from one school to another. Going through the programs of some architectural schools around the world, three levels of introducing the architectural conservation within exist. The first level is one or two architectural conservation courses/modules in the curriculum. The second level is a special conservation program on undergraduate or graduate levels. The third are the activities that schools organize such as practical training, seminars, trips, workshops and conferences. Some of the architectural schools do not offer architectural conservation courses although they are located inside an urban historic area.

- **What is taught?** This question provides the ground for reflecting about limits and borders of what intended to be “heritage”, and for various interpretations as regards ideas, concepts and activities spotted by architectural conservation. Other topics concern the contents of such teachings in architecture schools are: subjects and objects chosen for didactic activities, priorities which are assigned to them; which theoretical and technical principles are leading the organization of the conservation courses (Stubbs and Makas 2011). The subjects, however, that are included within the architectural conservation courses are varied. The following are some innovations and ideas regarding the subjects taught:

- ICOMOS adopted guidelines on education and training in the architectural and urban conservation, providing a general outline for the contents of educational and training programs. The document states that there is a need to impart knowledge of conservation attitudes and approaches to all those who may have a direct or indirect impact on cultural property and the practice of conservation is interdisciplinary; it therefore follows that courses should also be multidisciplinary. Training in disaster preparedness and in methods of mitigating damage to cultural property, by strengthening and improving fire prevention and other security measures, should be included in courses. In addition, there should be further training for conservation work with instruction in the history, historic details and practices, and the theory of conservation with the need for documentation. Many historic skills will have to be recorded and revived (ICOMOS 2011).

- A historical survey of heritage conservation: the evolution of conservation approaches, methods, and policies and global best practices. Far from being static and entrenched in the past, conservation interests and values have evolved from the protection of monuments and historic places to the management of cultural landscapes and the stewardship of intangible heritage (Tsenkova, Fraser &Hoefs 2016).

- Conservation as an interdisciplinary practice involves many key players and a broad range of expertise, from architects, historians, sociologists, planners, engineers and others. Activities and roles of education range from communication, negotiation, mediation, education to advocacy. Besides, conservation tools include heritage legislation, conservation charters, and policies at local, provincial, national and international contexts (Tsenkova, Fraser &Hoefs 2016).

- One of the main criteria of teaching conservation is understanding the identification and assessment of the significance of architectural heritage, which should be the core of conservation courses. The main factors which form the cultural heritage significance due to Madrid- New Delhi Document (ICOMOS 2017) may rest in its tangible attributes, including physical location, its associated landscape and setting, design (for example, colour schemes), construction systems and technical equipment, fabric, aesthetic quality and use, and/or in its intangible values, including historic, social, scientific or spiritual associations or creative genius. On the other hand, the valuable interiors -such as fittings, associated furniture, and art works- have to be included. The question of how to teach conservation attains directly to the conservation “pedagogy”, not only in terms of efficacious transfer of the knowledge involved, but also as regards synergies with other subjects included in school’s curriculum, with a particular attention to theoretical and operative aspects (Embaby 2014).

Who and how to teach? Defining who teaches subjects concerning architectural conservation is a further contribution for drawing up a coherent framework of innovation in the education process. The question which is usually asked, what should be the necessary background to make a teacher able to reach the designated goals. Which kind of experience, he/she should have and how colleagues of different disciplines could collaborate for the development of teaching and formative’s activities in such a complex field. According to the ICOMOS guidelines for education and training in the conservation of monuments, ensembles and sites (ICOMOS 2011), Conservation works should only be entrusted to persons competent in these specialist activities. Education and training for conservation should produce from a range of professionals, conservationists who are able to read a monument cultural and use significance; understand the history, setting and technology of monuments in order to define their

identity, plan for their conservation, and interpret the results of this research; find and absorb all available sources of information relevant to the monument; understand and analyze the behavior and the technical issues of monuments and sites as complex systems; give expert advice on maintenance strategies, management policies and the policy framework for environmental protection and preservation of monuments and their contents and sites; document works executed and finally be able to work with inhabitants, administrators and planners to resolve conflicts and to develop conservation strategies appropriate to local needs, abilities and resources.

A question frequently asked is if and how heritage's care can be taught in a project-laboratory and with which limits and prerequisites. This is under investigation while trying to understand if educators prevalently bound to create competences and ability "to know, understand and judge (analyses, diagnosis, etc.)" or rather if it should also provide specific "operative abilities (programming, intervention, management)" (Musso 2008). Conservation teaching must obviously be tailored taking into account who is being taught. Therefore, necessarily, the actual application of the forms of teaching may well differ from one discipline to another. The main issue is that the conservation of the built heritage requires its appreciation and acceptance by the society.

Dr. Mona Helmy mentioned six dimensions for how to integrate heritage education within the school of design and architecture. The first one is urban Heritage as a surviving history as it could be perceived as a rich story telling source. It demonstrates the formation, establishment, growth, expansion, development, changes, and transformations of all built forms, urban environments, and building traditions among others. The second is urban heritage as geographical place as one of the most important considerations of architecture and design is the building context, site, or its geographical place at large. The third is urban heritage as vibrant architecture as it has a set of design principles, categories and considerations. The fourth dimension is urban heritage as living culture as heritage doesn't only reflect a history of a city or a place, but also it reflects its culture. The fifth is urban heritage as an adapted technology; design principles of urban heritage are considered one of the main solutions to inform our contemporary needs in buildings in terms of sustainability. The last dimension is urban heritage as a meaningful sense of place which is an important element in perceiving, understanding and appreciating urban environments. It is a social phenomenon that incorporates individual people experience (Helmy, 2019). She proposes an important methodology that urban heritage needs to be integrated in architecture and design courses from different perspectives and following a variety of teaching dimensions. Some of these dimensions, such as urban heritage as history or as geography, are already imbedded in the nature of some architectural and design courses. However, other dimensions of teaching urban heritage, such as a guiding theme for architectural design studios, needs to get more flexibility and innovation in their topics and in their design nature. It needs not to be only limited to conservation oriented courses (Helmy, 2019). The methodology of introducing architectural conservation subjects within the architectural design studios, which contrasts the traditional one in the usual programs of architecture is a good and executable one. A practical course depends on design studios which are traditionally applied with modern theories and requirements. Design studios in the new concepts can assist the student to understand the heritage values and develop the abilities for investigation, understanding, analyzing, and creative thinking methods through documentation and recording, urban rehabilitation, renovation, adaptive reuse, reconstruction and restoration (Embaby 2014). Thus the design studios, which are taught each semester in the architectural programs are considered an outstanding opportunity to overcome the gaps between theoretical approaches in teaching conservation and practices of the architectural conservation parameters.

The last approach of how to teach is the importance of engaging architectural students with actual construction materials and training in the field. Boyer and Mitgang explained in their comprehensive survey of architectural programmes, that the 'curricular area of greatest dissatisfaction was "professional practice"' (Boyer and Mitgang, 1996). Similarly, conservation educators have continued to experiment with ways to integrate lessons learned in the classroom or studio, with the practical application demands of the field (Lister, 2000). In this way, lessons derived from both 'reflective practice' and 'problem-based learning' methodologies are being adopted, and increasingly adapted by conservation educators (Graves, 2005). Cody and Fong summarised the necessity of field work as a part of a student's conservation education in four points: The first is the importance of collaboration or partnership as a means of advancing the field of conservation. The second is the multi- and/or interdisciplinary nature of conservation efforts. The third is the potential disconnect between global norms and local values, and the fourth is the significance of community participation in the process of heritage identification and conservation (Cody & Fong 1995).

Finally, varied teaching methods and content delivery would maintain student engagement all the time and could include guest lectures, panel discussions, videos, webinars, class discussions and field trips. In-class exercises could draw upon client-submitted projects and involve role playing where, for example, students might take on the roles of a developer, heritage advocate, heritage planner, or other stakeholder. This immersive approach would challenge students and intensify the learning experience (Sasha, Shaw, and Hoefs 2016).

3. The Questionnaire

A short questionnaire has been distributed to twenty eight academics and specialists who are teaching in architectural schools around the world. Twenty valid questionnaires signifying around 71.4 % of the distributed questionnaires have been retrieved on time. The questionnaire consists of three parts discussing the themes of the innovation in the education of architecture schools to improve awareness of architectural conservation. The first part consists of 14 questions about the importance of education in improving architectural conservation awareness and how to integrate the built heritage as a part of the architecture education. The respondents have to click either strongly agree, agree, neutral, don't agree or strongly don't agree. The second part consists of ten points of innovation which could be applied in architectural programs and teaching to improve architectural conservation awareness. The respondents have to prioritize them according to their importance and to add additional proposals. The third part of the questionnaire is about the inclusion of conservation courses within the architectural programs and how to prioritize the suggestions upon their importance and to propose other innovations in this regard. The answers to the questionnaire questions could be summarized as follows:

Table 1 Answers to Part 1 of the questionnaire: The importance of education in improving architectural conservation awareness and how to integrate the built heritage as a part of the architecture education

No.	Item	Strongly agree %	Agree %	Neutral %	Don't agree %	Strongly don't agree %
1	University education is important in improving architectural conservation awareness	65	30		5	
2	Architectural programs must have one or more courses on architectural conservation	60	35	5		
3	The course/s of architectural conservation will help in improving the conservation awareness of students	70	30			
4	The course/s of architectural conservation will help in improving the conservation awareness of the community	35	25	40		
5	Architectural conservation course/s might include mathematical, geometrical analysis subjects	15	55	25	5	
6	Architectural conservation course/s might include history of the built heritage subjects	65	30		5	
7	Architectural conservation course/s might include the cultural aspects of architectural conservation	60	40			
8	Architectural conservation course/s might include the social aspects of architectural conservation	60	40			
9	Architectural conservation course/s might include the economic aspects of architectural conservation	30	55	15		
10	Architectural conservation course/s might include the technical aspects of architectural conservation	60	35	5		
11	Architectural conservation course/s might	40	35	20	5	

	include the legal and management aspects of architectural conservation					
12	Architectural conservation course/s might include the documentation methods of the built heritage	70	25	5		
13	Architectural conservation course/s might include the theories and attitudes of building and urban conservation	55	35		5	
14	Architectural conservation course/s might include the latest technology and, computerized and IT techniques	50	30	15	5	

The table shows that most of the respondents are strongly agree that university education is important in improving architectural conservation awareness and, therefore, architectural programs must have one or more courses on architecture conservation to help improve conservation awareness of both students and community. The respondents pointed out that architectural conservation courses should include the following subjects respectively according to their importance based on the majority of respondents: Cultural and social aspects, technical aspects and documentation methods, history and theories, economic aspects, technology and computerized techniques, legal and management aspects and finally mathematical and geometric analysis.

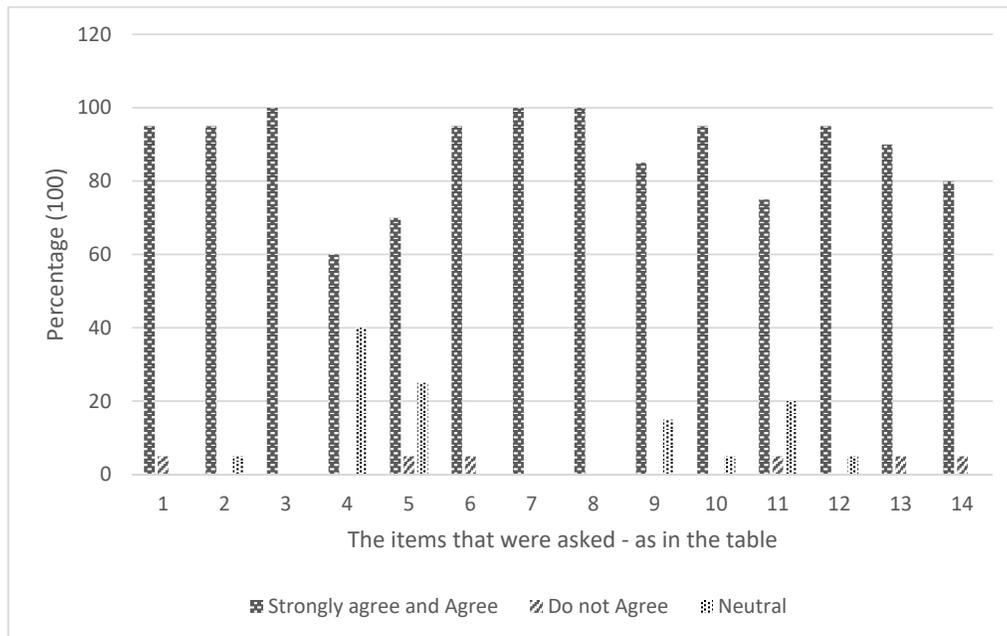


Figure 1: Percentage of the responds on items of part 1 of the questionnaire

Table 2 Answers to part 2 of the questionnaire: What innovation could be made to architectural programs and teaching to improve architectural conservation awareness

Innovation	Priority (%)									
	1	2	3	4	5	6	7	8	9	10
Concentrate in conservation course/s on theoretical studies such as history of architecture, history of architectural conservation, theory of the conservation project, legislation and so on	40	15	10	10	10	5	-	5	-	5
Concentrate in conservation course/s on technical issues such as tests, calculations, stone and other materials restoration techniques	20	35	20	10	5	5	-	-	5	-
Concentrate in conservation course/s on	15	30	25	10	5	10	-	-	5	-

technological knowledge such as photogrammetric and conservation software applications										
Concentrate in conservation course/s on practical work such as practical training on historic sites and buildings	45	20	15	-	15	-	5	-	-	-
In addition to conservation course/s the inclusion of conservation subjects in other courses such as architectural design, urban design, landscape, etc.	15	5	15	10	15	20	10	5	-	5
Conservation course/s include organizing awareness extracurricular activities outside the university (community service)	25	5	20	20	15	-	10	-	5	-
Conservation course/s include research in different topics	15	5	15	15	5	15	5	5	15	5
Conservation course/s include organizing field trips to historic sites and buildings	45	10	5	5	15	-	5	10	5	-
Architectural schools organize periodical seminars, workshops and conferences on architectural conservation	20	25	10	15	5	5	5	15	-	-
Architectural schools produce periodical brochures, manuscripts, posters on architectural conservation	5	5	15	20	15	5	5	5	10	15
Please add other innovations below: The following was proposed by some of the respondents:										
<ul style="list-style-type: none"> - International summer school training courses on historic conservation. - Institutional and organizational decision making. - Including issues about reuse of the historic buildings after restoration. - Exchange students. - Organizing trips abroad to historic buildings and sites. - Introduce materials and Nano science. - Courses could be coordinated with other universities to exchange experience. - Linked to sustainable conservation. - Knowledge should be multidisciplinary, so it is difficult to have all required knowledge in general architectural program. - Considering the legislation in the area that the site is located in. 										

The table shows that most of the respondents identified the innovation which could be made in architectural programs and teaching to improve architectural conservation awareness. Since the conservation courses/modules are limited, the concentration should be respectively on practical work such as practical training on historic sites and buildings; on technical issues such as tests, calculations, stone and other materials restoration techniques; on theoretical studies such as history of architecture, history of architectural conservation, theory of the conservation project, legislation; on organizing field trips to historic sites and buildings and on practical work such as practical training on historic sites and buildings.

Table 3 Answers to part 3 of the questionnaire: The number or type of architectural conservation courses in the Bachelor degree of architecture programs

No. of conservation courses in the architectural programs	Priority (%)									
	1	2	3	4	5	6	7	8	9	10
The architectural program should have at least one conservation course	50	10	15	-	-	-	-	-	-	-
The architectural program should have at least two conservation courses	25	25	-	15	20	-	-	-	-	-
The architectural program should have at least three conservation courses	20	-	15	-	15	-	20	-	-	10
The architectural program has the last two years concentrating on the architectural conservation	10	10	-	10	10	-	-	5	5	10
Another proposal: - The architectural program should have 3										

conservation courses: Local- Arab- International - Conservation projects to be integrated into design studios in the last two years of the program. - In addition to one course, important elements could be included in other courses.										
Another proposal:										

The table shows that the respondents identified the top priority is to have one or two conservation course in the architectural programs. In addition, conservation subjects which are not included in conservation courses could be included in other curriculum courses/modules.

