www.itcon.org - Journal of Information Technology in Construction - ISSN 1874-4753

AN INVESTIGATION INTO THE IMPLEMENTATION OF BUILDING INFORMATION MODELING IN THE MIDDLE EAST

SUBMITTED: July 2016
REVISED: November 2016
PUBLISHED: January 2017 at http://www.itcon.org/2017/1
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SUMMARY**:** *Architectural, Engineering and Construction (AEC) industry. There have been many changes in the past few years in the use of BIM and how to implement BIM in the AEC Industry. The purpose of this research is to examine the current status of BIM in the Middle East by exploring the extent of adoption of BIM among stakeholders in the AEC industry in this region. To this end surveys were sent out to 297 and empirical statistics have been applied. The respondents acknowledged they were aware of the benefits of BIM in terms of it being a more effective method for designing and managing construction projects by supporting collaboration, improving the quality of the design by providing the ability to closely visualize designs in 3D and rendered forms and providing a platform which would facilitate the sharing of information relevant for design, construction and maintenance of buildings over their entire lifecycle. However, only 20% of AEC organizations in the Middle East are using BIM or are in the process of adopting BIM, with more professionals beginning to adopt BIM although most professionals within this region still look at BIM just as an advanced AutoCAD tool. Raising awareness related to the benefits of BIM and increasing training opportunities in the Middle East are necessary in order to allow all stakeholders to benefit substantially from BIM.*

KEYWORDS: *AEC, BIM, construction, Middle East, stakeholders*

REFERENCE: *Michael Gerges, Steve Austin, Mohammad Mayouf, Ograbe Ahiakwo, Martin Jaeger, Amr Saad, Tamer-El Gohary (2017). An investigation into the implementation of Building Information Modeling in the Middle East. Journal of Information Technology in Construction (ITcon), Vol. 22, pg. 1-15, http://www.itcon.org/2017/1*

1. INTRODUCTION

The construction Industry in the Middle East is growing rapidly due the growing population and the greater demand for infrastructure projects. The Middle East region consists of the Gulf Cooperation Council (GCC), North Africa, and some countries in Asia. According to (Harris, 2014) there are currently 117 major projects that are ongoing in the region and to be completed by 2030 with a total cost of US$1 trillion dollar. Building Information Modelling (BIM) can be claimed as a procedural and technological shift in the Architectural, Engineering and Construction (AEC) industry (Succar, 2009), which was introduced by Eastman "The use of computers instead of drawings in buildings design" (Eastman, 1975). In fact, the evolution in computer science and information technology have changed the work pro-cess of most industries (Chan, 2014). BIM is an improved process and tool, which contains a set of virtual aspects, concepts and systems of a facility within one environment (Azhar, et al 2012). It involves applying and maintain an integrated digital representation of different information across various phases (design to handover) of a construction project (Eastman, et al 2011, Barlish and Sullivan, 2012). Sacks (2010) described BIM as the utilization of a database infrastructure to summarize built facilities with specific viewpoints of stakeholders, so that stakeholders can query, simulate and estimate activities and monitor the building process as a lifecycle entity. There are various BIM applications (Arayici, 2012), which can be utilized to support constructability and analysis, scheduling, cost estimating and sequencing (Memon, 2014). BIM as a new paradigm has a great potential for integration into life cycle of construction projects and this is a key tool in the project procurement (Nagalingam, 2013, Chen, 2011).

Recent research showed that BIM can be implemented in various tendering routes in order to improve the over-all process (Bolpagi, 2013, Ciribini, et al 2015). Many governments such as the UK (HM Government, 2012), USA (Wong, et al 2009) and Australia (BuildingSMART, 2012) have set implementations strategies for the use of BIM on construction projects. For instance, in North America, the adoption of BIM by contractors has escalated significantly from 2007 to 2012 (McGraw Hill, 2014). In a potential progressive shift, the UK government has mandated the use of fully collaborative BIM for government projects (minimum of 5m capital cost) by 2016 to reduce project delays and cost overruns (Constructing Excellence, 2008). This decision by the UK Government has put a lot of pressure on contractors as they currently making a rapid transition into BIM in order to meet the specified project demands (Withers, 2012). This mandate has resulted in the wide spread of the adoption of BIM especially in the Middle East, with the close economic relationship between the UK and the Middle East, which is reflected in the local dominance of British architects, project managers, engineers and contractors (Gerges, n.d.). In addition, there are many multi-national firms who have multiple offices across the Middle East region, which impose a wider adoption of BIM in construction processes across the Middle East. This is motivated due to the rapid growth of mega and complex projects in the UAE, Qatar, Bahrain, Kuwait and Saudi Arabia (Gerges, n.d.). This research seeks to investigate the current practices of implementing BIM in the Middle East. Countries that are involved in the research carried out here are Saudi Arabia, United Arab Emirates, Kuwait, Oman, Bahrain, Qatar, Yemen, Jordan, Lebanon, Iraq, Syria, Egypt, Sudan, Libya and Algeria.

