Barriers to Implement Building Information Modeling (BIM) in Public Projects in Saudi Arabia

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Abstract. The construction sector is a major contributor to the Saudi Arabia Gross Domestic Product (GDP). According to the Deloitte 2015, the total construction activities last year reach to $24bn ranked second after oil industry [1]. However, the current methods project are follow generates much waste and are not efficient. The recent 2030 vision plan that announced by the government of Saudi Arabia in 2016 encourages all sectors to be creative, efficient, and environmentally responsible. Technology such as Building Information Modeling (BIM) could help transform the construction industry in Saudi Arabia and improve the final outcomes. This study develops and administrates a questionnaire to identify the barriers of implementing the BIM technology in Saudi Arabia. Additional barriers are also identified through a case study for a public project after implementing BIM trough the feasibility and the design phase. The barriers are fallen under tow categories including; process implementing which comes first and technology and resources that come second.

Keywords: Building Information Modeling · Saudi construction industry · Waste reduction

1 Introduction

Saudi Arabia's market share in construction industry consider to be the highest with 43% within Gulf Countries Council (GCC) [1]. According to a report published by Deloitte in 2013, new contracts awarded in 2012 were worth about $24bn and are expected to go up to $52bn in 2015, about 10% of Saudi Arabia's Gross Domestic Product (GDP). However, construction activities generates abundance amount of waste on a yearly base that cost a fortune. According to market research, 75% of waste in the SA comes from construction, and buildings are responsible for 40% of carbon emissions. Therefore, a slight improvement to this sector could have a considerable impact on capital expenditure and environment. To elaborate more, a 10% saving on contracts could save $5bn a year, resulting in efficient executed projects. This is where Building Information Modeling (BIM) can deliver immense benefits to the building industry, especially by cutting capital cost on construction projects, reducing risks occurrence and delivering sustainable construction projects in line with the Saudi Arabia's Vision 2030. Applying a methodology such BIM, the SA's building industry could be better

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off by as much as $5–10bn (a 10–20% saving on construction projects) and have a digitally empowered sustainable infrastructure and environment [2]. However, implementing BIM in SA is not taking a fast base for many reasons. This paper is considered the first step toward establishing a framework to implement BIM in public projects. Therefore, the author is aiming to investigate barriers for implementing BIM via developing and administrating a questionnaire to BIM professionals with related work experience in GCC. In addition, this paper will investigate and summarizes a case study for a BIM project that constructed in Jeddah, Saudi Arabia. Finally conclude with recommendations for successively implementing BIM for better results.

The construction industry is known for its traditional non-collaborative work practices [3]. Moreover, sustainable development and smart cities are not possible without significant multidisciplinary efforts from the construction industry [4]. Even the legislation stipulating sustainable design and development is perceived as secondary by project teams, in comparison to the primary goals of time and budget in construction projects. Old construction practices based on competition only promote self-interest, forcing stakeholders to make decisions that reflect their own interests and adopt methods that offer the best solution to their organizational business stability instead of energy performance and environment sustainability [5].

In order to translate sustainable concepts into sustainable infrastructure, there is a need for innovate technology and collaborative working, such as BIM, to connect the different levels of the industry (decision-makers, urban planners, economists, architects, contractors and construction supply chain), from strategic urban and infrastructure planning to maintenance and operation of the built assets. Therefore, a slight improvement to this sector could have a considerable impact on capital expenditure and environment. To elaborate more, a 10% saving on contracts could save $5bn a year, resulting in efficient executed projects. This is where Building Information Modeling (BIM) can deliver immense benefits to the building industry, especially by cutting capital cost on construction projects, reducing risks occurrence and delivering sustainable construction projects in line with the Saudi Arabia's Vision 2030. Applying a methodology such BIM, the SA's building industry could be better off by as much as $5–10bn (a 10–20% saving on construction projects) and have a digitally empowered sustainable infrastructure and environment [6]. However, implementing BIM in SA is not taking a fast base for many reasons. This paper is considered the first step toward establishing a framework to implement BIM in public projects. Therefore, the author is aiming to investigate barriers for implementing BIM via developing and administrating a questionnaire to BIM professionals with related work experience in GCC. In addition, this paper will investigate and summarizes a case study for a BIM project that constructed in Jeddah, Saudi Arabia. And then conclude with recommendations for successively implementing BIM for a better results.

