Methodology for BIM implementation in the Kingdom of Saudi Arabia

Abstract

Purpose – The Architecture, Engineering, and Construction (AEC) industry is considered the most effective contributor to development in the Kingdom of Saudi Arabia (KSA). However, the industry faces myriad challenges due to the vast construction development required for the KSA 2030 vision. Developed countries use Building Information Modelling (BIM) to mitigate these challenges and reap the benefits of implementing BIM to improve the performance of the AEC industry. However, BIM is rarely used in KSA. This study aims to develop a methodology to implement BIM in KSA by exploring stakeholders' perception of factors affecting the implementation.

Design/methodology/approach – BIM users and non-users were surveyed using a questionnaire and structured interviews. The proposed BIM implementation methodology was validated through a further survey and structured interviews with BIM experts.

Findings – This study proposes a six-step methodology to implement BIM namely; raising awareness; perceived benefits; AEC industry readiness and organizations' capability; identifying the barriers; removing the barriers; and defining the key factors influencing the implementation.

Practical implications – The proposed methodology is expected to assist project participants in KSA to implement BIM to solve current AEC industry issues, improve projects' performance and reap the benefits of implementing BIM.

Originality/value – This study makes a crucial contribution by providing a new methodology to implement BIM in KSA that motivates decision makers and project players to adopt and implement BIM in their projects. It paves the way to develop BIM guidance and strategies.

Keywords: Building Information Modelling, Saudi Arabia, AEC, Barriers, Benefits, Key Factors, implementation

Article Classification: Research Paper

Introduction

The AEC industry is considered the backbone of the economy for nations (Eastman, 1975), significantly impacting nations' growth (Giang & Pheng, 2011). The AEC industry in KSA is considered to be the second economic boom after the oil sector (Banawi, 2017). For the sake of improving the AEC industry's performance and productivity, researchers have claimed that implementing BIM is the best solution (Eastman, et al., 2011; McGraw-Hill, 2012; Matarneh & Hamed, 2017).

The roots of BIM can be found in parametric modelling produced in the USA in the 1970s and that conducted in Europe in the 1980s. However, the AEC industry started to use BIM in its projects in the 2000s. Since then, companies and governments around the world have attempted to adapt and reap BIM benefits (Eastman, et al., 2011).

Developed countries have recognized the benefits of BIM and considered BIM as the AEC's future language. For example, in the UK, the government has mandated BIM in the AEC industry since 2016. Similarly, the USA and several European countries have mandated the use of BIM (Eadie, et al., 2013). However, developing countries are still in the early stages of exploring BIM and trying to find appropriate practical strategies for its implementation (Chan, 2014). There is no research providing a methodology to implement BIM in KSA, so this study aims to find a way to facilitate BIM implementation in KSA. The methodologies suggested for implementing BIM in the developed countries may not be suitable for use in KSA as the AEC industry there has different characteristics. Projects' parties in KSA consider that BIM benefits are not clear and believe that BIM implementation is very difficult due to the limited research on BIM in KSA (Almutiri, 2016).

Literature Review

Overview

BIM has been defined in various ways (Abbasnejad & Moud, 2013; Almutiri, 2016). For example, It has been defined as a group of interacting policies, software, processes and technologies, (Jung & Joo, 2011; Barlish & Sullivan, 2012) or as having a focus on applying information technology (IT) (Arayici & Aouad, 2010; Azhar, et al., 2015).

Whereas, Eastman, et al.(2011) defined BIM as a process that digitally manages the design, construction, and Operation and Maintenance. Azhar (2011) defined BIM as a virtual process that involves all aspects, disciplines, and systems of a facility within a single model that is shared with all stakeholders across the project lifecycle. Sabol (2008) defined BIM as a sophisticated software tool that helps to record information and to assist with its components.

Several researchers have cited the benefits of BIM as; leading to improved AEC industry performance and enhancing coordination and collaboration between various project parties. BIM is considered a revolutionary technology and management process, proposed as the potential solution to the current issues in the AEC industry (Liu, et al., 2010; Arayici, et al., 2011; Azhar, et al., 2015).

However, the main barriers that hinder BIM implementation can be summarized as; interoperability, functionality, unidentified BIM deliverables between parties, clients not requesting BIM, shortage in staff skilled in BIM, and the need for a 3D building product manufacturer (McGraw-Hill, 2012). This is in addition to, changing the organization of staff to suit particular skills (Eastman, et al., 2011), cost of implementation (software and training), lack of senior management support, scale of culture change required, lack of supply chain buy-in, ICT literacy and legal uncertainties (Eastman, et al., 2011; Eadie, et al., 2014).

Key factors influencing BIM implementation

Several researchers have argued that the main factors leveraging BIM implementation are recognising the benefits of BIM and driving forces (external forces) imposed from externals and/or the surrounding environment. For example, competitors using BIM, and internal readiness including IT sophistication and top management support (Liu, et al., 2010; Eadie, et al., 2013; Omar, 2015).

The most important factors for increasing BIM benefits are: improved interoperability between software applications, improved BIM software functionality, more clearly-defined BIM deliverables between parties, more owners asking for BIM, more 3D building product manufacturer content, reduced cost of

BIM software, more internal staff with BIM skills, more use of contracts to support BIM, more external firms with BIM skills and more entry-level staff with BIM skills (McGraw-Hill Construction, 2012).