2. BIM ADOPTION AND IMPLEMENTATION: A GLOBAL STATUS

BIM adoption and implementation is on rise, for instance, looking at the statistics from 2013 to 2015 (see Table 1), it can be seen that many countries have realised the potentials of such technological and procedural evolution within the construction industry (McGraw Hill, 2014). According to (Lee, et al 2014), BIM is mandated in some countries such as US, UK and a number of other countries. Many European countries such as Finland, Denmark, Norway and Sweden are considered as the BIM leaders in the world (Arayici, 2012). In south Asia, for instance, Singapore has been promoting BIM since 1997 where currently it is required for various aspects in construction such as building plan approvals and fire safety certifications (Wong, et al 2009). In Hong Kong, although BIM is being implemented, it is still considered in its early stages (Chan, 2014). However, it can be claimed that BIM implementation in Hong Kong is moving rapidly. This is because clients have started to realise various BIM benefits such as the ability to apply different tests on BIM model, generating different design options and early detection of design faults to minimise later changes. In Africa, where many developing countries exist, the implementation of BIM is relatively low. For example, in Nigeria, although the level of BIM awareness is high (Ogwueleka, 2015), implementation of both process and technology is considered to be low. Another example is in South Africa where its adoption is facing huge challenges which are attributed to contractual issues, personnel inadequacies in terms of education, training, and skills development; the population growth and the required

infrastructure to accommodate its implementation (Kekana, et al 2014). Looking at the current global status, it can be argued that whilst many approaches such as frameworks (Succar, 2009, Kekana, et al 2014) and technology adoption (Arayici, et al 2011, Masood, et al 2014) have been proposed to support the implementation of BIM, the practical mechanism to adopt and implement BIM still lacks. Perhaps, this can be reasoned by looking at the status of BIM in both the developed (where BIM is mandated or nearly mandated) countries and developing (where BIM is still at its early stages) countries, which show the need for more practical and applied view of BIM rather than its potential benefits.

Table 1: BIM implementation percentage 2013 and 2015 (McGrawHill, 2014).

Country	2013	2015
United Kingdom	28%	66%
Germany	37%	72%
United States	55%	79%
Brazil	24%	73%
Australia	33%	71%
France	39%	71%

3. BIM ADOPTION AND IMPLEMENTATION IN THE MIDDLE EAST

BIM advancement in the Middle East is on the rise. The Dubai Municipality was the first public authority in the Middle East to mandate the use of BIM for most large-scale projects in the Emirate (Guidline for BIM Implementation 196, 2013). In Kuwait, (Gerges, n.d.) reports that BIM implementation improved communication, mitigated project risks by encouraging collaboration and facilitated stakeholders in transparently monitoring the status of their project throughout the project phases (Gerges, n.d.). Building Smart reported on the adaptation of BIM in the entire Middle East region (BuildingSmart, 2011) .The report concluded that the use of BIM in Middle East region is not mandatory. The report surveyed the usage of BIM across the Gulf Cooperation Council (GCC) and Jordan and recommended how the use of BIM can be increased in the future. Although the survey showed that only 25% of people are using BIM, it was stated that the use of BIM has improved quality control, productivity and reduction in design errors. In addition, the report stated that the lack of BIM specialists was a concern since 64% of people who received training are self-taught. With consultants and contractors accounted for the highest number of BIM user, 40% of respondents have stated that they have used BIM on more than 5 projects, but there were a large number of companies who have only implemented BIM for one project. 62% of respondents stated that the main reasons why BIM has not been implemented is "that client has not asked for the use of BIM". Followed by there were 43% who did not know how to use BIM, and 41% were interested in using BIM but do not know how to start, and finally 19% of respondents stated that BIM is too expensive to be implemented. In addition, (Awwad, 2013) explained that the Middle East has the lowest take up of BIM, with the public sector not taking any steps to implement it. Professionals in the Middle East look at BIM as just a tool that presents a 3D model of the building (Awwad, 2013). In addition, (Jung, 2015) researched across six continents stated that the Middle East employed BIM service overall for 3D coordination, design authoring, and clash detection. A recent research by (Mehran, 2016) showed that non-existence of standards along with related implementation costs and uncertain profitability are the main challenges when investigating the use of BIM in the UAE. Although other countries (apart from the Middle East) have highlighted similar reasons for lack of adopting and implementing of BIM to those mentioned by current research in the Middle East, there are factors that motivate considering the Middle East as a whole entity when comparing it to the rest of the world. The first factor is the unified language (Arabic), which is used by all the arab countries. The second factor is the similarity of arab cultures whereas most of countries around the world have differentiated and distinguished cultures. The final factor is that most (if not all) construction practices within the Middle East use similar standards (mostly American or British) and protocols, which motivate the need for a holistic investigation of current BIM practices from different Middle Eastern countries. For these