1.1 Building Information Modeling

Building information modeling (BIM) is a revolutionary technology and coordinated process to create intelligent and information-rich 3D representations for stakeholders to cost-effectively design, construct, operate and manage construction projects [7]. BIM has

been proven to significantly reduce construction cost (10–40% of total project cost) and improve project delivery [7]. For example, BIM assisted the UK Government in saving approximately $1.7bn in construction costs in 2013–2014, paving the way for the Digital Built Britain strategy for fully BIM-driven construction and procurement in the UK [8].

Another inherent potential of BIM is its capability to lower the environmental impact of the construction sector, by reducing waste, cutting carbon footprint, and improving energy performance and life cycle management of built assets. BIM is a key enabler for the technology step change towards achieving smarter cities and sustainable developments, for example in energy management, waste reduction, sustainable design and better management of infrastructure and environment. BIM's potential for sustainable development and infrastructure hinges on collaboration and integration of reliable, up-to-date, research-based information and accurate, re-useable data. BIM can be used as a decision-making tool to visualize and optimize multiple design options early in a project stage. A fully coordinated BIM model stores information about components and materials of a project, which can be used to select most appropriate materials and check compliance against sustainable ratings and grades.

Visualization is a key strength of BIM which helps stakeholders see in a virtual environment how a particular development will fit within the surrounding environment, evaluating its interaction with and impact on people, culture and the existing urban landscape. BIM captures accurate design and construction data, which is useful throughout the life cycle of a project, enabling faster, safer, less wasteful construction, and more cost-effective, sustainable operation and maintenance of building and infrastructure projects.

2 Method

A questionnaire was designed to validate the list of barriers to implement BIM that finalized from an intensive literature review and multiples interviews with professionals in the field of construction industry in Saudi Arabia. Some of the participants shows a great experience of BIM background and their feedback scored high than the others with no BIM previous experience. All barriers were fallen under two categories including; process barriers to business including legal and organizational issues and technology barriers related to readiness and implementation. The questionnaire has two sections; the first one for acquiring general information of the respondents to be used for further evaluation. For instance, the participants were asked questions like if they had involved with BIM projects, and if they do so, what was the role they represent. The Likert scoring system was applied to each identified BIM implementation barriers consisting of five categorize of agreement–disagreement. In result, the low total scoring would represent the least impact barrier to implement BIM in Saudi Arabia, and the high total score would represent the major barriers in the area. The Likert system was applied to each identified BIM implementation barriers consisting of five categorize of agreement–disagreement. In result, the low total scoring would represent the least impact barrier to implement BIM in Saudi Arabia, and the high total score would represent the major barriers in the area. The Likert system was as follow 5 points worth

for strongly agree, 4 points for agree, 3 points neutral, 2 points for disagree, and 1 point for strongly disagree.

3 Results and Discussion

The questionnaire results showed that main barriers of BIM construction were classified into two fundamental aspects. First, process barriers counted for the most to BIM projects in Saudi Arabia. Barrier B1 Claiming that the Saudi construction market is not ready to adopt a business model like the one BIM is considered to be a major cause to adopted BIM practices in Saudi Arabia with 39% strongly agree, and 54% agree. Furthermore, many owners believe that if they change the contracts to require new types of deliverables, specifically 3D or building information models, they will not receive competitive bids, limiting their potential pool of bidders and ultimately increasing the price of the project. Barrier B9 came second as a major cause for not implementing BIM. Integrating multiple disciplines requires multi user access to the building information model. This does require technical expertise, establishment of protocols to manage updates, edit of the model, and establishing a network and server to store, and access the model. It is also provides an excellent context for new users to learn from more experienced one. Barrier B6 ranked third, which indicated that BIM projects demanding more direct owner involvement, and input, which should be seen as a benefits and not a drawback. However, owners need to establish clear roles, responsibilities, and methods to communicate with the project team and ensure that an owner representative is available as needed. Looking at Barrier B3, it is obvious that cost was a main aspect to implement or adopt BIM business model in Saudi construction market according to respondents' feedback. 80% of respondents were agree while 10% were natural or undecided and the remaining 10% did not see that cost should be an issue. Implementing new technologies such as BIM is costly in terms of training and changing work processes and workflows. Having workers, that familiar with BIM technology was very important to majority of the participants, especially for the contractors. This is will avoid losses in resources, deliver on time, and do it right.

Participants' showed high agreement that barrier B4 could be crucial to implement BIM successfully. It is often difficult to ensure that all project participants have the knowledge and willingness to participate in the creation or use of the Building Information Model. According to the questionnaire, a good number of respondents agreed that government should put more efforts to speed up the movements of green buildings. Furthermore, there is not much of governance and legislation driving the change combined with a lack of knowledge of modern methods such as BIM in the region driven by no requirement for continual professional development for architects and consultants such as American Institute of Architects (AIA). Barrier B2 which was ranked four in overall barriers showed no disagree neither strongly disagree from all participants. Barriers B7 and B8 were least importance under the shortage of resources category according to the questionnaire see Table 1.