4. Conclusion

Based on the literature review of the research problem and the attitudes of the questionnaire respondents and on the extended knowledge the author has through his teaching and drawing up architectural programs, the innovation in the education of architectural schools to improve awareness of architecture conservation could be fulfilled through the following:

- The importance of introducing conservation courses/modules in architectural programs: University education is very important in improving architectural conservation awareness and, therefore, architectural programs must have one or two specialised courses on architecture conservation to help improve conservation awareness of both students and community.
- The inclusion of the conservation courses/modules: Architectural conservation courses/modules should include multidisciplinary subjects and activities such as cultural, social, technical, economic, legal and management aspects of architectural conservation; documentation methods; history and theories; technology and computerized techniques; mathematical and geometric analysis; adaptive reuse of the historic buildings after restoration; linkage to sustainable conservation; practical work such as practical training on historic sites and buildings and finally field trips to historic sites and buildings locally and internationally.
- The level of architectural conservation courses within the architectural program: Introducing Architectural conservation courses in the Bachelor of architectural programs because they are spread all over most of the universities with many students in. The courses are one or two conservation courses/modules because there are different other subjects taught within the program. In addition, conservation subjects which are not included in architectural conservation courses could be taught in other curriculum courses/modules. For example, the history of historic buildings could be taught in history of architectural courses, Practical conservation projects could be done in architectural design studios, Historic materials and technical issues could be taught in building materials and construction courses, conservation software programs in computer application courses, training could be done in one of the field training courses, and finally, architectural schools could organize summer trips, seminars, workshops and conferences on conservation subjects within their extra curricula activities. Restructuring the programs’ study plan and course description based on what mentioned will help achieving a comprehensive development of conservation awareness.
- Strengthening the relationship between the university policies and the local community needs.
- The design studio courses are very important tools to apply the integrated approaches in teaching conservation, which promote students’ abilities in deeply understanding the heritage significance and revitalizing its values, investigation, understanding, analyzing, and creative thinking methods to provide a conservation planning. This will help to overcome the gaps between teaching and practice and formulating new concepts, thoughts, and methodologies that strengthen the creative thinking in dealing with the built heritage. In addition, this fulfils the opportunity of participating and supervising by many professionals in architecture and urban design, interior design, computer application, restoration and other disciplines.

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Section 8
Financial Innovation

Assessment of Predominant Barriers affecting the Progression of Transport Infrastructure Investment: A Case of Johannesburg Metropolitan Municipality

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Abstract

Infrastructure development is important for the growth of any country. Effective infrastructure development boosts the economy of both developing and developed countries. For progressive infrastructure development there is a need for extensive infrastructure investment. However, there has been barriers affecting transport infrastructure investment. This study determined and assessed barriers affecting transport infrastructure investment. Primary data was obtained through a questionnaire sent to construction professionals in the Gauteng Province. Out of 130 questionnaires sent, 100 were retrieved. The findings showed internal consistency with a Cronbach alpha value of 0.923. The retrieved data was analysed using Statistical Package for the Social Sciences. The study revealed that political interference, lack of funding, cost overruns, lack of financial capacity, and lack of infrastructure maintenance capacity were barriers affecting the progression of transport infrastructure investment in the Johannesburg Metropolitan Municipality. The study recommends that the central government plays a leading role in alleviating financial barriers to transport infrastructure, more so, domestic and international collaborations should be enhanced, which requires the relaxation of specific government policies to allow foreign direct investments. With accelerated construction, restoration and maintenance of transport infrastructure equals direct and improved socio-economic opportunities to communities and the country at large.

Keywords: Transport infrastructure development, Service delivery, Central government, World Bank, Financing models.

1. Introduction

Infrastructure development has an important role in aiding any country to achieve economic growth. Progressive infrastructure development assists government to sustain its economic and social growth, which in return attracts investment (Shen, Wu and Zhang, 2011). Infrastructure is categorised into physical infrastructure (includes water and power systems, roads and transport, as well as communication systems) and social infrastructure (includes education and health facilities), these types of infrastructure are very important in order to improve the lives of the public and also aid to stimulate economic growth and create jobs for the public (World Bank, 1994). This study mainly focuses on the contribution of transport infrastructure towards an economic prosperous country, like South Africa. Organisation for Economic Cooperation and Development (OECD) (2008) shares that transport infrastructure places a crucial role as a capital input into the production of many goods/products. Transport infrastructure is classified into five categories, namely; Railway infrastructure, road infrastructure, inland waterway infrastructure, airport infrastructure and sea port infrastructure.

Governments are expected to accelerate infrastructure development through investment in order to prosper and stimulate growth, including accelerating service delivery, as well as maintaining and restoring the existing infrastructure (KPMG, 2010). However, to attract investment governments need to review their fiscal position and capacity, as this will provide information which will enable them to make accurate decisions about the required infrastructure - whether it must be financed by public-private partnerships, private investors or by their own revenue. Also the information about their fiscal position will enable them to either provide low tax rates or not on private investors or public-private partnership (Shen, Wu and Zhang, 2011).

Funds are required to finance transport infrastructure and it is the responsibility of the government to provide those funds or obtain them elsewhere (loans, intergovernmental transfers, tariffs). Evidence has

shown that South African transport infrastructure is struggling to contest its growing population (National Treasury, 2014; National Development Plan, 2012). More so, evidence is also provided that there are possible ways to improve the current approach to infrastructure funding and provisions. African countries suffer from abandonment of infrastructure projects and the rejection by private sectors to provide finance for infrastructure development because of the low rates of return for their investments and the politics involved in many infrastructure projects (World Bank, 2005). Most infrastructure projects are being abandoned simply because of the shortage of funds to finance infrastructure. As a result of the above issues the study envisaged to rigorously determine barriers affecting transport infrastructure investment, a case of Johannesburg Metropolitan Municipality.

2. *Barriers affecting Transport Infrastructure Investment*

Moteff and Parfomak (2004) defines infrastructure as basic facilities, services, and installations needed for the functioning of a community or society, such is the means of transportation and communications systems, water and power lines, and public institutions including schools, post offices, and prisons. Goel (2003) declares that infrastructure is divided into; Economic and social infrastructure, which both are espoused into physical infrastructure. Every developing and developed nation depends immensely on its infrastructure to prosperously advance the socio-economic needs of its communities, the World Economic Forum (2015) and the World Bank respectively established Global Competitiveness Index (GCI) and Logistics Performance Index (LPI) to benchmark the performance of infrastructure development (Ojala and Celebi, 2015) in different countries.

As one of the quickest developing countries, India is experiencing difficulties with providing adequate service delivery to its communities, affecting the wellbeing of its citizens. Most required service delivery is means of transportation, there has been initiatives to expand and rehabilitate the current transport infrastructure (Della, 2014), however these initiatives have encountered financial barriers affecting the acceleration of infrastructure development. The City of London and Execution Noble (2012) conducted interviews with the domestic investors and developers involved in financing infrastructure projects in India. The results of the interviews revealed that India faces multiple barriers in infrastructure development, namely (CDIA, 2010; Baietti *et al.*, 2012):

- i. Lack of a meaningful supply of bankable projects;
- ii. Political and bureaucratic challenges;
- iii. Lack of transparency in the PPP bidding;
- iv. Lack of transparency in the awarding process of PPP projects;
- v. Delays in regulatory approvals;
- vi. Delays in land clearances;
- vii. Lack of availability of the right kind of long-term debt;
- viii. Taxation issues; and
- ix. Lack of an independent regulatory authority.

The National Development Plan (2012) clearly outlines that the South African government with optimistic views promises to address the overwhelming issues surrounding the progression of transport infrastructure, these issues include the deteriorating impact of transport infrastructure to the economic growth and job creation, difficulties encountered with maintaining and restoring the existing transport infrastructure, as well as difficulties experienced to lack of/no transport services to specific communities. According to Kutoane (2014) and CDIA (2010) each country encounters different barriers affecting the progression of transport infrastructure investment, however, most alarming barriers encountered in Sub-Saharan Africa include; Inadequate financial capacity to execute mega-infrastructure projects, inflexible infrastructure regulatory and policy frameworks at regional levels, complex and technical channels to raise funds, poor alignment of national and regional priorities and escalating conflict of interests of different parties involved in project execution. Furthermore, Rodrigue (2013) emphasised that the deteriorating progress of infrastructure development, particularly transport infrastructure investment solely lies with the central government, the study further identified the following as critical barriers facing infrastructure investment; Lack of funding, divergence of purpose, uncertainty in outcome and time-frame misalignment.

One of the barriers affecting developing economies is the provision of funds for infrastructure development. Laskar and Murty (2004) and Swarup (2007) revealed that developing economies still need to provide transport infrastructure such as expressways, national highways and state highways, major

district roads, other district roads and village roads to enable movement of trade of goods and services. More so, Sahoo (2011) revealed that developing economies are struggling with infrastructure segment and these issues include inadequate funding, inflexible tariff policy, limited private participation and poor institutional set up, below is the discussion of impactful barriers affecting the progression of transport infrastructure investment globally.

The obstacles facing central governments is that transport financing initiatives are normally inadequate for enhancing the execution of transport infrastructure. This was a noteworthy driver behind privatisation and deregulation in traveler and cargo transport commercial ventures around the world (Kutoane, 2014), which has a direct impact on the advancement of the base financing model. More so, Kutoane, (2014) shares that it is evident from the existing conditions of the transport infrastructure that the state owned institutions for financing, planning and executing transport infrastructure development do not have the financial capacity for mega-infrastructure projects, this is as a result of poor investment climate in many countries, the debt owed is continuously getting high (World Bank, 2006; KPMG, 2010). To elucidate the overarching barrier of finance, the government in power should show political willingness to private sector investors, which are willing to risk their capital on long-term complex projects. Furthermore, government inclusivity for efficient transport infrastructure development should be prioritised. The multiple spheres of government involved with the financing of transport infrastructure ought to be intended to advance efficiency; expanded openness, limit and execution (Sharp *et al*, 2015). Numerous venture activities are politically rather than industrially determined, which is unique in the motivation behind transportation infrastructure. CDIA (2010) clearly indicates that poor harmonized infrastructure regulatory and policy frameworks at regional level is amongst the highlighted barriers affecting the progression of transport infrastructure investment.

Government inclusivity is hindered when the priorities of all stakeholders involved differ. The actual envisaged time (determined by national government) for the execution of transport infrastructure projects is mostly not aligned with the estimated budget (determined by provincial or municipal government) of the actual project. The misalignment is evident during the course of the project, where a procurement method has already been selected to undertake the project (Pietroforte, 2002; Babatunde, Opawole and Ujaddughe, 2010). Proper selection of any procurement method should clearly determine the time scope of the infrastructure venture and the estimated budget. This underlines the difference between the long-term character of infrastructure and the short-term viewpoint predominant in finance. Rodrigue (2013) further asserts that time frame misalignment begins initially from failing to align national and regional priorities of transport infrastructure development.

The misalignment of time durations, will as result affect the estimated duration of the project. The amended time will in return affect the time estimated for the initial returns on investment (Perkins, Fedderke and Luiz, 2005) for the infrastructure project. Central governments across the southern region of Africa, on yearly basis perpetually fail to recover the costs incurred (KPMG, 2010) thus fall short to adequately finance the construction, operation, maintenance, restoration and expansion of the existing infrastructure facilities, transport infrastructure in particular (Mahabir and Mabena, 2014). As a result of this barrier potential investors have now decided to show no interests in such projects, whereby they stand to lose than gain due to unsteady revenue collection streams (CEFG Group, 2014). Amongst the most recognised models of collecting revenue, user charges and tariffs have come close to solving the constant inadequate collection of revenues for services provided.

3. Research Methodology

This study determined barriers affecting transport infrastructure investment, with the use of descriptive analysis. The study was undertaken in the Johannesburg Metropolitan Municipality, and a quantitative method was adopted for the survey. The research instrument employed was a structured questionnaire with two sections, which was administered to construction professionals, including Engineers, Architects, Quantity Surveyors, Construction Managers and Project Managers, over 50% of the professionals were working for the Department of Infrastructure Development and Department of Public Works situated in Johannesburg Central Business District (CBD). The questionnaire had a five-point Likert Scale which was used to calculate the mean item scores for the determined variables. Convenient sampling was adopted for selecting the construction professionals. The questionnaires were administered to 130 respondents, of which only 100 usable were retrieved, representing 77% response rate, which, according to Moser and Kalton (1971), indicates a credible study. Prior to the distribution of the questionnaire, face validity was undertaken. Churchill and McLaughlin (2001:1) as well as Lacity and Jansen (1994) share that face validity is evaluating the research instrument by looking at it, and giving personal opinions before the actual

distribution. The reliability of the administered questionnaire was determined, the cronbach's alpha value amounted to 0.923. According to Sekaran (2007) cronbachs' alpha value above 0.7 represents internal consistency. Statistical Package for the Social Sciences (SPSS) computer software was used for data analyses. Mean item sores and standard deviation values generated using SPSS were then used to rank the variables according to the level of agreement of the respondents, thus identifying prominent barriers affecting transport infrastructure investment in the Johannesburg Metropolitan Municipality.

The mean item scores were calculated from a total of all received questionnaires relating to the total responses on each question. This was based on the principle that respondents' scores on all the selected criteria, considered together, are the empirically determined indices of relative importance (Polit and Hunger, 1995:33). The index of MIS of a particular factor is the sum of the respondents' actual scores (on the 5-point scale) as a proportion of the sum of all possible maximum scores on the 5-point scale. A weighting was allocated to each response ranging from one to five. The formula below was used to determine the mean item scores for the identified variables;

$$MIS = \frac{1n_1 + 2n_2 + 3n_3 + 4n_4 + 5n_5}{\sum N} \dots \dots \dots \text{Equation 1.0}$$

Where:

- n_1 = Number of respondents for strongly disagree;
- n_2 = Number of respondents for disagree;
- n_3 = Number of respondents for neutral;
- n_4 = Number of respondents for agree;
- n_5 = Number of respondents for strongly agree;
- N = Total number of respondents.

4. Findings, Analysis And Discussion

4.1 Biographical Data and Results

The findings of the study indicated that out of 100 respondents that took part in the survey, 62% were male, while 38% were female. The respondents' age group indicated that 16% of the respondents were between the age group of 21-25 years old, 18% were between the age group of 26-30, while 31% of the respondents recorded were between the age group of 31-35 years old. More so, 18% of the 100 respondents were between the age group of 36-40 years old, 10% were between the age group of 41-45 years old, and only 7% were between the age group of 46-50 years old. The questionnaire administered had a section on ethnicity. The findings revealed that 41% of the 100 respondents were African, 22% were White, 23% were Coloured, while the remaining 14% of the respondents were Asian/ Indian. The study further determined the level of qualification obtained by the respondents. The findings indicated that 9% of the 100 respondents had a Higher Certificate, 32% had a National Diploma, 44% had a Bachelor's Degree, 12% had Master's Degree, and the remaining 3% of the 100 respondents had pursued a Doctorate Degree. The respondents' current employment position was next on the agenda. The findings showed that out of the 100 respondents that participated 13% were Consultants, 15% were Architects, 24% were Project Managers, 6% were Construction Managers, and 16% were Engineers, while the remaining 26% of the respondents were Quantity Surveyors. Lastly, the respondents' experience in their current positions were also determined. Thus, the findings revealed that 38% of the 100 respondents had experience of up to 5 years, 32% had experience between 6-10 years, 23% had experience between 11-20 year, and only 7% of the respondents had experience of more than 20 years.