Mehran (2015) argued that the main factors influencing BIM implementation are government support, BIM contract, standards and protocols, development of a BIM performance matrix and industry collaboration. Moreover, Alhumayn, et al. (2017) suggested strategies for implementing BIM in KSA which include providing legislation and a supportive regulatory environment, government funding, educating key players and gaining the experience of advanced countries using BIM. However, Arayici, et al. (2011) suggested that approaches should be undertaken with a bottom-up approach rather than top-down. Omar (2015) and Alhumayn et al. (2017) claimed that to accelerate BIM implementation, government should take the upper hand (top-down approach) by facilitating smooth information flow. Table 1 illustrates the main factors influencing BIM implementation uncovered by the literature review. ***(Please, Insert Table 1 here)***

Various research studies have argued for different key factors, sometimes agreeing with one or more factors, but not universally agreeing with all the same factors. Therefore, this study aims to examine all factors claimed by previous research and find any further factors not previously uncovered.

Suggested strategies and methodologies for BIM implementation

Arayici et al. (2011) claimed that setting clear guidance and a methodology guarantees the achievement of the ultimate benefits of BIM. Several researchers have developed frameworks, models, and methodologies to implement BIM as follows:

The strategy of Olugboyega (2017) to create a BIM environment can be summarized as: (1) Acquiring BIM software technologies (according to the project goals) and BIM hardware, (2) Developing a BIM contents library, (3) Developing BIM standards, and (4) Setting up a BIM platform (interoperability tools, collaboration tools, integration tools, coordination/ clash detection tools and communication tools) according to the types of BIM software and hardware. Wang, et al. (2013) developed a BIM user acceptance model applying a technology acceptance model (TAM) (Figure 1). ***(Insert Figure 1 here)***

Whereas, the EU BIM Task group suggested another strategic framework for BIM adoption in the public sector: growing capability, pilot projects, measuring and monitoring, case studies and embedding change (UK Construction Media, 2016). Furthermore, Jung and Joo (2011) proposed a BIM implementation framework as shown in Table 2. ***(Insert Table 2 here)***

In spite of many approaches such as frameworks (Kekana, et al., 2014; Succar & Kassem, 2015) and technology adoption (Masood, et al., 2014; Arayici, et al., 2011) being proposed to support the implementation of BIM, the practical mechanism to adopt and implement BIM is still lacking. Perhaps, this can be justified by considering the status of BIM in both the developed countries (where BIM is mandated or nearly mandated) and developing countries (where BIM is still in its early stages), which show the need for a more practical and applied view of BIM rather than its potential benefits. Therefore, this research explores a practical methodology to implement BIM in KSA.

Research Methodology and Data Collection

Method of data collection

A mixed methodological approach is selected for this research consisting of three phases (Figure 2): ***(Insert Figure 2 here)***

The first phase utilised an extensive literature review to build a deep understanding and to cover the research scope.

The second phase consisted of two steps, a questionnaire and interviews to investigate BIM user and non-user perceptions about each step that produces the suggested methodology to implement BIM in KSA. Prior to finalizing the questionnaire, a pilot study was undertaken whereby 12 professionals with average experience of 8 years in the KSA AEC industry were interviewed. Six of the 12 professionals represented BIM users and the other 6 represented non-users. Those professionals were selected from local and multinational AEC organizations in the KSA market. The initial questionnaire was refined based on the feedback received from those professionals. Afterwards, the final questionnaire was accessible via the online survey platform “Google forms”. This platform enabled easy and swift completion of the survey.

The structured questionnaire was distributed via mail and online. Also, the online questionnaire link was distributed to the organizations that are registered as members of the Saudi Commercial Chambers, which includes the entire KSA AEC industry organizations. Additionally, the Saudi Council of Engineers published the questionnaire in its monthly magazine.

The target population for this study included all professionals related to the KSA market whether they have a good knowledge and experience about BIM technology or not. It is almost impossible to calculate the exact number of the total targeted population as the number of engineers in Saudi Arabia according to the Saudi Council of Engineers is 230943 (Aleqt, 2017). Statistical equations were used to calculate the required sample size as follow (Eq. 1):

$$n = \frac{N}{1+N\,(c^2)} \qquad (1)$$

C = margin of error, taken as 9% = 0.09.

N= Total population, taken as 231,000.

n = Sample size.

Applying the equation: $n = \frac{231000}{1+231000\,(0.09^{\,2})}$ =123.39 ≈124

The returned responses were 272 responses with 27 (9.92%) uncompleted responses. Each respondent was asked to rate to what extent he/she agreed/disagreed with each of the main factors influencing BIM implementation in KSA, on a five-point Likert scale ranging from 1 to 5, where 5 represents 'Strongly agree', and 1 represents "Strongly disagree".

Complying with the sample strategy, 124 Structured interviews were completed (62 are BIM professionals and the rest are not users) from different organizations disciplines and sizes (small, medium to large-sized).

The third phase consisted of two steps, an online questionnaire followed by interviews to validate the suggested BIM implementation methodology from only BIM users' perspectives. For rapid validation, an online questionnaire was sent to professional BIM experts who are working in KSA from different nationalities. The questionnaire was sent to 150 individuals, with 48 responses received (32%). The quantitative approach was considered a reliable methodology to test the hypotheses composed of variables derived from the first and the second phases

(Naoum, 2012). As a second step of the third phase, fifty structured interviews were organized with BIM experts and BIM researchers.