reasons, it is anticipated that this study will provide a more solidified status of BIM in the Middle East in order support both its adoption and implementation more effectively.

4. RESEARCH METHODOLOGY

While finding an expert in BIM within the region was a challenge, the result of this research will help in implementing BIM in the region since it will give a clear understanding of what are the challenges and barriers of implementing BIM. It will also support construction practitioners to overcome the gaps investigated for more effective BIM implementation. More researchers have identified complementary components specifically developed to enable such assessment: BIM capability stages representing transformational milestones along the implementation continuum. BIM maturity levels representing the quality, predictability and variability within BIM Stages. BIM competencies representing incremental progressions towards and improvements within BIM Stages. Organizational scales representing the diversity of markets, disciplines and company sizes. Levels enabling highly-targeted yet flexible performance analyses ranging from informal self-assessment to high-detail, formal organizational audits. This paper explores these complementary components and positions them as a systematic method to understand BIM performance and to enable its assessment and improvement.

The research commenced by carrying out literature reviews on the implementation of BIM in the Middle East and around the globe. A questionnaire was then developed using closed questions, which is a common tool for collecting quantitative data. Questionnaires are a useful tool to gather a large amount of data in a short period of time. Due to the respondents' time it is believed that an online questionnaire was the quickest and easiest way for respondents to share their opinion. Hence, it was considered important to develop an online survey, since it could be easily accessed by construction professionals anywhere in the region, and could result in very high response rate. The questionnaire developed consisted of twenty-six questions that collected data relating to the respondent's years of experience working with BIM, location and current place of projects, use of BIM in the region, common software used, project delivery methods, BIM and project life cycle, BIM job duties, BIM training, challenges of implementing BIM, and future of BIM in the region. A Likert scale was used consisted of five points 1- strongly agree, 2-Agree, 3- Neutral, 4-Disagree, 5-Strongly Disagree. Some questions had the option of "other (please specify)" to give the respondents the freedom of giving a different answer. In addition, for some questions respondents could have choose more than one answer. A pilot study was completed to test the survey instrument. Invitations were sent to construction professionals in the Middle East construction Industry by emails, LinkedIn, and BIM Middle East forums. The invitation contained a description of the research and its aim. It was also made clear what the outcome of the results will be used for. A link was added at the end of the invitations which takes respondents to the online questionnaire. The authors have targeted consulting firms (architects, engineers, project managers, BIM managers, BIM coordinators, planners, and draftsmen), contractors, manufactures, construction managers, and site engineers. The authors made sure that the invitations were send to both the public and the private sector for a more accurate result.

Table 2: Questionnaire statistics

Number of sent invitations	297
Number of completed questionnaires	209
Number of valid questionnaire	200
Response rate	67.34%
Time taken to collect data	21 days

5. RESEARCH RESULTS

Respondents were from across the Architectural, Engineering and Construction (AEC) industry sectors operating in the Middle East and North Africa. The results of the questionnaire are presented in the next subsections.