4.2 Barriers affecting transport infrastructure investment

The study determined predominant barriers affecting the progression of transport infrastructure investment. The results in Table 1 shows the ranking of the determined barriers. From Table 1, it is evident that political interference (MIS=4.84; SD=0.368), cost overruns (MIS=4.72; SD=0.621), lack of funding (MIS=4.61; SD=0.852), lack of technical skills (MIS=4.37; SD=0.950), lack of infrastructure maintenance capacity (MIS=4.32; SD=0.815) and frequent delays in licensing and permitting (MIS=4.26; SD=0.895) were the dominant barriers affecting the progression of transport infrastructure investment in Johannesburg. More so, the findings indicated that insufficient/incompetent revenue collection streams (MIS=3.82; SD=0.687), poor public investment frameworks (MIS=3.81; SD=0.950), poor alignment of national and regional priorities (MIS=3.70; SD=0.798) and unconducive investment environment

(MIS=3.64; SD=0.772) had fair impact on the progression of transport infrastructure investment in Johannesburg.

These findings clearly indicate that political interference play a pivotal role towards the progression of transport infrastructure investment, this includes collusions and corruption activities taking place between politically connected individuals/entities. More so, these findings clearly show that without clear and flexible government investment policies in the South African infrastructure development the country will continue to experience economic decline, these findings are well in agreement with the World Bank (2006) and KPMG (2010) that the economic growth of any developing and developed country immensely depend on the development of infrastructure, particularly in the form of flexible investment policies. The central government is expected from these findings to play a leading role towards a progressive transport infrastructure development, institutions such as the South African National Roads Agency Limited (SANRAL), are also expected to provide innovative solutions to the deteriorating development of transport infrastructure in South Africa. These findings continue to reveal that the major issue of government orientated initiatives is poor alignment of national, provincial, regional, parastatals, and local government, and this was in agreement with the City of London and Execution Noble (2012), CDIA (2010), Rodrigue (2013) and Della (2014), the study shared that without government competency or capacity there will always be lack of transparency and accountability within government spheres. Each sphere of government has their own distinct programme of works that is not aligned to the other sphere, this is caused by incompetency and poor managerial skills by the executives appointed.

These innovative solutions should include the establishment of business models to recover the expected user charges and tariffs. Communities that are less fortunate should be excused from such initiatives, however strict measures should be put in place to manage, evaluate and monitor the existing transport infrastructure facilities. In addition to the business model initiatives, another appalling barrier experienced towards the progression of transport infrastructure investment is poor public investment framework, this type of framework should be followed by key performance indicators that will determine the success or failure of such initiatives. The findings are also in agreement with Kutoane (2014) that inflexible infrastructure regulatory and poor policy frameworks will always and continuously act as a barrier towards the progression of transport infrastructure investment. World Economic Forum (2015) shared that it is of utmost importance to have performance indicators to determine or even benchmark the success or failure of infrastructure development, as a result Global Competitiveness Index (GCI) and Logistics Performance Index (LPI) were established in that regard, the findings of this study revealed the importance of benchmarking, which was well in agreement with Ojala and Celebi (2015).

Table 1. Barriers affecting transport infrastructure investment

Barriers	MIS	SD	R
Political interference	4.84	0.368	1
Cost overruns	4.72	0.621	2
Lack of funding	4.61	0.852	3
Difficulty in raising finance	4.58	0.755	4
Lack of financial capacity	4.42	0.806	5
Lack of experienced project promoters	4.39	0.863	6
Technical skills has to be imported	4.37	0.950	7
Poor and costly tendering and procurement procedures	4.36	0.948	8
Contract cancellations	4.33	1.120	9
Lack of infrastructure maintenance capacity	4.32	0.815	10
Frequent delays in licensing and permitting	4.26	0.895	11
Shortage of private sector investors	4.11	1.043	12
Policy frameworks are not finalized in time	3.89	0.920	14
Poor revenue collection methods	3.83	0.697	15
No capital market sources of long term funding	3.82	0.687	16
Poor public investment framework	3.81	0.950	17
Regional/cross-border projects endure high cost of preparation	3.74	0.981	18
Lack of alignment with national and regional priorities	3.70	0.798	19
Poor investment climate	3.64	0.772	20
Tariffs do not cover costs	3.42	1.224	21

5. Conclusion

This study determined prominent barriers affecting the progression of transport infrastructure investment in South Africa. Using a survey approach, the study revealed barriers affecting transport infrastructure investment. Based on the findings, the study concludes that political interference, cost overruns, lack of funding, frequent delays in licensing and permitting projects, poor policy frameworks and insufficient and incompetent revenue collection streams are prominent barriers affecting the progression of infrastructure development, particularly transport infrastructure investment. It is therefore recommended that the central government plays a leading role towards the progression of transport infrastructure, this begins with the eradication of corruption, incompetency, maladministration and misalignment of programs within different spheres of government. Misalignment begins initially from failing to align national and regional strategies of transport infrastructure development. Executives that are politically motivated to degrade the advancement of transport infrastructure should be held accountable. Additionally, the capacity of the state should be expanded to cater for mega-projects to alleviate barriers affecting the complete delivery of transport assets, this should also include accelerating the processes of licensing and permitting the construction, maintenance and rehabilitation of expressways, national highways, state highways and major district roads, so as to enable movement of trade of goods and services. Based on the findings, initiatives to include the private sector to assist with technical skills towards infrastructure planning and financing should be incorporated, this includes amendment or establishment of competent revenue collection streams for provided services. With the assistance from the private sector the public is guaranteed socio-economic benefits through the transportation sector. Like the World Bank and World Economic Forum has done this study recommends that the South African government based on the attributes of this country develops a benchmarking index that will determine a complete progression of transport infrastructure development, the indexes should also be relative to the economic growth of South Africa.

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Culture, Bank Supervision, and Investor Protection: Evidence from Financial Crisis

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Abstract

This study examines whether two important behavioral attributes, religiosity and linguistic distance (from the English language), are considered by the investors to value bank equity prices during the time of a global financial crisis. We further test whether the level of bank supervision and investor protection could nullify the equity pricing consequence of these two behavioral attributes, based on the premise that in the presence of strong supervision and investor protection, behavioral factors' influence on stock price could be trivial. Using a comprehensive sample of global banks, we observe that both religiosity and linguistics are considered by investors to value bank equity during a financial crisis, and neither supervision nor investor protection could impact the equity valuation of religiosity and linguistic distance.

Keywords: Investor protection, culture, bank supervision, financial crisis, equity valuation, religiosity, linguistic.

1. Introduction

Prior studies investigate the role of several economic factors considered to be responsible for the financial crisis during 2008–09, for example, subprime mortgages, a vulnerable financial system with complex financial securities, extensive dependence on short-term funding markets, international trade imbalance, high corporate and consumer debt levels, and lack of adequate regulation and supervision. In addition to the combined effect of some or all of these factors, it is likely that the cultural attributes of a country have contributed to the country's financial crisis; however this issue did not get much attention of the academic community. This is surprising given that a large body of literature maintains that cultural attributes such as religiosity, and linguistic difference are linked with economic performance of business enterprises (e.g., Barro & McCleary, 2003; Callen et al., 2011; Hillary & Hui, 2009; Husted, 1999; Khatri, Tsang, & Begley, 2006; Getz & Volkema, 2001; Pirouz & Graham, 2010).

Behavioral research in economics and finance suggests that psychological and sociological factors can have an impact on stock price variability (Shiller et al., 1984; Summers, 1986; Shefrin & Statman, 1993; Morrin et al., 2002; Chang & Dong, 2006).¹ In addition, several studies document a systematic association between societal norms and financial attributes such as bank performance (Kwok & Tadesse, 2006) and stock trading behavior (Grinblatt & Kelohaju, 2001). Our study extends this research stream by examining the differential impact of religiosity and linguistic distance on the market valuation of bank equities, and how their impact varies according to the level of bank supervision and the investor protection regime in different countries.

First we conjecture that religion could influence the cost and benefit calculus that underpins important strategic decisions made by bank managers. Executives and other employees are more likely to live in or near a community and are likely to be linked to cultural values (Guiso et al., 2006). Therefore, corporate culture can reflect values of the community, for example, the community's tolerance level of undesirable behavior. Guiso et al. (2006) and Barro and McCleary (2003) use religion as a proxy for cultural value of a society, and show that stronger religious beliefs are associated with relatively less unethical management decision making and a higher rate of economic growth. This line of argument leads us to suggest that managers of banks located in a religious community are more prone to engage in better ethical practices, and are less likely to undertake opportunistic actions to serve their own interest at the expense of other

¹ An example of this is momentum, which is embedded in positive and serial correlations in stock prices. Another such example is herding. From a social psychology perspective, a herd-like mentality may influence stock price valuations (Shefrin & Statman, 1993; Shiller et al., 1984).

stakeholders. Based on these arguments, we predict a negative association between religiosity and bank equity prices.

We further conjecture that linguistic distance could explain the variation in bank stock returns in a financial crisis situation. In English-speaking countries, bank managers and firm CEOs share limited information, mostly financial in nature. However, because of stronger ties between bank management and other parties, a bank manager is more likely to assemble nonfinancial information on a more personal level. This type of information would help the manager to make better loan decisions and protect equity holders' wealth (West & Graham, 2004). In fact, West and Graham (2004) document a positive association between linguistic distance from the English language and management's better decision making. However, English-speaking countries have more mature and stronger capital markets than their non-English-speaking counterparts, and in these countries many investors focus on too many additional details, which might restrict managers' extending loans only to creditworthy parties (Nishbett, 2003). Therefore it is possible that shareholders' wealth is less susceptible to management's expropriation in English-speaking countries.

Many scholars contend that strong investor protection and supervision can effectively preserve bank wealth (e.g., Barth et al., 2004, 2013; La Porta et al., 2000, 2002, 2008; Klapper & Love, 2002). For example, it is argued that strong investor protection, an important mechanism of corporate governance, can play a crucial role in providing greater security of bank owners' wealth in a financial crisis situation, as legal protection of outside investors makes expropriation technology less effective (La Porta et al., 2008). In the absence of strong protection of investor rights, managers and controlling shareholders can more easily expropriate minority investors' wealth. As a result, proper investor protection mitigates these agency conflicts and helps preserve depositors' investment in banks. For example, well-protected investors can discipline insiders, for example, by replacing bank managers and enforcing contracts designed to limit insiders' private control benefits (La Porta et al., 1998; Nenova, 2000; Claessens et al., 2002; Dyck & Zingales, 2002). We suggest that strong investor protection is likely to mitigate the effect of culture on bank equity. In the presence of strong investor protection, managers are less likely to exhibit unethical practice, such as not financing unprofitable ventures, which would serve their own interests at the cost of shareholders' wealth. If bank investors are protected by stronger investor protection rules, linguistic distance and/or religiosity might have smaller valuation implications for stock prices.

Academics have conflicting views on the efficacy of bank supervision in preserving bank shareholders' wealth. On the one hand, supervision is likely to enhance bank performance and stability. In some countries, banks suffer from severe problems of information asymmetries that could be mitigated by healthy supervision (Barth et al., 2004). On the other hand, assigning too much power to supervisors can negatively impact bank performance. Supervisors sometimes exploit their power to support politicians by letting them access valuable bank funds, in which case politicians may misallocate bank capital for political gains (e.g., Shliefer & Vishny, 1998; Dkankov et al., 2002; Barth et al. 2004). In the presence of strong supervision, bank managers are likely to have limited scope to make self-serving decisions irrespective of the culture. Therefore, strong supervision may make bank investors feel protected, in which case they are likely to place considerable weight on supervision and less weight on cultural attributes such as linguistics and religion while evaluating bank performance.

To test our conjectures, we use a sample of 3,487 bank-year observations for 1,687 banks from 38 countries for the crisis period 2008 to 2012, and conduct multivariate regression analysis with excess stock returns as the dependent variable, and various societal norm and regulation attributes, as well as interactions between societal norms and regulation variables as the explanatory variables of interest. We employ Hofstede's cultural dimension variables such as power distance, individualism versus collectivism, masculinity versus femininity, and uncertainty avoidance (UA), in addition to several firm characteristic variables such as firm size, market-to-book ratio, leverage, and net operating income as control variables. Our analyses show that banks in more religious societies sustained less share price loss in the financial crisis situation. This paper is of academic and regulatory interest for several reasons. This research is the first of its kind to demonstrate that the two important cultural attributes—religiosity and linguistic distance—are priced positively by bank equity holders on a global basis. Additionally, it shows the pricing consequence of these cultural factors in the presence of regulatory attributes such as bank supervision and investor protection. This study is organized as follows. In the next section, we discuss prior studies and develop our hypotheses, followed by the sections on research design; data sources, sample, and descriptive statistics and correlation statistics; and results. In the final section, we include concluding remarks.

2. *Prior Studies and Hypothesis Development*

Linguistic Distance

West and Graham (2004) and Nisbett (2003) maintain that language is an important ingredient of culture, and it influences people's thought process and social interactions. English is more focused on information than relationships. For instance, in the Spanish and Chinese languages, there are multiple words for the second person (e.g., *tu* and *usted*, and *ni* and *nin*, respectively), and in these languages, the level of intimacy between two persons is determined by the usage of one word for second person instead of the other. However, English ignores such social context, and simply uses *you* in all types of relationships. Further, while English is mainly used to transfer information, the Japanese language promotes building and maintaining relationships (Hodgson et al., 2007). When a Japanese banker talks to the CEO of a smaller firm that is controlled by the bank, both parties would be concerned about the exchange of financial information; however, they would also consider the quality of their interpersonal relationship transmitted through their relationship-oriented language. On the other hand, when a U.S. bank manager communicates with the CEO of a company, they are more likely to focus on just financial information (Nisbett, 2003). Therefore, while in Japan, financial transactions involve interpersonal relationship-disseminated words through the use of an indirect and imprecise linguistic style, in the United States or the United Kingdom, communication is made through the more structured English language, and the executives do not exchange much information beyond economic performance. In this spirit, we can argue that the loan decision by a Japanese bank manager could be more informative compared to his or her U.S. or UK counterparts. In fact, West and Graham (2004) established a strong positive association between linguistic distance from English and management's better decision making. Furthermore, if linguistic distance influences thinking patterns, it may very well influence individual decisions such as investment decisions.² However, based on Nisbett's (2003) findings that English-language speakers put too much focus on details compared to other language speakers, one might argue that English-speaking individuals can make better investment decisions by analyzing all available details compared to their non-English-speaking counterparts, who might get an ambiguous picture of the organization's performance. Moreover, English-speaking countries are relatively more resourceful, and have more mature capital markets compared to their non-English-speaking counterparts. In the context of these arguments, we predict the association between linguistic and bank stock prices in null form as follows:

Hypothesis 1: There is no association between linguistic distance (distance from the English language) and bank share prices in a period of financial crisis.

Religiosity

The recent financial crisis raised important issues concerning the ethical responsibilities of the corporate sector. Religion can play a major role in establishing moral and ethical values of the corporate sector, and thus mitigate management's self-serving behavior. The interfaith declaration (1993) maintains that shared moral, ethical, and spiritual values of different religions may potentially improve corporate ethics. The findings of Grullon et al. (2010) support this view by showing that firms headquartered in more religious countries are subject to fewer class action securities lawsuits, lower opportunistic earnings management behavior, less option backdating, and less unreasonable compensation. Brammer et al. (2007) find that religious individuals, in general, value corporate social responsibilities (CSR) more than their nonreligious counterparts, and they suggest that more religious people are likely to exhibit greater concern for ethical and discretionary components of CSR. A growing body of empirical research establishes a positive relationship between religiosity and ethical values in the economics and business context (e.g., Angelidis & Ibrahim, 2004; Guiso et al., 2003; Ibrahim & Angelidis, 1993; Miesing & Preble, 1985; Smith & Oakley, 1999; Terpstra et al., 1993) and in managerial attitudes and decision making (Agle & van Buren, 1999; Kidwell

² Nisbett (2003) presents evidence supporting the notion that language learned influences thinking. In an experiment, they had Americans and Japanese look at the same picture and explain what they saw. "Americans start out with describing an object ('There was a big fish, maybe a trout moving on the left') whereas Japanese sentence starts with the context and topic rather than jumping immediately to a subject as is frequently the case in English" (pp. 157–158). American parents focus on teaching children clear, context-independent definition of words, whereas Japanese parents' teaching on language is often ambiguous and highly context dependent. This observation indicates that structures of respective languages learned influence the processes of thinking (West & Graham, 2004).

et al., 1987; Longenecker et al., 2004). These studies, in general, show that religious managers make more ethical decisions and are more committed to fulfill their corporate social responsibility (CSR).