Respondents General information

The received responses were 272. Of these responses, 63.1% indicated that they do not have enough knowledge to continue. However, 36.9% continued answering the questions. This suggests a lack of knowledge about BIM in KSA, in spite of literature (Farah, 2014) reporting a high level of awareness of BIM technology in KSA's AEC industry.

Table 3 shows the reasons that the non-BIM user respondents provided for not being interested in BIM. The largest percentage reported, "Don't Know what BIM is and it is out of my scope." Hence, this percentage implies raising BIM awareness could perhaps increase BIM adoption. ***(Insert Table 3 here)***

Also, 25.4% of the respondents represent public sector organizations and 74.6 % private sector organizations. This result may suggest that the public sector is less interested in BIM than the private sector. The highest percentage of respondents' specializations, 38.6%, are working in residential building projects Table 4. ***(Insert Table 4 here)***

As shown in Table 5, the majority of respondents' organization size (64.0%) are over 200 employees. Also, a large percentage of respondents' organizations (35.52%) are working on large projects (501M SR -1Billion SR), as shown in Figure 3. ***(Please, Insert Table 5 here) (Insert Figure 3 here)***

The largest percentage of the respondents (36.76%) are project/section manager (Figure 4). As shown in Figure 5, most respondents (29.36%) reported that they represent a Designer / Architect / Engineer. ***(Insert Figure 4 here) (Insert Figure 5 here)***

Most of the respondents' educational level is B.Sc. (69.85%), while 23.16% and 6.99% of the respondents have Masters and PhD degrees, respectively. Most of the respondents (37%) have 5-10 years of experience as shown in Figure 6. ***(Insert Figure 6 here)***

The randomly tested sample covered all the KSA regions, however, the highest percentage (41.2%) is from Riyadh, followed by Makka al-Mukarama (13.2%), Eastern Province (6.3%), Madinah (4.8%), Najran (2.9%), Tabuk (1.8%), Qassim (1.8%), Asir and Jazan (1.8%), Northern Borders (0.7%), Jawf (0.70%), Ha'il (0.4%) and Bahah (0.4%).

Results analysis

Questionnaire

Key factors influencing BIM Implementation

The weighted mean as a descriptive statistical analysis which is based on the item's relative importance is used to rank the main factors influencing BIM adoption (BusinessDictionary, 2017). Table 6 illustrates respondents' ranking of the push factors for implementing BIM. Government, universities, and clients play a vital role to support and provide the requirements to expedite successful BIM implementation. This result conforms to the literature findings (Smith, 2014; McPartland, 2017). ***(Insert Table 6 here)***

Figure 7 shows respondents' factors representing the internal push for BIM implementation. Top management and organization capabilities are considered the main internal factors for BIM implementation. This result is compatible with the literature (Gerges, et al., 2016; Alhumayn, et al., 2017). ***(Insert Figure 7 here)***

Additionally, other internal push factors include encouragement from all stakeholders and understanding how BIM will add value to the procurement process.

The average weighted mean for the importance of both the external push (3.9475) and the internal push factors (3.9858) to implement BIM are similar. As such, both types of factors are important to the adoption of BIM in KSA.

As presented in Table 7, non-BIM users' respondents intend to use BIM due to its perceived benefits, to keep up with the latest technology; perceiving it to be the future, to improve their competences, and to respond to top management and client demands. ***(Insert Table 7 here)***

Interviews

Interviews with 124 professionals (62 BIM professionals and 62 non-users of BIM) were arranged to validate the results of the questionnaire. The interviewees suggested mixed approaches to expedite BIM implementation (Top-down and Bottom-up).

Key factors influencing BIM implementation

Interviewees suggested many factors representing a push for implementing BIM as follows:

- Focusing on the information (data) rather than the 3D model as globally, it is accepted that BIM is all about information. BIM is about converting design into reality.
- The most important factors to implement BIM are client and consultant. BIM must be applied at the design stage, and the contractor cannot start working on BIM from scratch because of the long time required for modelling.
- Increasing awareness among projects' participants is highly demanded.
- The decision should come from top management to spread the knowledge and train users.
- Focusing on BIM success stories to guide the market.
- Governments need to support the BIM process if they want to help the market.
- The government should mandate BIM in KSA.
- There is a need for BIM training for engineers (another discipline) to excel in their fields.
- All internal stakeholders should collaborate through BIM, especially in the area of coordination.
- BIM needs more research for further development.

External Push

As per the interview with the experts, the factors for the external push to implement BIM are ranked in Table 8. These factors are the same as those obtained from the questionnaire survey, however, interviewees added availability of appropriate software and hardware. ***(Insert Table 8 here)***

Internal Push

As shown in Table 9, interviewees respectively ranked the factors for the internal push to implement BIM. Although, 12 of them are the same as the questionnaire result; they are in different order. Interviewees added collaboration among all project parties and projects complexity and profit declination as internal push factors. ***(Insert Table 9 here)***

Proposed Model for BIM Implementation:

The proposed model (Figure 8) is developed based on the extensive literature survey, and the recognized six factors influencing the implementation of BIM in the KSA AEC industry as a result of the questionnaire survey and the interview analysis. ***(Insert Figure 8 here)***

The level of maturity readiness is investigated to implement and mandate BIM effectively considering the six factors. The proposed conceptual model is expected to assist the KSA AEC industry players to recognize the gaps that diminish the chances of successful implementation of BIM. The following subsections discuss the research hypotheses.