5.1 Survey findings

From the findings of the survey, it can be stated that BIM implementation and adoption has increased in the Middle East compared to BuildingSmart (BuildingSmart, 2011) . All 200 respondents have had experience of using BIM and been able to realis both its advantages and disadvantages when applied it in projects. From Figure

1, it can be seen that the highest number of respondents were Architects (47 responses), followed by Structural Engineers (38 responses) and Mechanical engineers (22 responses). The lowest response rate was from Site Supervisors (5), followed by Electrical Engineers (11), and Quantity Surveyors (13). Other professionals have also participated in the questionnaire (14 respondents) such as BIM coordinators, BIM managers, BIM modelers, and planning engineers.

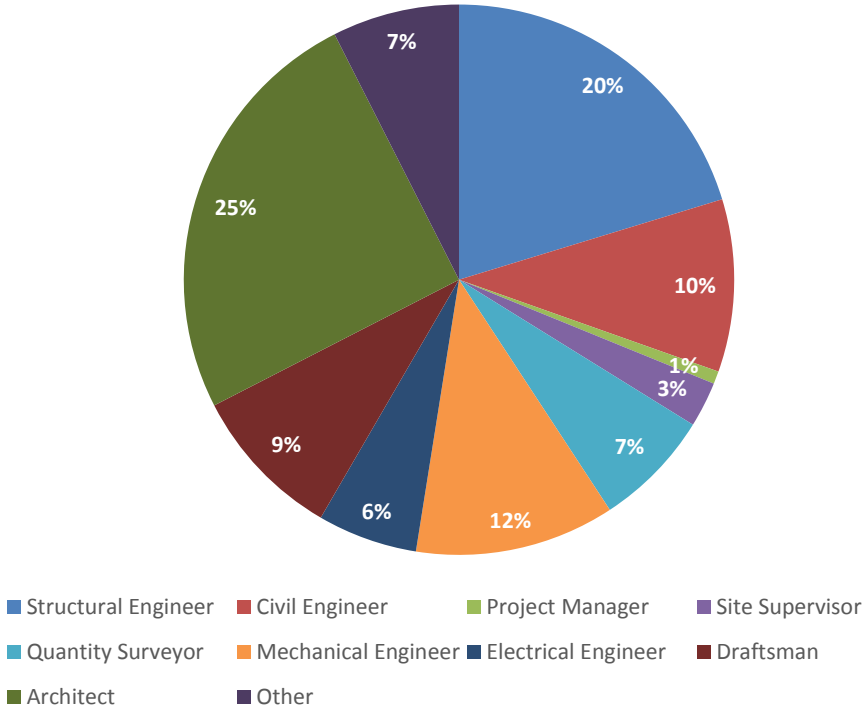

Figure 1: Respondents' profession

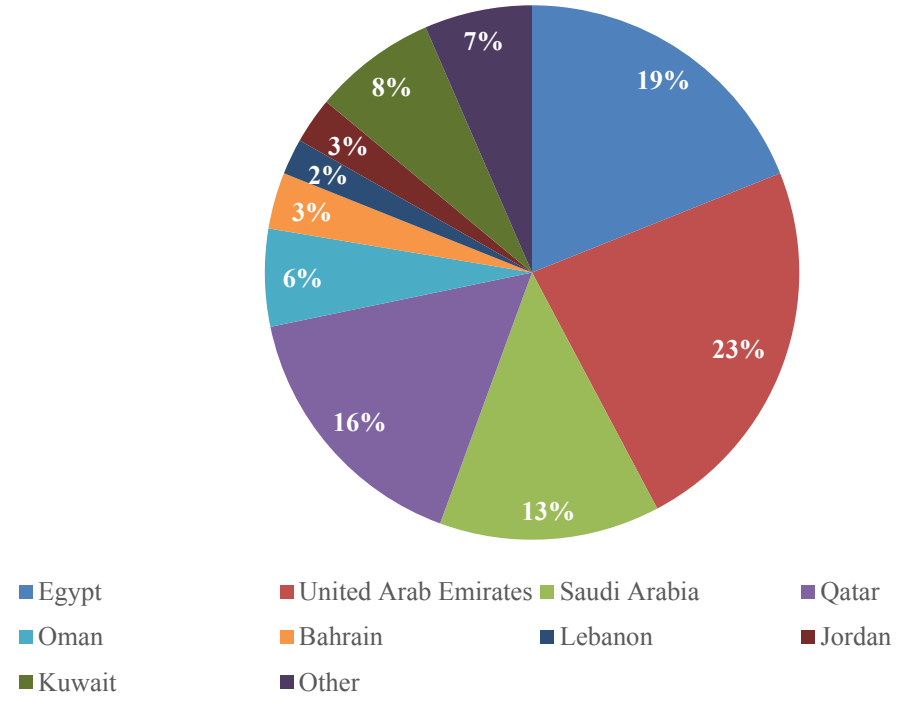

Figure 2: Countries' respondents who are involved in construction projects using BIM