If greater religiosity implies more adherence to religious ethics and values, we expect that management's unethical behavior would be subsided by religiosity. All religions have some common attributes, which could be best capsulized in the ideas of the "Golden Rule." The main aspects of the Golden Rule are (a) "Treat others as persons of rational dignity like yourself"; (b) "Extend brotherly or sisterly love to others, as you want them to do to you"; (c) "Treat others according to moral insight, as you would have others treat you"; (d) "Do to others as God wants you to do to them" (John 14: 34). Managerial literature persuasively argues that values defined by the Golden Rule can be used to establish a foundation for viewing companies as responsible to various stakeholders in the society (Donaldson & Preston, 1995; Evan & Freeman, 1998; Trevino & Nelson, 1995). In summary, these arguments claim that managers belonging to more religious societies are more prone to fulfill corporate social responsibilities than those with fewer religious values. In the backdrop of these arguments, we anticipate that bank managers operating in more religious countries are more likely to work hard to preserve shareholder value. In this situation, it is quite likely that investors would value religiosity positively while estimating the intrinsic value of bank share prices. Accordingly, we predict the relationship between religiosity and bank share prices in the following alternative hypothesis:

Hypothesis 2: There is a positive relationship between religiosity and bank share prices in a period of financial crisis.

2.1 Interaction among cultural attributes, investor protectionism, and bank supervision

The second stage of our research deals with examining whether investor protectionism and supervision impact the valuation consequences of cultural attributes, that is, linguistic distance and religiosity, during the financial crisis.

Supervision

There are conflicting arguments on the efficacy of supervision on improving bank performance. Some scholars contend that it is always desirable to grant more power to bank supervisors. Inadequate monitoring leads to suboptimal bank performance and threatens bank stability. Strong supervision can protect banks from such market failure. Furthermore, many countries impose deposit insurance schemes, which motivate bank managers to undertake excessive risks and reduce depositors' incentives to monitor bank performance. Under such circumstances, supervision can prevent management's excessive risk-taking behavior and improve bank performance. Finally, in some cases, the presence of severe information asymmetries in banks may cause a socially harmful bank run. Supervision in such situations can play a major role in ensuring bank stability (Barth et al., 2004).

However, another school of thought contends that supervision actually harms bank performance and stability. Research suggests that supervisors might use their powers to benefit their favored politicians by financially supporting their costly political campaigns (Shliefer & Vishny, 1998; Dkankov et al., 2002; Barth et al., 2004). Under these circumstances, supervisors would act corruptly, which would negatively impact bank share prices. From a different point of view, Boot and Thakor (1993) advance their arguments against bank supervisions inspired by the agency problem between taxpayers and supervisors. Boot and Thakor establish a model based on the self-serving nature of bank supervisors when supervisors' ability to monitor banks is questionable. Their model indicates that bank supervisors would make socially suboptimal decisions, which negatively impact bank shareholders' wealth.

The above discussion suggests if investors value bank supervision either positively or negatively, the interaction between supervision and culture could have an incremental valuation implication. However, if investors stay neutral with respect to supervision, the interaction between supervision and cultural attributes would not have any incremental valuation consequence. We therefore do not make any directional hypothesis about the effect of bank supervision and express our prediction in null form as follows:

Hypothesis 3: Bank supervision does not impact the pricing of linguistic distance and religiosity in a financial crisis.

Investor Protection

Investor protection is a major element of corporate governance (La Porta et al., 2000). In the absence of strong investor protection, managers and controlling shareholders (i.e., the insiders) are in a better position to expropriate external shareholders' wealth. Business enterprises in a weak investor protection country are characterized by higher agency costs. When external shareholders purchase a bank's stock, they may run the risk of losing their investment. In a low investor protection economy, there is a greater possibility that return on investments would never be materialized, and insiders can expropriate bank wealth in different ways; while in some cases they might simply steal profits, in other cases they sell products, assets, or additional securities to other firms they own at below-market prices. Expropriation could also take place in the form of diversion of corporate opportunities, such as hiring family members in important managerial positions or overcompensating executives (La Porta et al., 2000). Generally speaking, expropriation of wealth is linked to the agency problem, which Jensen and Meckling (1976) describe as consumption of "perquisites" by managers. Strong outside shareholders' rights—in the form of rights to receive dividends on a pro-rata basis, to participate in shareholder meetings, to vote for directors, to sue managers or other insiders for suspected expropriation, or to call for extraordinary shareholder meetings—can restrain managers from engaging in such self-serving practices.

It follows from the aforementioned arguments that in an economy with strong investor protection, even less religious and thereby less ethical bank managers are constrained from exhibiting self-serving behavior, in fear of antagonizing outside shareholders, who, under extreme circumstances, have the right to call for extraordinary meetings and dismiss the managers. That is to say, in the presence of strong investor protection, the impact of religiosity on bank stock price could be minimal. Further, difference in linguistics could become very trivial to investors while valuing bank stocks, when they feel protected, based on the assumption that the type of association between bank loan officers and borrowers—oriented by the language of their country of residence—would play a very minor role in determining whether bank managers are able to extend finance to unworthy parties. However, if external investors do not have much faith in the investor protection mechanism of a country, they are likely to value culture more, by assigning inconsequential weight on the investor protection.³ In light of these arguments, we assert that in the presence of strong shareholder protection, how investors perceive cultural attributes constitutes an interesting empirical question. We form our next hypothesis in null form as follows:

Hypothesis 4: Investor protection does not impact pricing of linguistics and religiosity in a financial crisis.

3. Research Design

We use the following model to examine the relation between different cultural attributes and annual excess return:

$$\begin{aligned} \text{ABN_RET} = & A_0 + A_1 \cdot \text{LING_IND} + A_2 \cdot \text{HH_RELIG} + A_3 \cdot \text{PDI} + A_4 \cdot \text{IDV} + A_5 \cdot \text{MAS} + A_6 \cdot \text{UAI} + A_7 \cdot \text{LN_GDP} \\ & + A_8 \cdot \text{MB} + A_9 \cdot \text{LEVERAGE} + A_{10} \cdot \text{LN_ASSTS} + A_{11} \cdot \text{NOI} + \text{COUNTRY FIXED} + \text{YEAR FIXED} + \varepsilon \end{aligned} \quad (1)$$

The variables have been defined in Panel A of Table 1.

We define the variables in detail in Panel A of Table 1. The variables of interest are LING_IND and HH_RELIG. A positive (negative) statistically significant coefficient would indicate a positive (negative) equity pricing consequence and vice versa. The following two models are used to examine the pricing consequence of interactions of supervision and investor protection with cultural attributes, respectively.

$$\begin{aligned} \text{ABN_RET} = & \Delta_0 + \Delta_1 \cdot \text{LING_IND} + \Delta_2 \cdot \text{HH_RELIG} + \Delta_3 \cdot \text{SUPERV} + \Delta_4 \cdot \text{LING_IND} \cdot \text{SUPERV} + \\ & \Delta_5 \cdot \text{HH_RELIG} \cdot \text{SUPERV} + \Delta_6 \cdot \text{PDI} + \Delta_7 \cdot \text{IDV} + \Delta_8 \cdot \text{MAS} + \Delta_9 \cdot \text{UAI} + \Delta_{10} \cdot \text{LN_GDP} + \Delta_{11} \cdot \text{MB} \\ & + \Delta_{12} \cdot \text{LEVERAGE} + \Delta_{13} \cdot \text{LN_ASSTS} + \Delta_{14} \cdot \text{NOI} + \text{COUNTRY FIXED} + \text{YEAR FIXED} + \varepsilon \end{aligned} \quad (2)$$

In the above model, the joint statistical significance of the sum of linguistics and interaction of linguistics and supervision ($\delta_1 + \delta_4$) would indicate that bank-supervised linguistics has a pricing consequence.

³ For example, in a low investor protection economy, even though the company law of the country dictates that minority shareholders have the right to vote in director selection meetings, in reality, sometimes they are not allowed to exercise such rights.

Similarly, a statistically significant value of $(\delta_2 + \delta_5)$ would mean that religiosity when interacted with supervision is valued by bank equity holders during the period of financial crisis.

$$\begin{aligned} \text{ABN_RET} = & \Phi_0 + \Phi_1 * \text{LING_IND} + \Phi_2 * \text{HH_RELIG} + \Phi_3 * \text{INVST_PROT} + \Phi_4 * \text{LING_IND} * \text{INVST_PROT} + \Phi_5 \\ & * \text{HH_RELIG} * \text{INVST_PROT} + \Phi_6 * \text{PDI} + \Phi_7 * \text{IDV} + \Phi_8 * \text{MAS} + \Phi_9 * \text{UAI} + \Phi_{10} * \text{LN_GDP} + \\ & \Phi_{11} * \text{MB} + \Phi_{12} * \text{LEVERAGE} + \Phi_{13} * \text{LN_ASSTS} + \Phi_{14} * \text{NOI} + \text{COUNTRY FIXED} + \text{YEAR FIXED} + \\ & \varepsilon \end{aligned} \quad (3)$$

Like the previous model, the coefficients of interest are $(\varphi_1 + \varphi_4)$, and $(\varphi_2 + \varphi_5)$, and their statistical significance would indicate how investor protectionism could impact the pricing consequences of the interaction of linguistics and religiosity with investor protection.

4. Concluding Remarks

This study investigates whether two important cultural attributes, religiosity and linguistic distance (from English), are priced in bank equity at the time of a financial crisis. Additionally, we examine whether bank supervision and shareholder protection can impact the valuation consequence of religiosity and linguistic distance. Based on the premise that the economic and political scenarios of developed and developing economies vary considerably, we further test whether the impact of these two cultural attributes and their interactions with supervision and shareholder protection differ across developed and emerging countries. No study to date tests the market valuation of religiosity and linguistic distance during a time of financial crisis. The uniqueness of this research further lies in the fact that this is the first of its kind to empirically test the equity pricing of the interaction between cultural attributes and two important shareholder wealth preservation mechanisms—supervision and investor protection.

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Inflation Targeting and the UIP Puzzle – Do Central Bank Announcements Matter?

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Abstract

This paper investigates the validity of UIP by testing for the effect of central bank announcements on the cointegration relation between the exchange rate and interest rate differentials for inflation targeting and non-inflation targeting countries. Using an error-correction mechanism we find that central bank announcements can lead to short run exchange rate deviations from UIP. We establish that announcements by inflation targeting central banks only cause UIP deviations if they are related to the inflation targeting fundamentals and it is announcements by non-inflation targeting central banks which are the more predominant cause of UIP deviations. This insight is of importance to central banks in order to be able to manage their communications more effectively.

Keywords: UIP Puzzle, Inflation Targeting, Macroeconomic Announcements, International Finance, Exchange Rates

1. Introduction

The uncovered interest rate parity (UIP) puzzle has been extensively assessed by the literature in international finance over the past three decades. The parity, which is an arbitrage condition of the exchange rate and cross-country interest rate differentials, is an important component of most exchange rate determination models (Sarno, 2005). Classical open economy models such as the monetary model rest their properties on the assumption that UIP is a permanent condition in international markets. However, the assumption of UIP as a continuous phenomenon has largely been rejected by the empirical literature in the field (Chinn and Meredith, 2005).

An understanding of whether and when UIP holds is important for researchers to comprehend the shortcomings of fundamental exchange rate determination models in order to be able to accurately determine and predict the relationships between the underlying economic variables. The validity of UIP is also of importance to policy makers when using the interest rate as a monetary policy tool in order to correctly assess the effects of interest rate changes on international capital flows and other economic variables (Jaramillo and Servan, 2012). Particularly, since exchange rates are an important integral component of monetary policy decision-making, inflation targeting central banks need to be aware of the impact of their policies and policy announcements on UIP in order to reduce the impact on the inflation targeting regime.

Most of the literature on UIP reject the hypothesis in the short run (see Engel, 1996; Sarno and Taylor, 2003; Banerjee and Singh, 2006) and in some cases even in the long run (Lothian, 2016). The literature has adopted various methodologies to investigate the validity of the parity amongst which cointegration methods are the most frequently used. The advantage of cointegration models is that they circumvent the limitations of estimation methodologies which solely evaluate long run relations between variables. The error correction framework investigates the effect of shocks on the UIP equilibrium and allows us to decompose the shock impact into temporary and permanent components (Jaramillo and Lozano, 2012). A temporary or permanent misalignment of the exchange rate with interest rate differentials is important for central banks to formulate appropriate monetary policy decision in support of their overall policy objective.

While the validity of UIP itself has been tested in a number of contexts, only limited research thus far has attempted to establish causes for the failure of UIP. One of these yet unexplored factors is the impact of central bank announcements on deviations from UIP. While the effect of central bank announcements on the exchange rate path and volatility has been investigated in a separate large strand of literature, announcements have not been considered an explanatory factor of UIP deviations in the context of inflation targeting.

Such an investigation would be of interest to the central bank in particular is how their monetary policy actions and communications influence the formation of expectations in the economy. Central bank communications and in particular announcements have the ability to affect expectations related to inflation rates, interest rates or the exchange rate, which in turn can influence the future path of these fundamentals themselves (Eusepi and Preston, 2010).

In this study we use an approach which allows us to test whether UIP holds conditional on monetary policy communications in order to gain valuable insights into the monetary policy transmission mechanism (Kiley, 2013). We join the large number of papers adopting cointegration frameworks to investigate this and show that central bank announcements are indeed a cause of short run deviations from UIP.

However, we find that announcements by non-inflation targeting countries tend to be a more predominant cause of UIP deviations than announcements by inflation targeting countries. For inflation targeting countries, deviations from UIP occur only in response to announcements regarding the interest rate or the inflation rate, but not both. The other observable difference is in the speed of convergence to equilibrium, which is faster for exchange rates including the GBP. These findings have implications for policy makers in understanding how expectations regarding the regime are formed in response to central bank communications and how these affect underlying economic parameters. Central banks need to consider the timing and content of announcements in order to ensure economic stability.

The remainder of this paper is organised as follows: section 2 presents the existing literature in the field, section 3 outlines the methodology and data used for the empirical estimation, section 4 discusses the results and section 5 concludes.

2. Literature

The theory of UIP states that, under perfect capital mobility, increases in cross-country interest rate differentials lead to a depreciation in the high interest rate currency given international risk neutrality. The nominal exchange rate depreciation offsets any potential excess returns from changes in interest rates and therefore eliminates any international capital market arbitrage opportunities. The classical UIP relation postulates that the interest differential is an unbiased predictor of the expected future change in the exchange rate. This concept assumes forward market efficiency:

$$f_t^{t+1} - s_t = \alpha + \beta(i_t^* - i_t) + \vartheta_t \quad (1)$$

where s_t is the log of the nominal exchange rate, f_t^{t+1} is the log of the forward rate at time t for the subsequent period, i_t^* and i_t are the foreign and domestic interest rates respectively and ϑ_t is a time-varying risk premium. This original equation, postulated by Fama (1984), assumes efficient capital markets and rational expectations. Theoretically, under rational expectations and given risk neutrality, UIP is defined by the following equation:

$$\Delta s_{t+1}^e = \alpha + \beta \tilde{i}_t + \varepsilon_t \quad (2)$$

where $\Delta s_{t+1}^e = s_{t+1}^e - s_t$ is the expected change in the nominal exchange rate, $\tilde{i}_t = i_t^* - i_t$ is the cross-country interest rate differential and ε_t is a standard error following a white noise process.

When estimating the ex-post UIP relation empirically, this becomes:

$$\Delta s_t = \alpha + \beta \tilde{i}_{t-1} + \varepsilon_t \quad (3)$$

where $\Delta s_t = s_t - s_{t-1}$ is the ex-post change in the nominal exchange rate and \tilde{i}_{t-1} is the lagged interest rate differential.

Tests for UIP itself are considered to be more appropriate than tests of forward market efficiency, since the forward rate does not feature as a frequent component in either theoretical models or real inflation-targeting policies such as Taylor rules (McCallum, 1994).