Developing the hypotheses

1. Raising awareness (independent variable):

This factor aims to increase the KSA AEC industry players' knowledge about BIM, including BIM definition, BIM deliverables, BIM dimensions, maturity level, the comparison between BIM and CAD, BIM applications, integration with BIM, BIM status globally, lessons learned from countries using BIM, and how BIM works. The study checks the validity of a first hypothesis, *H1: The higher the appropriate awareness, the greatest are the opportunities for successful implementation of BIM.*

2. The perceived benefits of BIM (independent variable):

This factor refers to the anticipated benefits and advantages that the use of BIM can offer to the organization and the entire AEC industry. The perceived benefits of BIM are highly influencing the decision for the implementation of BIM. The study checks the validity of a second hypothesis, *H2: The higher the appropriate recognition of the benefits of BIM, the greatest are the opportunities for the successful implementation of BIM.*

3. Barriers to implementing BIM (independent variable):

This factor refers to the obstacles that diminish the chances of the implementation of BIM. The study checks the correctness of the third hypothesis *H3: The higher the level of barriers, the lesser are the opportunities for the implementation of BIM*.

4. Removing the barriers to implementing BIM (independent variable):

This refers to removing the obstacles that diminish the chances of the implementation of BIM. The study checks the correctness of the fourth hypothesis *H4: The more the barriers are removed, the higher the opportunities for successful BIM implementation.*

5. Key factors influencing BIM adoption (independent variable):

This includes two main categories:

- The main driving forces: or the external factors which are recognized as the external pressure from authorities (either the government or the client), to impose the utilization and mandate of BIM as a compulsory requirement.
- Assistant factors: or the internal factors, including individuals, organizations and software suppliers.

The study checks the correctness of the fifth hypothesis *H5: The more the adoption of factors influencing BIM, the greater are the opportunities for the implementation of BIM*.

6. The KSA AEC industry readiness and organisations capability (independent variable):

This refers to the readiness of the organisations and the industry for BIM implementation. The study checks the correctness of the sixth hypothesis *H6: The higher the internal readiness to adopt the change to BIM, the greater are the opportunities for successful implementation of BIM*.

7. Implementation of BIM in the KSA AEC industry (dependent variable):

This dependent variable is directly influenced by the six independent variables as suggested in the conceptual model and the proposed hypotheses.

Model validation

Questionnaire

The respondents ordered the six independent variables which impact the dependent variable (implementing BIM in KSA AEC industry), as shown in Figure 9. The weighted mean for 5 variables are greater than four, while the sixth is almost equal to 4 (3.94), so all research hypotheses are accepted (Boone & Boone, 2012). ***(Insert Figure 9 here)***

Interviews

The interviewees ordered the independent variables which impact the BIM implementation in KSA, as shown in Table 10. ***(Insert Table 10 here)***

Most of the interviewees agreed with the steps of the suggested methodology, and they confirmed those are enough, but slight conflicts have been uncovered regarding the order of the steps. Moreover, an interviewee reported that "factors influencing the implementation are possibly the road that you travel on - not just a point. The factors will be there from the very beginning - attitudes/beliefs/money/resources/leadership etc. will change as the journey continues. Perhaps not a path, but a cyclical process."

Whereas, another said "*Define desired BIM outcomes, and think what you want to achieve once it's all implemented*." While, other interviewees said that "*The perceived benefits of BIM should be the actual benefits of BIM". The perception happens in the mind of the person who has never used BIM in the construction process before. This is a transition from 2D thinking in the construction process to 3D+, visualization and simulation of a true digital construction asset to be used in conjunction with the projects life cycle plan. It's like telling someone who has been doing something their whole life that their industry has become a tech industry and its benefits are the base that the next generations of construction will have a foundation on. Custom manufacturing using 3D printing and milling, component and modular construction, you can't use these if you do not use BIM*."

Additionally, another reported that "*to implement BIM in KSA, the first step should be raising awareness, secondly, convince the key decision makers about perceived benefits of BIM, then make a feasibility study to prove the profit and BIM benefits acquired from its implementation. The last step is to develop a strategic* *plan with consideration of experiences and examples of successful application of BIM*."

However, interviewees agreed with the methodology. They suggested that it can be applied for organisations and requires further modification if it is applied to the overall KSA AEC industry projects. Whereas, another said that "*To implement BIM in any organization, the first step is to create a community of practices*."

Also, to test the hypotheses, the interviewees reported that BIM implementation impacted by the six factors (raising awareness, perceived benefits of BIM, organizations capability, identifying barriers, removing the barriers, key factors influence the adoption), so that, the six hypotheses could be accepted. From all research steps, the suggested methodology for BIM implementation in KSA is set as shown in Figure 10. ***(Insert Figure 10 here)***

Conclusions

Currently, the attention of the construction industry is to eliminate waste and inefficiency to improve quality and profitability. However, BIM proved its competence in this way which motivated developed countries to use and mandate BIM. There are only limited examples of BIM implementation within the AEC Industry and AEC education in KSA.

This research proposed a model for BIM implementation in KSA to pave the way to facilitate using BIM, which in turn, increases the chances for creative and innovative solutions to the AEC industry issues, increases the quality, profitability and improves projects' performance and efficiency.