The respondents also provided some additional barriers to implementing BIM technology that were not listed in the questionnaire based on their relative experience. For example, local design schools programs are lacking of design computing

Table 1. Summarized of most important barriers to BIM projects in Saudi Arabia according to the questionnaire and the case study

Barrier	Descriptions
B1	The market is not ready
B2	The project is already financed and design is complete – It's not worth is to implement BIM
B3	Training Costs and the learning curve are too high
B4	The difficulty of having everyone on board to make BIM effort worthwhile
B5	Too many legal barriers exit and they are too costly to overcome
B6	Issues of model ownership and management will be too demanding on owner resources
B7	Designers or Architectural Engineering firms do not usually prove empirically the benefits of BIM to customer
B8	Construction Insurance companies do not have BIM projects risk specific policies
B9	Technology risk and barriers technology is ready for single-discipline design but not integrated design
B10	BIM is not having a full support of upper management or decision makers

knowledge in terms of architectural design and that led to high shortage in work force with related backgrounds in GCC region. Moreover, companies are not willing to train their staff because investment in software and hardware is typically exceeded by the training costs and initial productivity losses.

3.1 Case Study

Rabigh Community Centre (RCC) is scheduled to start construction mid 2018 in Rabigh city, Saudi Arabia. Rabigh is small city close to main oil refineries and major schools like Aramco and King Abdullah University for Science and Technology (KAUST), on the west cost of Saudi Arabia with a small community in population of 41000. However, this number is been increasing lately due to the number of people are moving to Rabigh to settle in to stay close to their jobs. The government of Saudi Arabia has allocated 2500 sq2 property in the Rabigh city Centre for the RCC project where the large number of citizens are living. A team consists of faculty members from college of engineering in Rabigh campus, King Abdulaziz University volunteered to develop the design works for the RCC project. The project budget is 80% covered by the government while the remaining, the project team mainly Rabigh Society for Family Development has to secure it. The RCC will provide many services that related to family including but not limited to; training, marriage counselling, shopping plaza, recreation, and kids club. The use of Building Information Modeling was introduced due to the limited budget and the short time is given to complete the design works and select the construction team. Level of details 02 is what the team decided to reach with BIM model due to the team background in BIM, where not everyone knows how use the technology. After a short period of using BIM, the team was able to finish the feasibility studies and got the stakeholders approval earlier than it was scheduled with

one month. The reason for that is the using of BIM to present studies to decision makers such as cost estimation, project scoping, early and accurate visualization, optimize energy efficiency and sustainability. However, the team faces many obstacles at the beginning, and yet still have some in progress to be resolved. Implementing BIM for the RCC is challenging due to many reasons including; lack of owner's vision, trained staff, appropriate technology, and stakeholders' BIM knowledge. These issues might reflect the limited resources and stakeholders' assistance to the project team members. In addition, not all team members are enough trained and ready to get involved with BIM projects. To solve this, a weekly meeting that includes all team members along with the stakeholders is scheduled for a month to discuss, train, and identify the BIM level of details and align them with the project main objectives. In the meantime, the project team members' success to bring more experts on board which next will develop a process map and highlighted all required resources like work force. The final design will be wrapped soon and send for the final review. The upper management will evaluate the final results and decided if BIM fulfil the requirements to approve a further BIM implementation. To conclude, the Saudi's construction market is not fully ready to embrace a powerful technology like BIM due to the lack of the fundamentals resources to successfully complete a BIM project and meet the designed objectives.

4 Conclusion

This paper develops a questionnaire to investigate the barriers to implement Building Information Modeling technology in Saudi building industry. The questionnaire was made using a specialized website and an invitation were submitted through emails and in personal. All groups counted in this study showed considerable relative experience of BIM technology and construction industry overall in the area. Total of 195 surveys were included in this study out of 230. The results analyzed results showed that barriers classified under BIM technology implantation process aspect were totaled first followed technology and the appropriate resources. These findings were mainly similar to studies were develop in the area [9–13]. Some additional barriers were discussed in addition to some suggestion were exposed by the respondents that might help accelerate the implementing of BIM technology. For future work, the author is planning to act on the questionnaire and the case study findings to develop a framework that would help stakeholders to adopt the practice of BIM technology and overcome the major related barriers.

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