Empirically, the assumption of UIP as a long run condition has been rejected by most of the literature (Sarno, 2005). The original definition of UIP proposed by Fama (1984) states that in order for relative interest rate increases to result in an exchange rate depreciation the slope coefficients of the regression of the exchange rate on interest rate differentials needs to be positive unity. General tests of this proposition

often find insignificant slope coefficients and thereby the failure of interest differentials to explain exchange rate depreciations (Taylor, 1987). Moreover, some more recent papers report significant but negative slope coefficients in the UIP regression which means that increases in interest rate differentials cause an appreciation of the exchange rate rather than a depreciation (Chaboud and Wright, 2005; Itskhoki and Mukhin, 2017). Other tests of UIP against the random walk hypothesis often fail to reject the latter as a more suitable determinant of exchange rate depreciations (see Huisman and Mahieu, 2007).

General tests of cointegration confirm the validity of UIP in the long run, albeit not necessarily in the short run (Juselius, 1991). Other papers using multivariate cointegration and vector error correction models in this context highlight the differences between short and long run effects, providing evidence for UIP in the long run due to the existence of a stationary time-varying risk premium (Johansen and Juselius, 1992). Only few papers report additional validity of UIP in the short run. Most papers report speeds of adjustment following a deviation from the parity equilibrium of up to one year (Banerjee and Singh, 2006). In general, the persistence profile of the UIP relations has a high speed of convergence to equilibrium with about 90% of deviations being adjusted within the next period (Pesaran and Shin, 1996). Jaramillo and Servan (2012) combine an investigation of the UIP puzzle with a function for PPP for the Peruvian economy and find that UIP is cointegrated with the PPP equation.

Edison and Pauls (1993) who use error-correction models to investigate cointegration between real exchange rate and real interest rate differential, but are unable to find a long run relationship between the two. Potential reasons for the absence of a cointegrating relationship have not yet been investigated. We use a similar approach to the authors but include central bank announcements into an error correction framework and we find evidence for a cointegrating UIP relationship with short run deviations caused by central bank announcements. Despite the somewhat inconclusive and contradicting results obtained in the empirical literature, cointegration and error-correction models are regarded as highly suitable to investigate the UIP puzzle due to their separate short run and long run properties. Overall, the failure of UIP has been so persistently observed in the empirical literature, it is now regarded a stylized fact (Lothian, 2016). Although the question of whether UIP holds has been extensively investigated to date, only a small number of studies have attempted to identify causes explaining the occurrence of the UIP puzzle.

While UIP has generally been assessed for various countries, only few contemporaneous papers have been devoted to investigating the parity condition in inflation targeting regimes. According to Blinder *et al* (2008) inflation targeting regimes exhibit a lower uncertainty environment than non-inflation targeting regimes. This is due to the existence of perfect knowledge which drives expectations in the regime. Given this less adverse expectational environment, it is worthwhile investigating whether UIP holds more consistently or that deviations from UIP are corrected for more quickly in inflation targeting regimes than non-inflation targeting regimes. Under inflation targeting, precise central bank communications about monetary variables, monetary policy strategy and the inflation target are of high importance and it is necessary that monetary policy actions are reflective of these communications (Eusepi and Preston, 2010). The literature in international finance which investigates communications and economic announcements primarily focuses on the effect of scheduled and unscheduled news on the exchange rate path and volatility (Jansen and de Haan, 2005). The potential role of economic announcements as an explanation for the UIP puzzle has been neglected so far.

3. Methodology

Our empirical estimation of the role of central bank announcements in explaining the UIP puzzle is outlined below. Firstly, we compute the UIP implied exchange rate according to equation (3). The computed exchange rate represents the equilibrium exchange rate value which satisfies the UIP condition.

Next, we use Johansen cointegration tests to investigate the existence of a long-run relationship between the exchange rates and the interest rate differentials for inflation targeting versus non-inflation targeting countries. We test for unit roots in the series using Augmented Dickey Fuller Generalised Least Square tests (Elliott *et al*, 1992). The maximum lag length is chosen according to the Schwert criterion. The results reported in table 1 below indicate that all interest rate and exchange rate series are $I\sim(1)$.

Table 1: Dickey Fuller Unit Root Test

Variable	Test Statistic	
	Level	First Difference
GBPUSD	-1.392	-68.224***
GBPEUR	-1.529	-65.721***
GBPCAD	-2.219	-69.798***
USDEUR	-1.832	-68.354***
USDCAD	-1.596	-71.345***
EURCAD	-2.971	-68.161***
UK-US Interest Differential	-1.175	-21.412***
UK-Canada Interest Differential	-1.437	-23.807***
UK-EU Interest Differential	-1.118	-22.376***
Canada-US Interest Differential	-1.778	-13.007***
Canada-EU Interest Differential	-1.543	-4.531***
US-EU Interest Differential	-1.375	-8.147***
*** significant at 1% level H_0 : variable contains a unit root H_1 : variable is stationary		

Since all variables are integrated of order 1, we test for cointegrating vectors using the Johansen maximum likelihood cointegration rank tests (Johansen, 1991). We find one cointegrating vector for all relationships, suggesting that UIP holds in the long run (see table 2). Having established the long-run relationship, we use vector error-correction models to assess any short run deviations from UIP. The Johansen-Juselius cointegration model does not assume UIP *per se* but presupposes the tendency of UIP fundamentals to react to UIP deviations by adjusting to the UIP equilibrium over time (Johansen and Juselius, 1992). This proposition makes the model most suitable for the estimation in this paper. The model assumes the existence of an error correction mechanism and differentiates between short run and long run effects, which are estimated through maximum likelihood estimation:

$$\Delta x_t = \rho_1 + \theta_1 (ecm_{uip})_{t-1} + \delta_1 \Delta s_{t-1} + \delta_2 \Delta \bar{i}_{t-1} + \sum_{i=1}^3 \beta_i d_{it} + \sum_{i=1}^3 \gamma_i d_{it}^* + u_t \quad (4)$$

where Δx_t is the change in the UIP implied exchange rate, ecm_{uip} represents the error correction term, Δs_{t-1} is the change in the nominal bilateral exchange rate for the two countries from $t-1$ to t , $\Delta \bar{i}_{t-1}$ is the change in the cross-country interest rate differential from $t-1$ to t , θ is the speed of adjustment parameter on the previous period's disequilibrium between the exchange rates and interest differentials. d_{it} and d_{it}^* are the dummy variables representing domestic and foreign central bank announcements respectively. We allow the announcement variables to enter the model exogenously in the form of a shock to the cointegration relation between the UIP implied exchange rate and the explanatory variables.

Once shocked, cointegrated variables are anticipated to return to a state of equilibrium determined by the values of the endogenous variables in the model. Cointegrated variables should react similar to shocks due to their common underlying stochastic trends (Granger and Yoon, 2002). An interesting question posed by the literature is whether cointegrated variables respond together to all types of shocks. We go beyond the conventional assessment of shocks to the cointegrating system by specifying the type of shocks and exogenously including them into the vector error correction framework. The shocks enter the system in the form of country-specific central bank announcement variables. Our methodology in computing these builds on the work by Jansen and De Haan (2005) by grouping central bank event data into several announcement variables. Announcements of interest rate changes are recorded in d_1 , announcements related to inflation and inflation targeting in d_2 and announcements related to any monetary policy decisions in d_3 . d_1 comprises of two variables, the first being a dummy which takes the value of 1 if the central bank announces an interest rate change and 0 otherwise. To form the variable d_1 , the dummy is integrated with a variable recording the size of interest rate change announced by the central bank and reflects the direction of change in the sign. The announcement that the interest rate remains unchanged is also recorded in d_1 . d_2 takes the value of 1 if there is a central bank announcement or statement

regarding the inflation rate or the inflation targeting regime. d_3 takes the value of 1 if the central bank makes a monetary policy decision or statement other than changes to the interest rate or inflation rate.

3.1 Data

We use daily data on interest rates, nominal exchange rates and central bank announcements for the period from 1st January 2005 until 31st December 2017. The data were obtained for the UK, the US, Canada and the EU and the corresponding interest rates are the Bank of England base rate, the FED funds rate, the Bank of Canada interest rate and the European Central Bank interest rate respectively. The UK and Canada are classified as inflation-targeting countries, while the US and the EU are classified as non-inflation targeting countries (Jahan, 2012).

4. Results and Discussion

The Johansen cointegration test results in table 2 confirm the existence of one cointegrating vector for all exchange rate and interest rate relations, evident in the significant eigenvalues and trace statistics rejecting $H_0: r = 0$ against $H_1: r = 1$. This indicates that there is a long run cointegrating relationship for all exchange rates and interest differentials, which means UIP holds in the long run.

Table 2 Johansen Cointegration Test

Null	Alternative	Eigenvalue	Critical Value 95%	Trace	Critical Value 95%
GBPUSD – UK US Interest Rate Differential					
r=0	r=1	703.05**	15.67	704.79**	19.96
r≤1	r=2	1.74	9.24	1.74	9.24
GBPEUR – UK EU Interest Rate Differential					
r=0	r=1	641.99**	15.67	645.44**	19.96
r≤1	r=2	3.45	9.24	3.45	9.24
GBPCAD – UK Canada Interest Rate Differential					
r=0	r=1	748.40**	15.67	753.27**	19.96
r≤1	r=2	4.86	9.24	4.86	9.24
USDEUR – US EU Interest Rate Differential					
r=0	r=1	268.29**	15.67	272.02**	19.96
r≤1	r=2	3.73	9.24	3.73	9.24
CADUSD – Canada US Interest Rate Differential					
r=0	r=1	508.33**	15.67	511.19**	19.96
r≤1	r=2	2.85	9.24	2.85	9.24
CADEUR – Canada EU Interest Rate Differential					
r=0	r=1	474.05**	15.67	483.27**	19.96
r≤1	r=2	9.22	9.24	9.22	9.24
** significant at 5% level					
r denotes the cointegration rank and number of significant vectors. We use the Osterwald-Lenum critical values.					
The significant eigenvalue and trace statistic for $H_0: r = 0$ versus $H_1: r = 1$ exceed the critical value at the 5% significance level, which confirms one cointegrating vector for all relationships.					

Table 3 Johansen Cointegration and Error Correction Model Results

	GBPUSD	GBPCAD	GBPEUR	USDEUR	CADUSD	CADEUR
Short run deviations						
β_1	-0.0854	-0.0211	-0.581	-0.148	0.129*	-0.219***
	(0.397)	(0.364)	(0.373)	(0.137)	(0.0757)	(0.0740)
β_2	0.535*	0.670***	1.030***	-0.187	0.383	-0.253
	(0.275)	(0.251)	(0.257)	(0.240)	(0.416)	(0.407)
β_3	-0.0955	0.0757	0.357	-0.468***	0.120	-0.0907
	(0.273)	(0.250)	(0.258)	(0.134)	(0.110)	(0.108)
γ_1	-0.489	-0.0934	0.923**	-0.731***	0.0428	-0.0372
	(0.329)	(0.268)	(0.455)	(0.201)	(0.0847)	(0.122)
γ_2	2.855***	-3.166**	2.032**	-1.224***	0.543***	-0.310
	(0.572)	(1.478)	(0.927)	(0.413)	(0.148)	(0.250)
γ_3	3.312***	-0.244	2.013***	-0.901***	0.653***	-0.138
	(0.321)	(0.391)	(0.351)	(0.157)	(0.0827)	(0.0939)
Adjustment to long run UIP						
Intercept:						
ρ_1	0.000410***	0.000649***	0.000255***	0.000400***	0.000153**	0.000429***
	(0.000116)	(0.000138)	(7.89e-05)	(5.79e-05)	(6.61e-05)	(5.09e-05)
Autoregressive coefficients:						
δ_1	0.0159	-0.00704	0.0530***	0.0147	-0.0427***	0.0311**
	(0.0144)	(0.0144)	(0.0144)	(0.0144)	(0.0144)	(0.0144)
δ_2	9.92e-05	4.88e-05	-6.31e-06	-0.000126	-0.000121	2.08e-05
	(6.53e-05)	(8.07e-05)	(4.59e-05)	(0.000125)	(0.000148)	(0.000362)
Adjustment coefficient:						
θ_1	0.000116***	-0.000212***	-8.21e-05***	6.37e-05***	4.66e-05***	6.73e-05***
** significant at 5% level, *** significant at 1% level. Standard errors in parentheses.						
Representations are based on the model with the following equation specifications:						
$\Delta x_t = \rho_1 + \theta_1(ecm_{uip})_{t-1} + \delta_1 \Delta s_{t-1} + \delta_2 \Delta \bar{i}_{t-1} + \sum_{i=1}^3 \beta_i d_{it} + \sum_{i=1}^3 \gamma_i d_{it}^* + u_t$						
θ is the transition coefficient representing the speed of adjustment to equilibrium. The cointegration rank is 1 and the ECM has a lag order of 1.						

The results in table 3 show that only some central bank announcements cause exchange rate deviations from UIP. The β_1 and γ_1 coefficients show the effect of announcements of interest rate changes on UIP deviations. The β_2 and γ_2 coefficients indicate how UIP deviations are affected by announcements related to the inflation rate while the β_3 and γ_3 coefficients show the effect of announcements related to monetary policy decision other than interest rate and inflation rates on deviations from UIP. In summary, announcements of interest rate increases or decreases only lead to UIP deviations when they are released by the Canadian or European central banks. All central bank statements related to the inflation rate and inflation targeting overall have a high magnitude impact on UIP deviations. Announcements about monetary policy other than to do with inflation targeting and interest rate changes only causes UIP deviations when they originate from non-inflation targeting central banks.

The magnitude of effect of announcements on UIP deviations varies between different countries' central banks. The release of an announcement causes UIP deviations with a magnitude of between 0.1 and 3 standard deviations. These occur either in the form of a larger than expected depreciation of the exchange rate or an appreciation instead of a depreciation. Announcements of interest rate increases by inflation

targeting central banks lead to a stronger than expected depreciation only if paired with announcements related to the inflation rate and monetary policy from a non-inflation targeting central bank (like in the CADUSD case), otherwise it leads to an UIP deviation by appreciating the exchange rate (like in the CAEUR case).

The majority of announcement types generate a positive deviation from UIP, which means that the exchange rate depreciates more in response to an announcement than how much it is expected to depreciate according to the value of the interest differential. This is the case for Bank of England announcements as well as announcements by non-inflation targeting countries for bilateral exchange rates against an inflation targeting country. Negative deviations are common for announcements by non-inflation targeting countries and are observable for the case where both countries are non-inflation targeting. The negative deviation represents an exchange rate appreciation in response to an announcement which is contrary to the expected exchange rate depreciation according to the value of the interest differential.

The exchange rate deviates from the current interest differential to account for the announced monetary policy change, reflecting the expectation of a future interest rate adjustment by the central bank (Gürkaynak *et al*, 2010). This is consistent with the theoretical understanding of the UIP equation, which postulates that high interest rate currencies tend to depreciate while low interest rate currencies tend to appreciate. The announcement pre-empts the expectation of a future change in the interest rate which has an immediate effect on the exchange rate (Faust *et al*, 2007). Therefore, announcements influence interest rate expectations in accordance with the inflation targeting framework. Expected future changes in interest rates can lead to anticipations of changes in the inflation rate and therefore result in exchange rate movements factoring in the expected changes (Johnson, 2002). In summary, both positive and negative announcements cause a deviation from UIP by influencing expectations about future interest rates.

The value and sign of adjustment coefficient θ shows that adjustment occurs within the next period only for the GBPCAD and GBPEUR exchange rates, but for others there is a further divergence from the long run equilibrium. The additional exchange rate divergence can be related to an overshooting mechanism which persists over more than one period, while the adjustment process to equilibrium is initiated by the interest rate in the period immediately following the announcement. The asset price behaviour of the exchange rate in reaction to the announcement causing large exchange rate movements could explain the occurrence of such deviations and the absence of adjustment (Jansen and De Haan, 2005).