The key findings of this research are: exploring the main driving forces and the main external pressures pushing the implementation of BIM in the KSA AEC industry, identifying the main internal pushes, and proposed a methodology for BIM implementation in KSA AEC industry.

The questionnaire respondents and interviewees ordered the main external factors influencing the BIM implementations as; (1) Providing guidance on using BIM; (2) Government support and pressure for the implementation of BIM; (3) Providing education at university level; (4) Developing BIM and data exchange standards, rules and regulations; (5) Perceived benefits from BIM to client; (6) Collaboration with universities (research collaboration and curriculum designed for students); (7) Increased demand for BIM by other project parties; (8) Client pressure and demand for the application of BIM in their projects; (9) Clients providing pilot projects for BIM; (10) Contractual arrangements; (11) Promotion and awareness of BIM; (12) Competitive pressure; (13) Availability of appropriate software and hardware. This result is the same as the literature, but factors are ordered differently.

Unlike the literature, interviewees and questionnaire respondents in this study respectively ordered the internal push factors as; (1) Top management support; (2) Cultural change; (3) Perceived benefits from BIM; (4) BIM training program to staff; (5) Improving built output quality; (6) Continuous investment in BIM; (7) Desire for innovation with competitive advantages and differentiation in the market; (8) Technical competence of staff; (9) Financial resources of organization; (10) Improving the capacity to provide whole-life value to client; (11) Safety into the construction process (reduction of risk for accidents); (12) Collaboration among all project parties; (13) Projects complexity and profit declination. This result is in line with the literature, but the factors are ordered differently.

This study observed that failure to adopt the change to BIM would result in loss of competitive advantage and accordingly fewer chances to win new projects. Developing countries' governments must keep up with the development of the other developed countries which represent a pressure factor to mandate the latest technology like BIM. This pushes organisations to preserve themselves surviving and implementing BIM.

The suggested methodology consisted of six steps. The first is raising BIM awareness. The next steps are identifying the perceived benefits for each party, studying the AEC industry readiness and the organizations' capabilities, identifying the barriers, proposing strategic plans to remove those barriers, while the key factor for successful implementation is that each factor acts as a motivating factor and pushes the next one (not just as a separated step). The interviewees claimed that the methodology must be practical as a cyclical process, not a linear one.

The interviewees validated the proposed conceptual methodology and suggested a suitable order for its steps which in turn results in the final methodology for implementing BIM. The interviewees confirmed that, however, the main factor for rapid BIM implementation in KSA is collaboration among different parties; the government, organizations (client, designer, contractor, subcontractor, suppliers) and all project stakeholders. The main role is derived from the government as if the government mandates BIM, all parties will be committed to the change. The same way worked in advanced countries in mandating BIM.

This study recommends applying a mixed approach (top-down and bottom-up) to expedite and effectively implement the suggested methodology. Therefore, all AEC industry parties must collaborate and combine the efforts. The government of KSA can play a massive role to present convenient practical strategic plans for BIM implementation by providing a timeframe to mandate BIM as an obligatory requirement in the AEC industry projects. Also, the government could support the entities to overcome the barriers that hinder BIM implementation. For instance, the government can aid entities to overcome the initial BIM implementation cost. Involvement of BIM in the AEC undergraduate and postgraduate syllabuses seems to be a premise in raising new generations fully oriented with BIM (long-term). Organizational decision makers have to support the staff, for example train the staff (short term), and put strategic plans in place to implement BIM.

Applying the suggested methodology could help to ensure the success of the BIM implementation, which in turn could improve the AEC industry performance and effectiveness, solve the project's issues, adapt creativity and innovation and create a positive future for the AEC industry.

Suggestions for future research develop detailed, separate and special models for implementing BIM in KSA for each project party; client, architectural & designer, contractor, and subcontractor. Deriving models from the offered model in this research is to develop a short-term model and long-term model.

Limitations and assumptions of research

There is a difficulty to collect information for the construction industry in KSA due to the large area of 2,149,690 square kilometers involving different areas, each area having its own specific cultural nature. It was therefore not possible within the confines of the study to collect a large number of questionnaires or interviews from all the various areas around the whole country to provide an integrated image for construction industry in KSA.

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Figures:

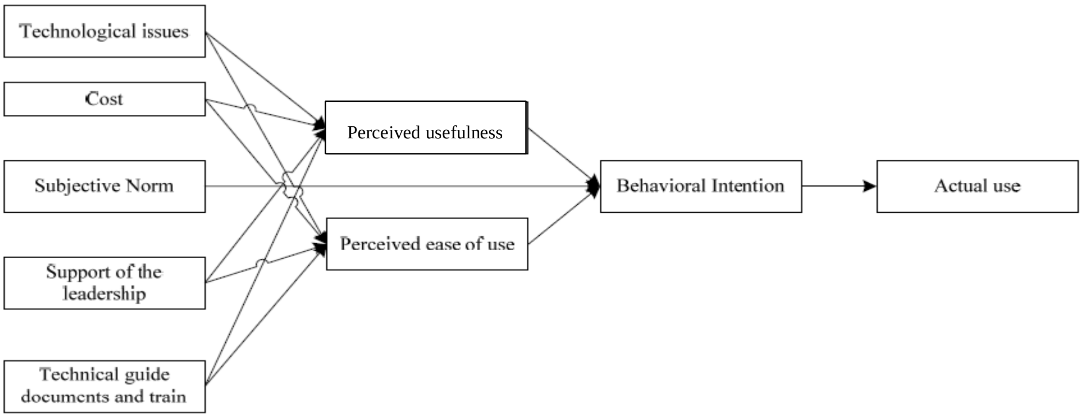

Figure 1: BIM User Acceptance Model (Wang, et al., 2013)

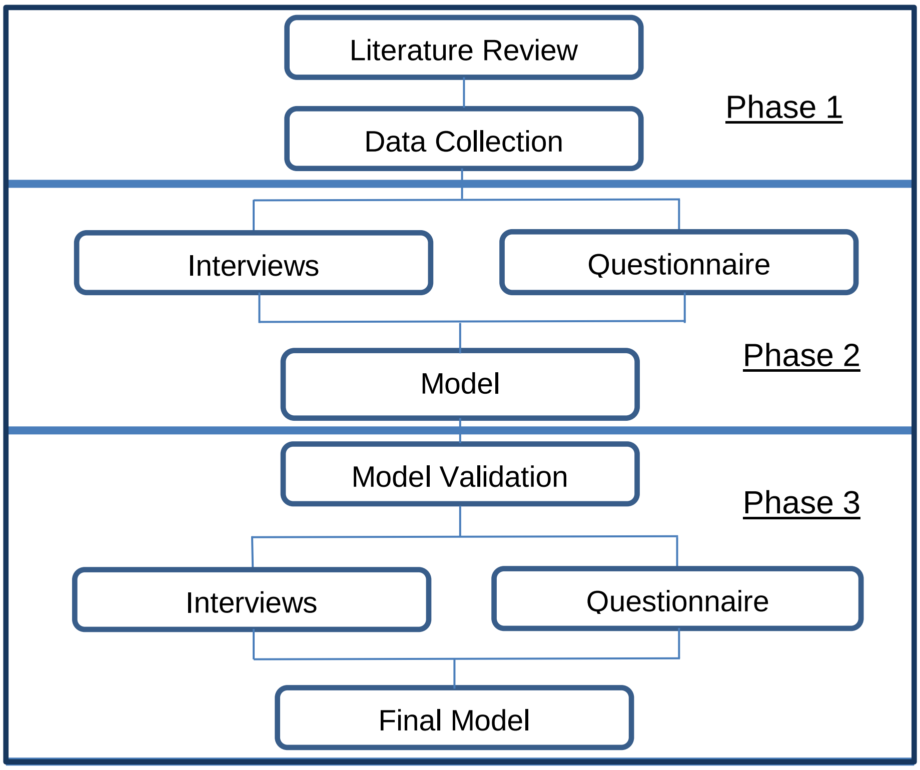

Figure 2: Research Methodology Flow Chart

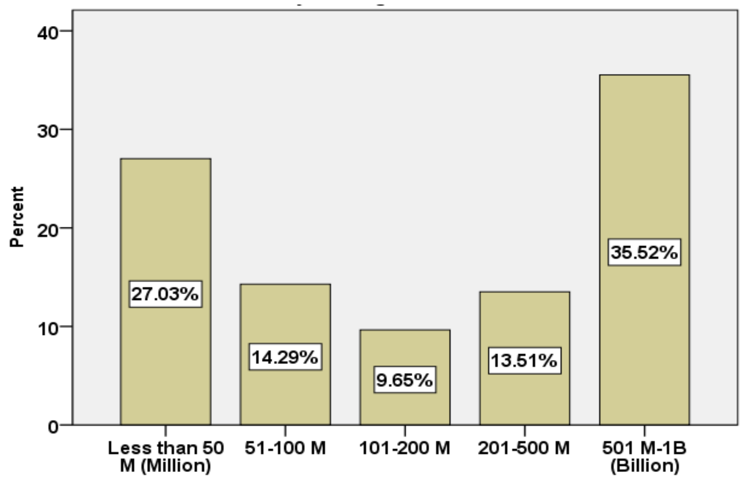

Figure 3: project budget

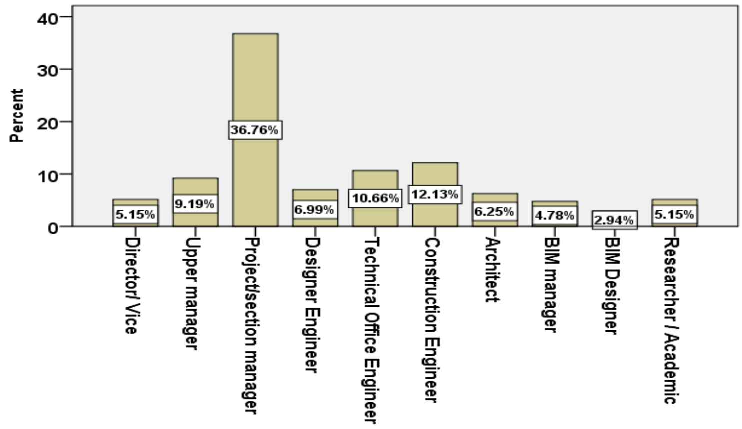

Figure 4: Respondents Position

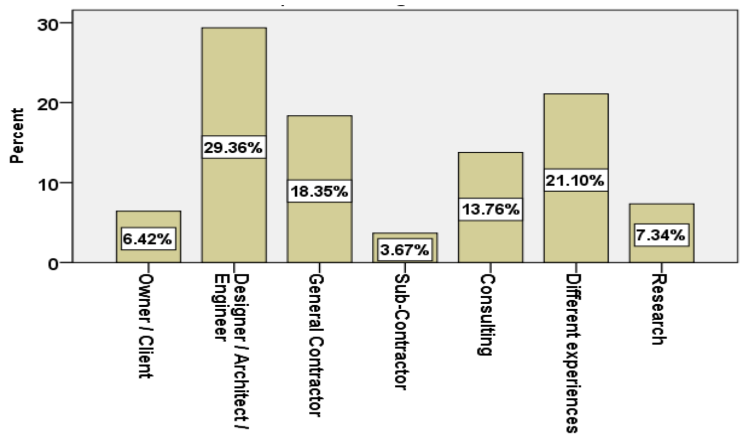