Interestingly, it is announcements by non-inflation targeting central banks which have larger and more consistent effects on deviations from UIP than announcements by inflation targeting central banks. These results mean that exchange rate deviations from UIP are less reactive to inflation targeting central bank announcements about the underlying parameters which define the targeting regime, namely the inflation rate and the interest rate. However, deviations are responsive either to interest rate announcements or inflation announcements by inflation targeting countries, but not to both simultaneously. UIP deviations are more sensitive to announcements by non-inflation targeting countries if they contain information about monetary policy decisions unrelated to the interest or inflation rates. The exception are European central bank announcements about interest and inflation rates which are a cause of UIP deviations.

5. Conclusion

In this paper we have aimed to fill a current gap in the UIP literature by assessing the UIP puzzle for inflation targeting countries. Having adopted a Johansen cointegration and error correction framework including central bank announcements as shock variables, we find that announcements are responsible for short term exchange rate deviations from UIP.

We find that the type and direction of UIP deviation depends on which central bank the announcement originates from and the type of exchange rate itself. Only for exchange rates between two non-inflation targeting countries do central bank announcements lead to UIP deviations in the form of an appreciation of the exchange rate. If at least one or both countries are inflation targeting, announcements lead to UIP deviations in the form of a larger than expected depreciation of the exchange rate in relation to the value of the interest differential. Announcements by inflation targeting central banks only lead to deviations from UIP when their content is concerning either the interest rate or the inflation rate, but not both. When the content of the announcement is related to other monetary policy matters, only those announcements of non-inflation targeting central banks trigger deviations from UIP. Our findings suggest that expectations are primarily reactive to inflation targeting central bank announcements if they are related to the underlying inflation targeting parameters.

We find that the adjustment speed is higher for currency pairs which feature the GBP, which suggests that the Bank of England has shorter time lags between announcement and implementation of monetary policy. We suggest that central bank transparency in communication and managing expectations can influence the persistence of UIP deviations.

The results provide important insights into the relationship between central bank announcements and deviations from UIP. Our contribution is twofold: firstly, we assessed causes for the UIP puzzle in both the short and the long run by extending existing cointegration estimations to include central bank communications as an explanatory factor. Secondly, we found that the UIP puzzle can partially be explained by central bank announcements, although UIP deviations are more reactive to announcements by non-inflation targeting central banks.

Since we establish that announcements can lead to UIP deviations, central banks need to consider managing communications more effectively in order to control the effects on expectation formation in the economy. General awareness of central banks about the impact on monetary policy requires to adapt not only the timing of announcements but more importantly the content of the communication.

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Islamic Finance for SMEs: Past, Present and Future Direction

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Abstract

Small, and medium enterprises (SMEs) constitute a major part of economies around the world both at developed and developing countries. According to the World Bank Group formal SMEs contribute up to 60% of employment and 40% of National Income (GDP) in emerging economies. However, access to finance is still a big problem for SMEs, more than 50% of SMEs don't have access to formal credit. This financing gap is even bigger when adding informal and micro enterprises, more than 70% of micro, small, and medium enterprises (MSMEs) lack access to credit in emerging markets. In the developing economies the credit gap reached to US\$2.1 to US\$ 2.6 trillion.

Islamic finance as an alternative way of finance other than the conventional finance, has a greater opportunity to fill the credit gap for SME's in emerging economies at the Middle East, Asia, Africa, and globally. Since Islamic banking and finance institutions has the economic and social development objectives as part of their overall banking philosophy, it is possible that Islamic finance can play a major role in entrepreneurship finance, innovation finance, SMEs finance, financial inclusion, poverty reduction and economic development.

Therefore, the objective of this paper is to identify the past trend, the present situation, and the future direction of Islamic finance for SME's locally, regionally, and globally.

The data gathered and analyzed from internationally published reports for the period 2000 up to the present time. The research paper concludes with recommendations for Islamic banking and finance institutions around the world regarding SMEs financing.

Keywords: Islamic finance, SMEs, Economic Development, Entrepreneurship, Poverty Reduction.

1. Introduction

Small and Medium Enterprises (SMEs) constitute a major part of economies around the world both at developed and developing countries. According to the World Bank Group formal SMEs contribute up to 60% of employment and 40% of National Income (GDP) in emerging economies. According to Ernst & Young Megatrends 2015, making sense of a World in motion report, it identified entrepreneurship as a raising trend that will shape the future of work in the world.

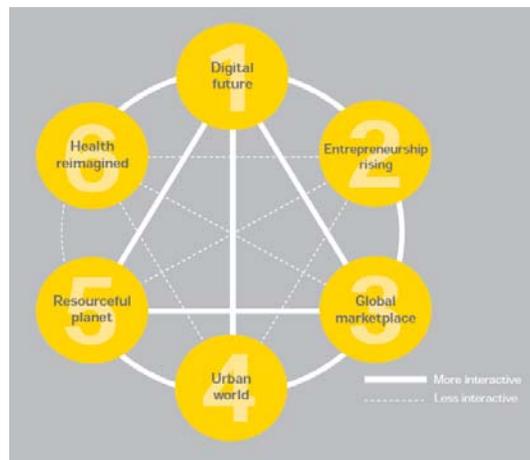


Figure 1: Entrepreneurship as a raising trend

Source: E&Y Report 2015.

The Ernst & Young Megatrends 2015 Report, also indicated that nearly 50% of the World's entrepreneurs are youth between the ages of 25 to 44 years. Moreover, female entrepreneurs are increasing in number around the world to nearly 126 million women are launching or operating a new business in 67 economies globally.

Nowadays, small and medium enterprises (SMEs) are widely recognized as one instrument factor for sustainable on economic growth in all countries, including in the Middle East and North Africa (MENA) region. SMEs play a vital component in creating the opportunity for employment either skilled or unskilled workers in many sector mainly in manufacturing and service sector. Globally SMEs approximately contributed to 43.5 percent of total employment and are responsible for 57.8 percent of total new jobs created. In Asia, more than 98% of SMEs with total employment around 62% and contribute to GDP for 42%. In MENA region, SMEs contribute to GDP more than 42% and total employment around 49% (MIFC, 2016). Access to finance is still a big problem for SMEs, more than 50% of SMEs don't have access to formal credit. This financing gap is even bigger when adding informal and micro enterprises, more than 70% of micro, small, and medium enterprises (MSMEs) lack access to credit in emerging markets. In the developing economies the credit gap reached to US\$2.1 to US\$ 2.6 trillion.

In the last decade, Islamic finance has greater opportunity to facilitate access to finance for SMEs. As stated by Islamic Finance Development report in 2018, shows that the global Islamic finance asset around 2.4 trillion US\$ in 2017, mostly from Middle East and South and Southeast Asia. In Saudi Arabia, note up to 90% of SMEs are only looking for sharia compliant banking services. Meanwhile, when the net is widened to include Iraq, Pakistan, Yemen, Saudi Arabia, Jordan, Tunisia, Morocco Lebanon and Egypt around 35% of SMEs are discouraged from borrowing due to the lack of Islamic finance option.

This is a gap that Islamic finance can be addressed. Islamic finance emphasizes partnership financing, which useful in developing access to finance especially for small and medium businesses. In addition, Islamic finance risk sharing features and strong link of credit means it is well-suited for SMEs and startup financing which can promote inclusive of growth. Therefore, the objective of this paper is to identify the past trend, the present situation, and the future direction of Islamic finance for SME's locally, regionally, and globally.

2. Research Methodology

This study employed a descriptive manner and mostly extract from secondary data from different journals, magazines, annual report of Islamic finance and other related studies in this regard. Thus, these relevant and authentic source for the data and references can help us to infer conclusion which useful for future researches. The data gathered and analyzed from internationally published reports for the period 2000 up to the present time.

3. SMEs Overview

The impact of small and medium-sized enterprises (SMEs) on the performance and future prospects in the economy of a nation is one of interest issue among the policymakers at locally, regionally and globally. This reveals the fact that SMEs create most chance of firms and major sources of employment in most countries. As stated by Sogorb-Mira (2005), SMEs proved to be main role for boosts the economy and also generates employment. On the other hand, Lu and Beamish (2001) added that SMEs as the main factor of globalization among different countries. Since the financial crisis 2008, SMEs in particular small firms give huge contribution for the growth of employment and the rationale behind the better concern on the performance of SMEs become clear (International Trade Centre, 2015).

According to International Trade Centre (2017), SMEs constitute up to 90% of the world's firms and around 70-80% from the total of employment especially in the developing countries. The term of SMEs have been defined in different way across globs such as capital and income of enterprise, level of development, employment and geographic region (Cunningham, Li and Chris, 2008). For instance, European commission mentioned that the definition SME as a company which employs less than 250 persons. Meanwhile, if a company have less than 10 workers considered as micro organization. Similarly, if company has between 10-49 workers can be called as small company whereas if has 49-249 workers refer as medium sized.

SMEs provide a large portion of employment from the majority of firm in the world. In most countries, SMEs contribute up to 45% of total employment and 33% of GDP (Kumar, 2017).

Figure 1 represents more than 50% of total net employment creation can be attributed to firm with fewer than 100 employees for both developed and developing countries. In south Asia, the total share

based on SMEs is close to 100%. It indicates that larger firm with more than 100 employees contribute a portion of job growth. Meanwhile, in the countries which net job losses, the small firms show as a net positive job growth rates. For example in Ethiopia, the relative growth of employment comes out from the smallest firm (6% for firms with 10 to 19 workers) (ILO, 2013). In Tunisia, firm analysis between 1996 and 2010 contribute 55% of total net employment growth from firms with fewer than 100 employees and 73% for firm less than 100 employees. (Aga, Francis & Meza 2015).

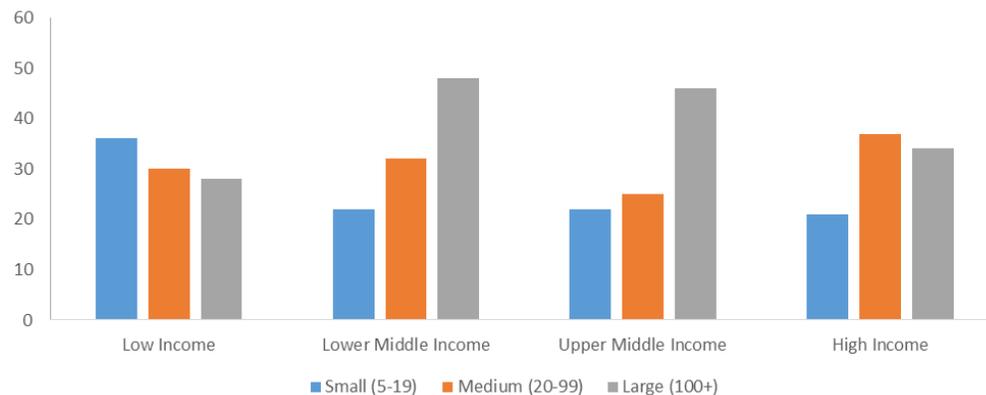


Figure 2: SME Percentage Contribution to Employment Growth (by income groups)
Sources: Ayyagari *et al.*, (2016)

4. Problems Faced by SME Sector

SMEs across the world are facing many problems especially in developing countries such as inadequate infrastructure, limited access to finance, lack of human skilled resources, insufficient of access to market and the limited access to technology. The most challenge for SME is limited access to finance. Failure in financial markets, due to asymmetric information and agency problems will impact on the limitation access to credit for SMEs as well as may lack the expertise needed to produce financial statement (OECD, 2017). Thus, it needs to be addressed more thoroughly by policy makers to correct these failures. Credit constraint is the main barrier to formalization and develop of SME especially in mid and low-income countries. On the other hand, the charged of interest rate can affect the higher credit risk in SMEs. Nevertheless, the access on bank credit will remain focus for SME in the year to come. In spite of recent improvement, access to finance remains problematic particularly for credit constraints and it became problematic in many economies. Generally, even the credit condition improved, but still remain tight on average. Moreover, many financial institutions continue to deleverage and, due to tightened regulatory requirements, this will likely impact small businesses disproportionately. Furthermore, lack of skill, poor internal management practices and low level of training for employees are one problem faced by SME. As mentioned by OECD (2016d) that SMEs have higher lack of skills and weak for training per employee than large firm. Mostly, SME faces problem in attracting and retaining highly qualified of staff skill and difficulties on identify workers with sought-after skills in market labor. Lack of investments in this area also limits the uptake of digital technologies and their effective use to improve productivity and access markets. Poor management practices considered as shortage on the structure of corporate governance especially for family enterprises. In some cases, management limitation are compounded by financing constraints, small markets for business transfer, regulatory hurdles and administrative with tax burdens. Thus, it need concern from policy makers in many countries, particularly where the population of entrepreneur going rapidly.



Figure 3: Challenges Hampering Islamic SMEs and MSMEs
Source: Joint World Bank-IDB Policy Report 2015

5. Islamic Banking Opportunities for SMEs

Islamic finance as an alternative way of finance other than the conventional finance, has a greater opportunity to fill the credit gap for SME's in emerging economies at the Middle East, Asia, Africa, and globally. According to Ernst & Young World Islamic Banking Competitiveness Report 2016, Islamic banks assets grew by 16% annually from 490 US\$ Billion to 882 US\$ Billion in five years period from 2010 to 2014, moreover, it is expected that the total asset will reach US\$ 2.0 trillion by 2020.

Since Islamic banking and finance institutions has the economic and social development objectives as part of their overall banking approach, it is very important that Islamic finance play a major role in entrepreneurship finance, innovation finance, SMEs finance, financial inclusion, poverty reduction and economic development. According to Dusuki (2008) that social and economic objectives of Islamic banks are considered as important as the financial objectives, since Islamic banks have social and economic development responsibilities towards their communities.

For the Islamic banks to be able to accomplish their social and economic objectives, they are expected to encourage equity financing modes such as; "*Mudarabah and Musharakah*", over the debt financing modes like; "*Murabahah*" (Farooq, 2015). However, in reality only less than 5% of financing modes of Islamic banks are equity based financing "*Mudarabah and Musharakah*" and 95% of the financing modes of Islamic Banks are debt based financing "*Murabahah*" (Suzuki & Uddin, 2016).

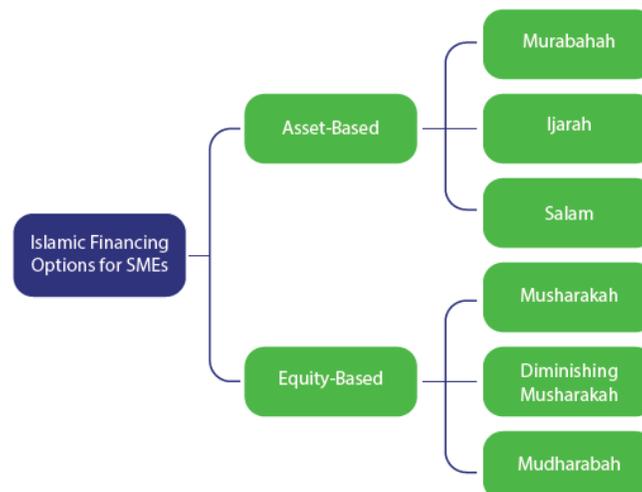


Figure 4: Islamic Financing Options for SMEs
Source: ISRA

There are advantages and disadvantages of equity financing and debt financing of Islamic banks. The advantages of *Murabahah* as a debt based financing are; the credit risk is transferred to the client, it keeps Islamic banks' liquidity levels high, however, the disadvantages of *Murabahah* are; it is delinked from the real economy activities, it has also limited contribution to the social and economic development of the community (Cebeci, 2012). The advantages of *Mudarabah* and *Musharakah* as an equity based financing are; they are embedded in the real economy sectors sharing the risks and the profits of the investments with the clients, thus contribute significantly to social and economic development of the community, more importantly, *Mudarabah* and *Musharakah* gives the opportunity to those who have skills but do not have capital to be able to implement their business ideas such as; youth, women, and farmers, conversely, the disadvantages of *Mudarabah* and *Musharakah* are; they are difficult to implement, they are considered to be low liquidity investments (Cebeci, 2012). Therefore, Islamic banks should focus more on equity financing modes such as; *Mudarabah* and *Musharakah* to be able to serve the financial needs of entrepreneurs and SMEs in Middle East, Asia, Africa, and globally.