Figure 5: Respondents Role

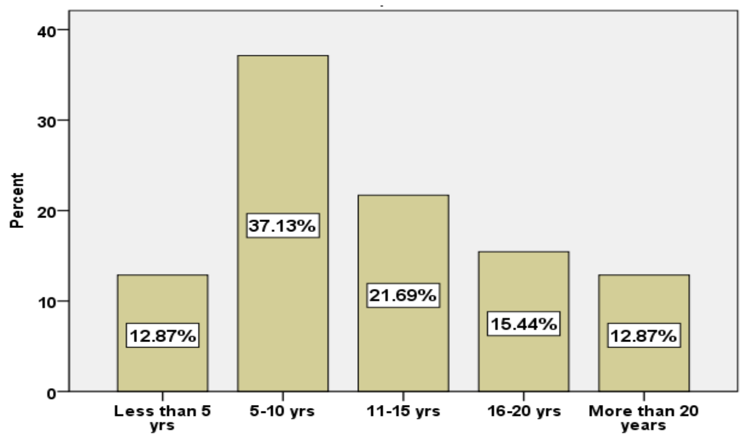

Figure 6: Respondents years of experience

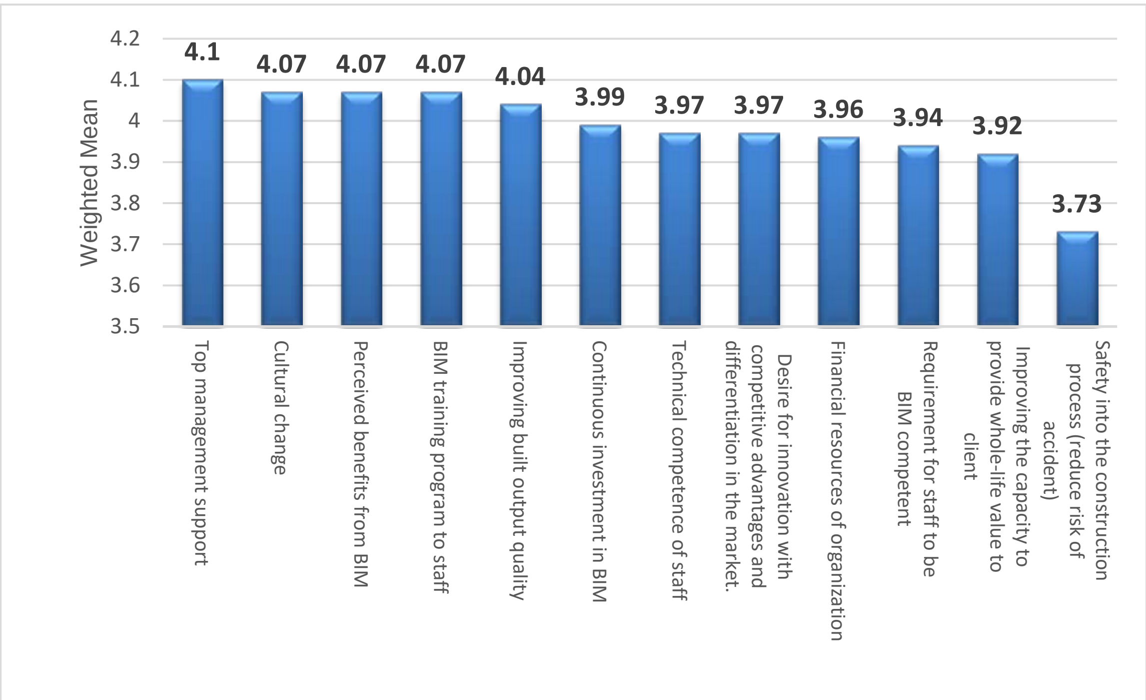

Figure 7: Internal Push Factors for Implementing BIM in KSA

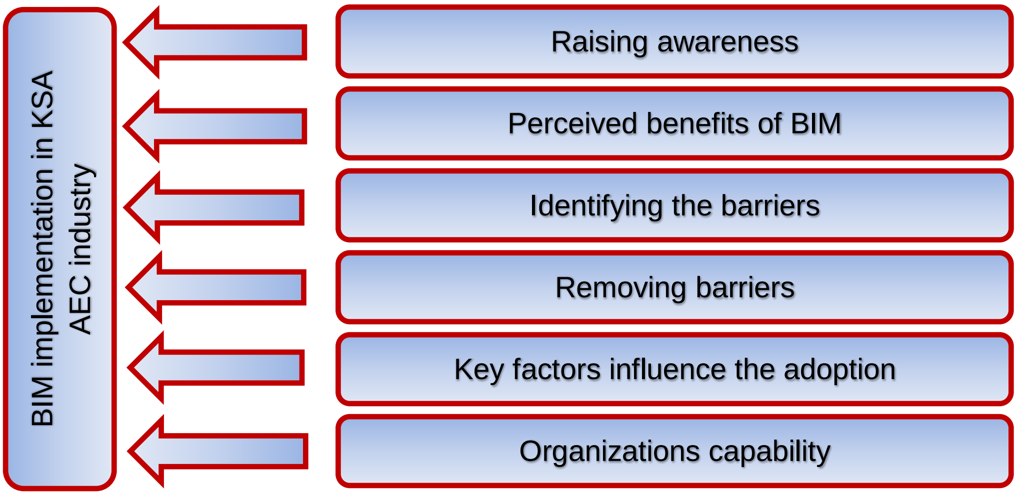