The lack of SMEs financing for both conventional and Islamic banks has created a Credit Gap globally for SMEs in totally of 1,297 Billion USD according to a joined report by The World Bank Report and Islamic Development Bank (2015).

Table 1: SMEs Credit Gap in Selected G20 Countries

Country	Number of Enterprises (in thousands)	Total Credit Gap (US\$ billions)	Access to Finance as Major/Severe Barrier (%)
Argentina	2,133	67	34
Brazil	16,030	237	42
China	103,548	338	18
India	49,634	140	23
Indonesia	41,116	28	15
Korea	4,644	114	17
Russia	3,605	50	44
Saudi Arabia	1,843	237	42
South Africa	2,213	13	15
Turkey	4,120	73	20
Total	228,886	1,297	

Source: Joint World Bank Group-Islamic Development Bank G20 Islamic Finance Policy Paper, Leveraging Islamic Finance for SMEs, Istanbul, 2015.

This Credit Gap is the result of law penetration levels regionally and internationally and also due to the environment surrounding SMEs both regionally and internationally as well.

Table 2: Enabling Environment and Supply Side Analysis (Conventional SMEs Finance and Islamic SMEs Finance)

	SME Offering	Islamic SME Offering	Enabling Environment
Egypt	Low	Very low	Low
Pakistan	Moderate	Low	Medium
Saudi Arabia	Moderate	Moderate	High
Jordan	Low	Very low	High
Morocco	Moderate	Very low	Medium
Tunisia	Very low	Very low	Medium
Yemen	Low	Very low	Low
Iraq	Very low	Very low	Low
Lebanon	Low	Very low	Medium

Source: International Finance Corporation, Islamic Banking Opportunities across Small and Medium Enterprises in MENA, May 2014, p. 41

There are many obstacles faced by banks that limit the ability of both conventional and Islamic banks to offer finance to SMEs in the region as indicated by the International Finance Corporation Report (2016).

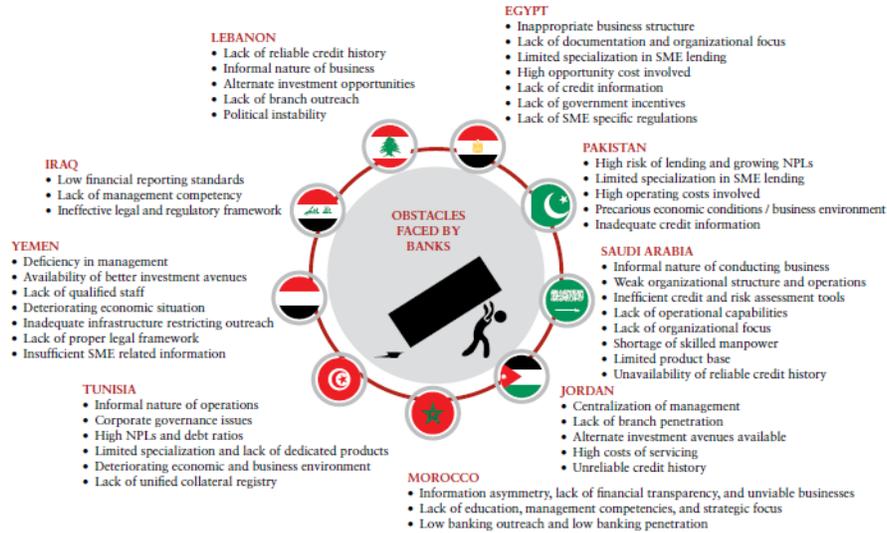


Figure 5: Obstacles Faced in SMEs Financing
Source: IFC Report 2016

In a closer look and analysis of the demand and supply side of Islamic SEMs financing in the region it shows a high preference for Shari'ah-Compliant products which creates big opportunities for Islamic banks for fill the funding gap in SMEs credit market.

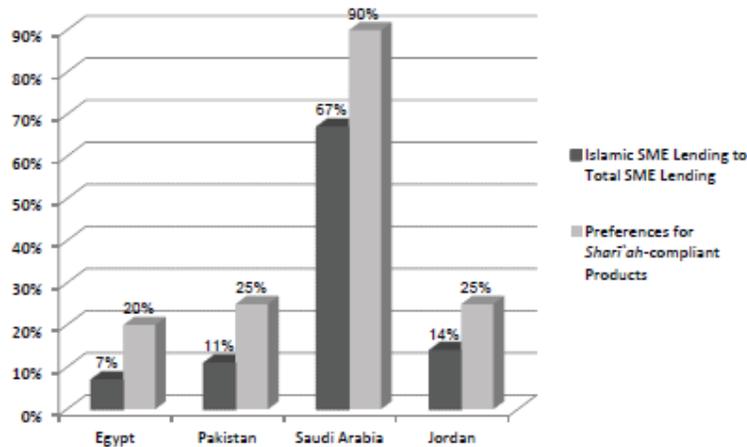


Figure 6: Demand and Supply Side of Islamic SMEs Financing
Source: International Finance Corporation, Islamic Banking Opportunities across Small and Medium Enterprises in MENA, May 2014; Joint World Bank Group-Islamic Development Bank G20 Islamic Finance Policy Paper, Leveraging Islamic Finance for SMEs, Istanbul, 2015

Based on the above mentioned statics and analysis, the Islamic SMEs funding opportunities in the region can be summarized as follow:

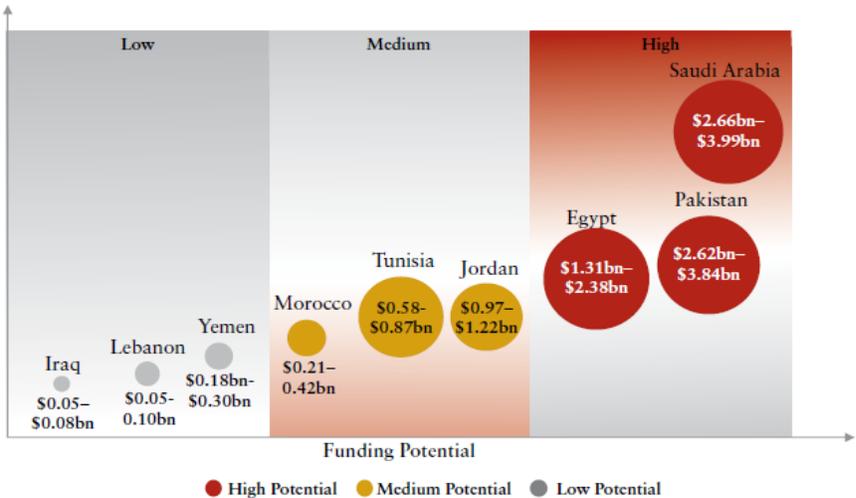


Figure 7: Comparative SMEs Funding Opportunities
Source: IFC Report 2016

6. Conclusion and Recommendations

The research paper concludes with recommendations for Islamic banking and finance institutions in the region and around the world to be able to close the SMEs financing gap and take this huge opportunity for the benefit of all parties; entrepreneurs, Islamic banks, local communities, and the region economies at large.

1. Supportive Entrepreneurial Ecosystem must be structured by the governments to create supportive environment for SMEs and Entrepreneurs.

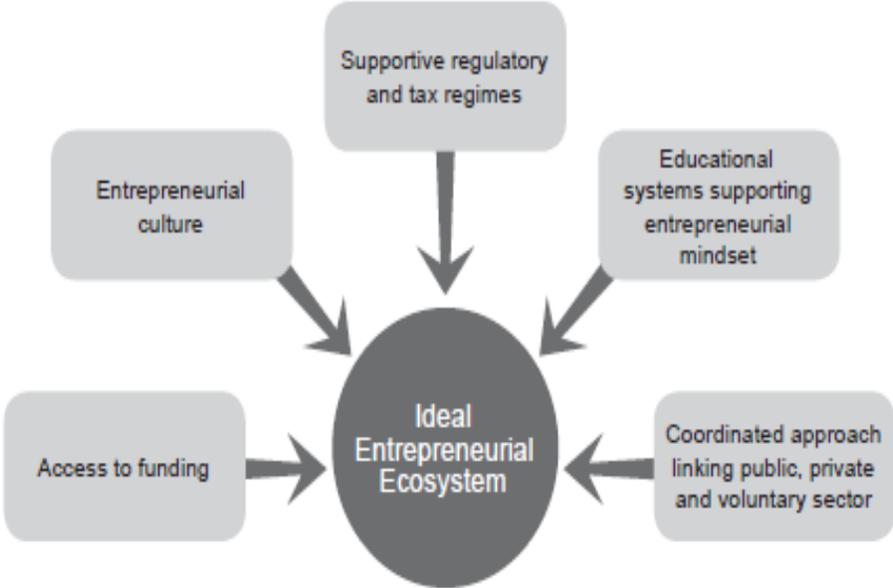


Figure 8: Ideal Entrepreneurial Ecosystem Pillars
Source: Ernst & Young, Megatrends 2015: Making Sense of a World in Motion, Ernst Young, 2015.

- Islamic banks should put in place a Strategy framework to provide specialized services for SMEs finance.



Figure 9: Proposed Strategy Framework for Islamic SMEs Banking
Source: IFC Report 2016

- Finally, many challenges at different levels have to be dealt with to enable Islamic banks to offer SMEs finance services and cover the credit gap in the region.

Therefore, there are some recommendation for Islamic finance to be more grow up for future.

- Create a SME Islamic finance forum platform, workshop and training for staff who works in Islamic financial institutions.
- The establishment for non-banking financial services which provides ijarah, mudarabah and musharakah
- Providing a legal framework for secured transactions and centralized sharia boards and issuance of guidelines.

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The Prominence of Publicly and Privately Funding Transport Infrastructure Projects in the Gauteng Province, South Africa: Appraisal of Financial Mechanisms

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Abstract

Infrastructure development has an impact on the development of any economy. Inadequate infrastructure investment excludes citizens from flourishing socially and economically, thus affecting the economic growth of the communities and the nation at large. Without funds to construct, maintain and rehabilitate infrastructure, citizens continue to struggle. The purpose of the study was to assess sources of financing transport infrastructure projects. A quantitative approach was employed, to select the construction professionals convenience sampling was adopted. A total of 130 questionnaires were sent and 100 were retrieved, representing a 77% response rate. The findings showed internal consistency with a Cronbach alpha value of 0.744. The retrieved data was analysed using Statistical computer software. The study revealed that infrastructure finance companies, bank financing, sales of public property, public-private partnerships and foreign direct investments were prominent sources of advancing transport infrastructure investment in the Gauteng Province. Based on the results the involvement of the private sector is eminent with regards to infrastructure planning, execution, operating and maintenance, this involvement requires flexible government policies and well governed provincial, regional and local governments, however, the central government remains the custodian of public infrastructure projects and needs to take a leading role towards infrastructure development. The limitations of the study include allocated time and cost to complete the study.

Keywords: Infrastructure development, transportation, socio-economic benefits, financing models, development agencies

1. Introduction

Infrastructure development is the most significant focus area for many countries. Effective infrastructure development boosts the economy of any developing and developed country (Uzuegbunam, 2005; World Bank, 1994). In Africa, financing infrastructure is one of the most important roles which the government and the private sector must execute in order to achieve economic growth. South Africa's most common source of infrastructure financing is taxation obtained from the citizens and private investors in the country. The South African government has been the main custodian of public infrastructure development, particularly transport infrastructure (Ruiters, 2013). Any developing country needs to provide means of transport and other infrastructure such as sewage systems, schools, parks, buildings and power systems (Alm, 2011) in order to improve and advance the livelihoods of its citizens.

Luke and Walters (2010) shares that the contribution of infrastructure is recognised on the impact it has on the economic growth and development of any developing economy. Furthermore, the study states that infrastructure plays two roles in any economy. Firstly, it functions as an intermediate good, which suggests that it facilitates the movement of labour, capital and other inputs to production, thus improving productivity and reducing costs (World Bank, 2011). It also increases information flows, opening new opportunities and reducing irregularities and other market inadequacies (Parvu and Voicu-Olteanu, 2009). Secondly, it functions as a final good, suggesting that the intake of infrastructure services improves quality of life through access to power, clean water, telephones, and serviceable roads and mass transit (Mahabir and Mabena, 2014), all providing people with greater movement and improved choice of service, and thereby advancing the wellbeing of the public.

Like any other infrastructure, transport infrastructure plays a significant role towards the growth of any economy (World Bank, 2011). In Romania majority of transportation is undertaken by the utilisation of roads and railways system, in 2010, 74% of goods were transported by roads, while only 14% of the goods were

transported using railways (Pogrletchi, 2014). The most re-cognisable benefit of the development of transport infrastructure is the improved reliability of traffic, which results in an enormous reduction of costs due to road accidents. Therefore, this study focused mainly on transport infrastructure, and sources of financing its development.

Over the years there has been a declining effort to adequately finance the development of transport infrastructure. The execution and financing of projects can be improved by enhancing private participation (Ehlers, 2014). Most private investors can only commit large sums of finance to infrastructure development if they can trust the legal and political procedures. Ehlers (2014) states that an increase in infrastructure financing must be obtained from private sectors, however government is also required to remain or continue to play a leading role in advancing infrastructure development (Makana Municipality, 2013). Barriers of providing adequate financing for public infrastructure which is faced by many governments in the developing countries include inflexible investment policies and poor governance. It is imperative that a developing country like South Africa attend to such issues if any international funding was to be made. The following section expands on international agencies and other sources required to finance the construction, operation, maintenance and restoration of infrastructure assets, transport infrastructure in particular.

2. Literature Review

The central government has solely been responsible for the advancement of infrastructure development in developing and developed economies (Mahabir and Mabena, 2014). This includes both infrastructure planning and financing. For infrastructure financing there are a lot of sources, models, institutions and mechanisms used to ensure adequate funding on the much needed infrastructure. As a result the study assessed prominent sources of financing transport infrastructure projects, particularly in the Gauteng Province, South Africa.

Calitz and Fourie (2010) reveal that there are various sources of financing infrastructure development, however not every method or model of financing available can be suitable for different forms of infrastructure. Owusu-Manu, Edwards, Uddin, Hudson and Haas (2013), Sinha (2014), Bothra (2011) and Ray (2015) were all in agreement that tax revenues, lenders to government (form of loans, guarantees), private investors (equity), development agencies and donors (grants) are key sources of financing infrastructure development, so as to ensure that there is adequate service delivery to different communities. Uddin *et al.*, (2013) also outlines that there are various forms of financing public infrastructure, this includes government budget, loans, donors and external support from international agencies, more so. Ray (2015) also shared that user charges, property taxes, general taxation, intergovernmental transfers and bonds were all government initiatives to accelerate service delivery through the financial advancement needed for infrastructure development.

Bothra (2011) discusses that for progressive infrastructure development, there needs to be reliable, resilient, sustainable and cost effective mechanisms that will finance the construction, operation, maintenance and restoration of infrastructure, the study continued to name the following sources as significant; public-private partnerships, bank financing, infrastructure finance companies, foreign direct investment, foreign institutional investors' investment, infrastructure bonds and infrastructure debt funds. The most prominent and key sources of financing infrastructure has to be government budget (revenue fund), driven from the Gross Domestic Product (GDP). The GDP comes as a result of taxes collected by the revenue services, for better prioritisation.

Amongst other sources of financing within the government budget, there are user charges. These are service fees which are mostly likely charged on a monthly basis, for services such as water use, toll charges on expressway or even electricity usage (Bahl and Bird, 2008). These charges are collected by revenue services. In addition to user charges the central government also collects charges known as property taxes, these charges are only for individuals or corporations that own property (National Treasury, 2014). Above all there is a fee charged on almost everything one can purchase, the fee is known as a general tax, the fee is charged on income, consumer goods and fuel. It is an obligatory levy made by public authorities for which nothing is received directly in return. Additionally, there are tariffs, known as the customs duties or taxes imposed by governments when goods are imported or exported (Inderst and Stewart, 2014). A rate is charged for all goods entering a country and vice versa.