Figure 8: Conceptual Model for implementing BIM in KSA

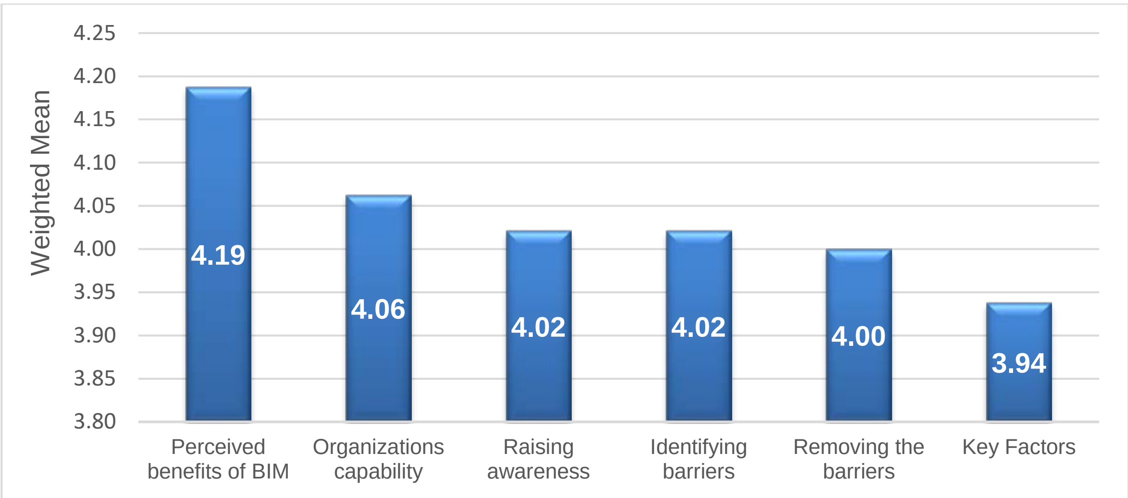

Figure 9: independent variables impact the BIM implementation in KSA

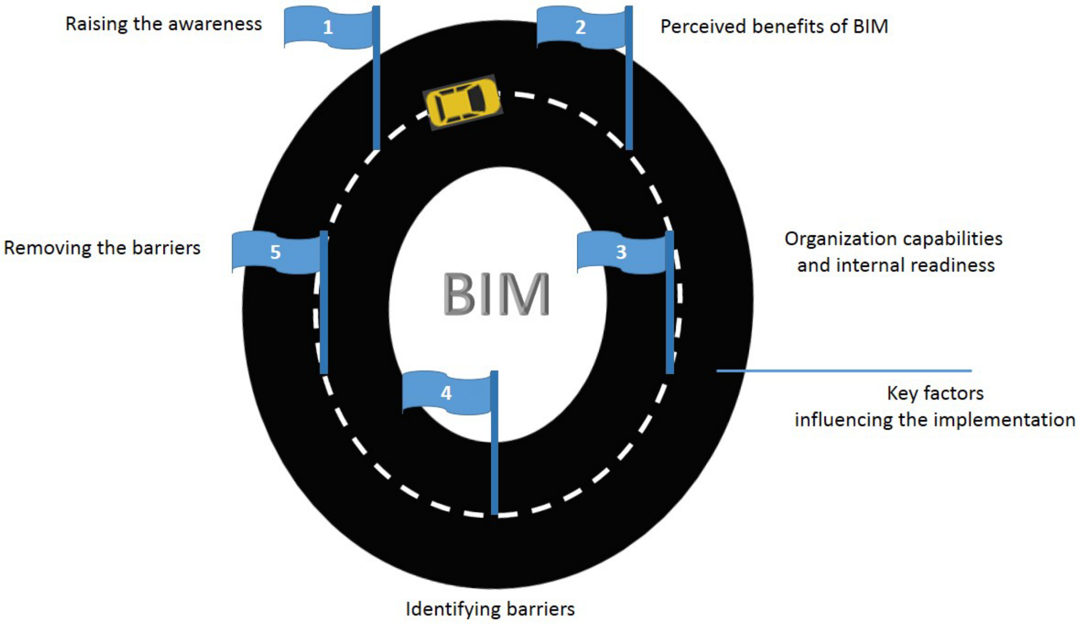

Figure 10: Final methodology for BIM implementation