In addition to taxes, there are grants from the central government provided to local governments, there are referred to as intergovernmental transfers, these are non-refundable payments made to municipalities when they can no longer be able to self-sustain for that particular medium-term budget (Owusu-Manu *et al.*, 2015; Alm, 2011). Provided that the intergovernmental transfers are not adequate to provide the much

needed service delivery municipalities are given an authority to borrow funds from financial institutions, however the municipalities have to be declared creditworthy to qualify for funding. Borrowing occurs when government has fully exhausted or exceeded its budget required for infrastructure development, the only thing that is left is to borrow capital from financial institutions, commercial banks, non-banking finance companies, insurance companies and the external commercial borrowings (ECB) (Bothra, 2011; Nataraj, 2014), in the form of loans. Calitz and Fourie (2010) discusses that governments obtain funds in the form of a loan from lenders or financial institutions to finance infrastructure. Most governments adopted this method of financing, since this appears to be a fair system to them when a lower rate of interest is being charged on the loan (Owusu-Manu *et al.*, 2015). When the required infrastructure asset is completed, as in the case of a highway, or a road, government places a toll fee for using the road and collect the proceeds to repay the loan. Normally the user charges pay off the debt servicing and the operational cost.

Brits (2010) expands on the fact that various spheres of government, and the state owned institutions often fail to sustain, operate and maintain the existing infrastructure facilities, as a result there needs to be other forms of mechanisms employed to rehabilitate the current state of these facilities, the study further elaborates that a pivotal solution to public funding is private sector investment – funding supplied through public-private partnerships and concessions. More so, Amoa-Gyarteng (2015) alluded to the importance of corporate finance – this happens when multiple or individual private companies provide funds for a specific project, for a return on investment. Helm (2010) shares that private sectors' involvement in infrastructure development is immensely important, since it is better at handling the construction as well as the operational risk.

There has been hesitation from the public sector to make the private sector a full custodian of infrastructure development (privatisation) in the past, as a result of failed privatisation of infrastructure facilities, and the national government failing to plan, finance, execute, operate, maintain and rehabilitate infrastructure facilities there has been calls for both government and private sector to merge (Cohen, Freiling and Robinson, 2012), known today as public-private partnerships. There has been successful projects carried out under the public-private partnership initiative (Rodrigue, 2013) over the years, and other infrastructure sectors are considering the full adoption of the initiative to minimise the load on the public sector, but sectors such transport are yet to realise public-private partnerships as an alternative model to advance infrastructure development.

Ray (2015) reveals that public-private partnerships are normally acknowledged as long-term cooperative institutional arrangements between public and private actors to achieve predetermined objectives. To complement the existing forms of financing, there has also been domestic and international donations made to finance the operation, maintenance and restoration of the existing infrastructure facilities (Chiloane and Aigbavboa, 2016). Donors made to infrastructure development, are usually voluntarily. These can be donations from domestic or even international institutions, for instance the United Nations as well as China make considerable donations to Africa's infrastructure development (Brits, 2010). These donations have been mostly on advancing or expanding the current water infrastructure facilities, this is to ensure that communities that are mostly affected by inadequate water supply are also granted the satisfaction.

Lastly, Maniar (2013) determined the importance of funding from international institutions, even with the hesitation from multiple states in Africa to receive funding from Western countries its importance cannot be over emphasised. The study shares that the World Bank, International Monetary Fund, African Development Bank (ADB) and Japan Bank for International Cooperation (JBIC) (Hall and Lobina, 2010) have made enormous and recognisable contribution to the development of infrastructure in Africa, this is shown in the Lesotho Highlands Water Project (LHWP), where the World Bank approved a loan (\$150 million) that will see Lesotho successfully supplying water to South Africa, in exchange for a hydropower system (Wentworth, 2013).

Other than the above mentioned sources of financing infrastructure there are also infrastructure finance companies (IFCs) (Sinha, 2014), this can be private domestic or international entities that have the required resources to finance the existing deteriorating infrastructure. Calitz and Fourie (2010) states that in addition to IFCs, there are also development agencies that offer government institutions loans on reasonable interests. Additionally, Nataraj (2014) states that the non-banking finance companies' funding infrastructure in India include the Power Finance Corporations (PFCs), the Rural Electrification Corporation (RECs), the Infrastructure Development Finance Company (IDFCs), the India Infrastructure Finance Company Limited (IIFCL), Larsen & Toubro (L&T) Infrastructure and the Industrial Finance Corporation of India (IFCI). While Sinha (2014) also revealed that the Indian government uses the following sources to obtain funds to finance infrastructure and these are considered the main sources of long-term financing; Banks, bond market, India Infrastructure Finance Company Limited (IICL) and long maturity tax-free infrastructure bonds.

3. Research Methodology

This study assessed prominent sources of financing transport infrastructure projects in South Africa. The study was undertaken in the Gauteng Province, particularly in the Johannesburg Metropolitan Municipality, and a quantitative method was adopted. The research instrument employed was a structured questionnaire with two sections, which was administered to construction professionals, including Engineers, Architects, Quantity Surveyors, Construction Managers and Project Managers, which most of these professionals were working for different construction firms and the Department of Infrastructure Development in Johannesburg CBD. The questionnaire had a five-point Likert Scale. Furthermore, a convenient sampling was adopted for selecting the construction professionals. The questionnaires were administered to 130 respondents, of which only 100 usable questionnaires were retrieved, representing 77% response rate, which might not be enough to generalise the proceedings within the Gauteng Province. Statistical Package for the Social Sciences (SPSS) statistical software was then used, to analyse the collected data, from which a Cronbach's alpha was generated to measure the internal consistency of the questionnaire. The questionnaire showed a reliability value of 0.744, which according to George and Mallery (2003) is adequate for the reliability of the questionnaire. Mean item scores and standard deviations of the variables were used to rank the level of agreement of the respondents on sources of financing transport infrastructure projects in the Gauteng Province.

4. Findings, Analysis And Discussions

4.1 Biographical Data and Results

The findings of the study indicated that out of 100 respondents that took part in the survey, 62% were male, while 38% were female. The respondents' age group indicated that 16% of the respondents were between the age group of 21-25 years old, 18% were between the age group of 26-30, while 31% of the respondents recorded were between the age group of 31-35 years old. More so, 18% of the 100 respondents were between the age group of 36-40 years old, 10% were between the age group of 41-45 years old, and only 7% were between the age group of 46-50 years old. The questionnaire administered had a section on ethnicity. The findings revealed that 41% of the 100 respondents were African, 22% were White, 23% were Coloured, while the remaining 14% of the respondents were Asian/ Indian. The study further determined the level of qualification obtained by the respondents. The findings indicated that 9% of the 100 respondents had a Higher Certificate, 32% had a National Diploma, 44% had a Bachelor's Degree, 12% had Master's Degree, and the remaining 3% of the 100 respondents had pursued a Doctorate Degree. The respondents' current employment position was next on the agenda. The findings showed that out of the 100 respondents that participated 13% were Consultants, 15% were Architects, 24% were Project Managers, 6% were Construction Managers, and 16% were Engineers, while the remaining 26% of the respondents were Quantity Surveyors. Lastly, the respondents' experience in their current positions were also determined. Thus, the findings revealed that 38% of the 100 respondents had experience of up to 5 years, 32% had experience between 6-10 years, 23% had experience between 11-20 year, and only 7% of the respondents had experience of more than 20 years.

4.2 Sources of Financing Transport Infrastructure

The study assessed sources of financing transport infrastructure projects in the Gauteng Province. The findings in Table 1 shows the ranking of the assessed sources in their descending order, which is according to their mean item scores. It is evident from Table 1 that infrastructure finance companies (IFCs) (MIS=3.82; SD=0.520), bank financing (MIS=3.80; SD=0.492), sales of public property (MIS=3.78; SD=1.040), public-private partnerships (MIS=3.77; SD=0.548), foreign direct investment (MIS=3.75; SD=0.783), domestic savings (MIS=3.74; SD=0.613) and development agencies (supplying loans) (MIS=3.72; SD=0.637) were rated amongst the prominent sources of financing transport infrastructure projects. More so, user charges (MIS=3.71; SD=0.656), equity (private investors)(MIS=3.60; SD=0.752), life insurance (MIS=3.60; SD=0.829), private sector investment (MIS=3.53; SD=0.745), general taxation (MIS=3.51; SD=0.772) and pension funds (MIS=3.51; SD=0.823) with a mean item score of over 3.5 were also amongst the prominent sources of financing transport infrastructure projects in the Gauteng Province. However, tariffs (MIS=3.27; SD=0.802), donors (MIS=3.25; SD=0.936), toll revenues (MIS=3.22; SD=0.596), bond market (MIS=3.13; SD=0.734), fines for traffic violations (MIS=3.11; SD=0.994), property taxes (MIS=3.01; SD=0.732) and transfers from

state/ provincial government (MIS=2.89, SD=0.898) were all less prominent sources of financing transport infrastructure projects in the Gauteng Province.

Mahibr and Mabena (2014) as well as Calitz and Fourie (2010) made emphasis on the importance of government being the main custodian of infrastructure investment, through government budget (taxes, tariffs, user fees). However, this is not reflected in the findings (Table 1) of the study, the findings endorses private financing, bank financing as well as foreign direct investments before the exhaustion of the revenue fund, the use of domestic savings was ranked fifth. In agreement with the findings Rodrigue (2013) and World Bank (2011) discussed the significance of private participation, on how this method of financing can literally accelerate infrastructure development in developing countries, the findings of this study were well in agreement in that regard of prioritising private financing for advanced infrastructure development. These findings were comparable to Helm (2010) and Hall and Lobina (2010) which revealed that user charges, property taxes, general taxation, public-private-partnerships, tax-investment financing, bonds and tariffs are amongst sources used for infrastructure development, more so, Calitz and Fourie (2010) and Ray (2015) agree with the findings that equity, debt, public sector, private sector, bond market, public-private partnership, cross-border public-private partnership and international infrastructure funds are amongst the recognised sources of transport infrastructure financing. However, Nataraj (2014) and Makana Municipality (2013) shared that domestic savings debt and public-private partnerships were prominent sources of financing transport infrastructure, which was contradicting the findings of this study that clearly indicated infrastructure companies, bank financing and sales of public property as prominent sources.

Table 1 Sources of financing transport infrastructure projects

Sources of Financing	Mis	Sd	R
Infrastructure finance companies (IFCs)	3.82	0.520	1
Bank financing	3.80	0.492	2
Sales of public property	3.78	1.040	3
Public-private partnerships	3.77	0.548	4
Foreign direct investment	3.75	0.783	5
Domestic savings	3.74	0.613	6
Development agencies (supplying loans)	3.72	0.637	7
User charges for the service involved	3.71	0.656	8
Equity (private investors)	3.60	0.752	9
Life insurance	3.60	0.829	9
Private sector investment	3.53	0.745	10
General taxation	3.51	0.772	11
Pension funds	3.51	0.823	11
Cross-border public-private partnership	3.38	1.052	13
Tariffs	3.27	0.802	14
Donors (grants)	3.25	0.936	15
Toll revenues	3.22	0.596	16
Bond market	3.13	0.734	17
Fines for traffic violations	3.11	0.994	18
Property taxes	3.01	0.732	19
Transfers from a state or province to a local	2.89	0.898	20

5. Conclusion

This study assessed prominent sources of financing transport infrastructure projects in the Gauteng Province, South Africa. The findings of the study revealed that sources of private financing or sources of financing other than government financing were more prominent for transport infrastructure projects, however according to the adopted likert scale this revealed that even with private financing not much has been achieved in terms of adequately funding transport infrastructure. Additionally, infrastructure finance companies (IFCs), bank financing, public-private partnerships and foreign direct investment were recognised as alternative sources of financing transport infrastructure projects, while tariffs, donors, bond market and state transfers were less prominent when it came to progressive transport infrastructure investment. Based on the results the study recommends that government policies are reviewed for reliability, transparency and accountability to allow more private participation towards infrastructure planning, execution, operation and maintenance. A more market oriented infrastructure environment to

attract investors (foreign direct investments) should be encouraged, which will have a direct impact on the economic growth of the country. Private financing encourages sufficient infrastructure investment that aids developed countries to achieve their full potential of economic growth, this includes creation of socio-economic opportunities, such as jobs.

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Proceedings of the International Conference on Innovation, Technology, Enterprise and Entrepreneurship

This proceedings contains 69 papers submitted by researchers from 16 countries around the globe into the International Conference on Innovation, Technology, Enterprise and Entrepreneurship (ICITEE). The conference was held under the Patronage of HE Dr. Majid bin Ali Al Nuaimi, the Minister of Education in the Kingdom of Bahrain, and organised by Applied Science University in collaboration with London South Bank University (LSBU), UK. The ICITEE served as an international and inter-disciplinary platform where academics and industry had the opportunity to explore emerging trends and address obstacles affecting innovation, technology and entrepreneurship.

The Editors

Professor Ghassan Aouad has been the President of Applied Science University since November 2014. He spent five years in the Department of Civil and Building Engineering of Loughborough University, where he obtained his MSc in Construction (1987) and his PhD entitled Integrated Planning Systems for the Construction Industry (1991). In 1992, Professor Aouad joined the University of Salford as a Research Fellow and progressed through to the role of Pro Vice Chancellor for Research and Innovation and Dean of the College of Science & Technology before he left in December 2011. During that time, he successfully supervised 24 PhD students, externally examined 52 PhD students, authored 3 major research books and co-authored one book, generated more than £10M in research funding as Principal Investigator and £8M as Co-Investigator, published 92 papers in top rated refereed journals, delivered more than 50 keynote speeches and invited lectures, and presented his work in more than 42 countries. In January 2012, he became President of the University of Wollongong in Dubai (UOWD) and in May 2013, he became Vice President for Academic Affairs at Gulf University for Science & Technology (GUST) based in Kuwait. Furthermore, Prof Aouad was appointed as Vice President of the Chartered Institute of Building (CIOB) in March 2010 and became President in June 2014 for a year. He is the first ever president with a Middle Eastern background. The Chartered Institute of Building is the world's largest and most influential professional body for construction management and leadership established in 1834 with a membership of 45,000 from across the globe. Professor Aouad sat on the REF 2014 (Research Excellence Framework) sub-panel 16: Architecture, Built Environment and Planning. In July 2016, Professor Aouad received an Honorary Doctorate of Technology from Loughborough University in the UK.

Professor Paul Ivey is Deputy Vice-Chancellor and Chief Business Officer and has LSBU group responsibility for Innovation: specifically campus development, enterprise, and global delivery. Educated at the Duke of York's Royal Military School, Professor Ivey began his career as an engineering apprentice and as a certificated sea-going marine engineer. He then studied at the University of Sussex, awarded BSc Engineering and Applied Science, and Doctor of Philosophy. After working as an aerospace design engineer in the US, he returned to the UK to research aero-engine thermo-fluid-mechanics: he authored over one hundred publications in journals, conferences and book chapters; supervised twenty-five Doctoral students securing £13.5M in research contracts and two aero-engine anti-icing patents. He was awarded the title Professor of Turbomachinery. During his career he has been a Research Fellow at the University of Sussex, Professor at Cranfield University, Head of School at the University of Hertfordshire, Executive Dean at Coventry University and Pro Vice-Chancellor at Birmingham City University. He was also elected County Councillor and twice selected as a Westminster Parliamentary Candidate. Currently he is a Governor at the Emirates Aviation University in Dubai, and Chair of the University of London's Military Education Committee.

Mrs Maryam Ali is the Office Manager of the Quality Assurance and Accreditation Centre at Applied Science University in the Kingdom of Bahrain. She is a "Bachelor in Banking and Finance" graduate from the University of Bahrain and is currently working on the thesis to complete her "Master in Business Administration" (specialty - Finance) at University of Bahrain as well. She was on the organizing committee of the International Conference for Sustainable Futures 2017 (ICSF) that was held in the Kingdom of Bahrain, and also contributed to preparing the proceedings of the ICSF 2017.

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