Figure 2 shows countries in the Middle East currently carrying out BIM related construction projects. It was observed from the surveys that the United Arab Emirates had the most respondents indicating that they were currently working on BIM related projects in different parts of the country. While, the countries that had very low respondents indicating that they were working with BIM in their projects was Lebanon with 7 responses and Jordan with 9 responses. It was however identified that 21 respondents indicated that they were members of other countries like: Algeria, Iraq, Libya, Sudan, Iran, Tunisia, and Yemen. Respondents were asked about their years of experience in the industry. Only 13% had less than 2-year experience in the industry, while 87% had over 5 years of experience. 32% of respondents had between 5 to 10 years' experience of working in the construction industry. Figure 3 presents the respondents years of experience. 81 respondents (40.5%) expressed that they have between 2 to 5 years' experience working with BIM. Over 15 years of experience had 27 responses (13.5%). Respondents were asked about their experience with using BIM in projects. Results are presented in Figure 4, where the majority of respondents had 2 to 5 years' experience working with BIM. The second highest response rate was under 2 years' experience working with BIM. In addition to the number of years' experience, respondents were asked the number of BIM projects they had worked on within their years of experience. The results in Figure 5 showed a percentage of respondents to the number of BIM projects. It was observed that although 13.5% indicated they had over 15years experience in BIM, only 32% had worked on a maximum of 5 BIM projects.

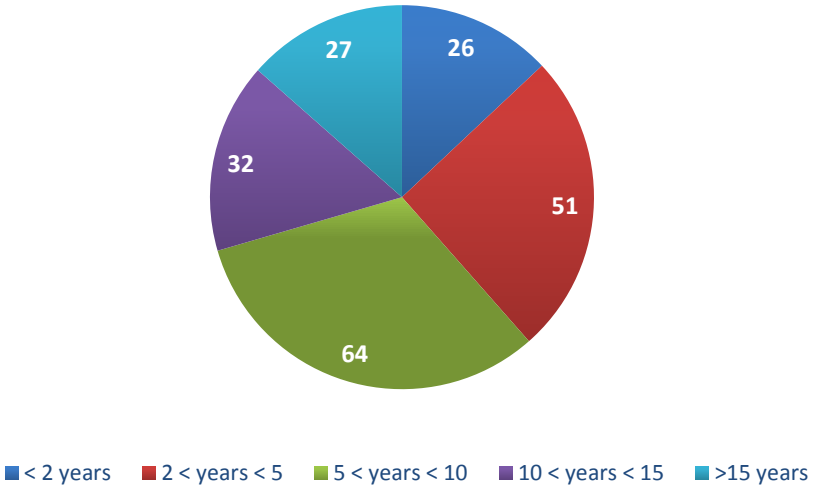

Figure 3: Years of respondent's experience in the Industry

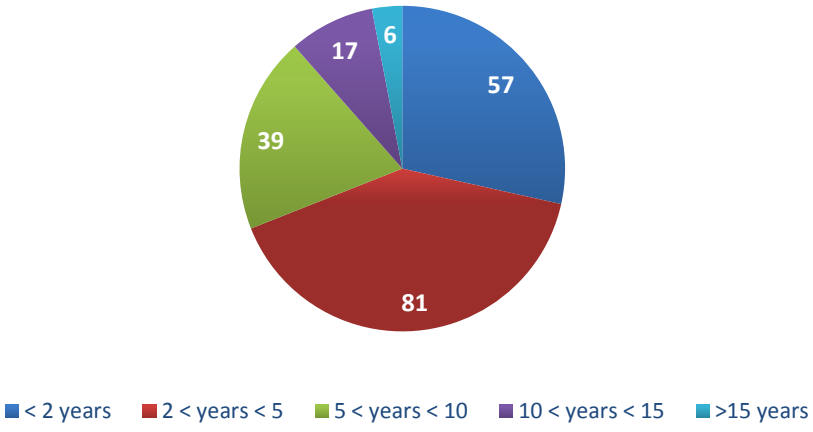

Figure 4: Years of respondents' experience working with BIM

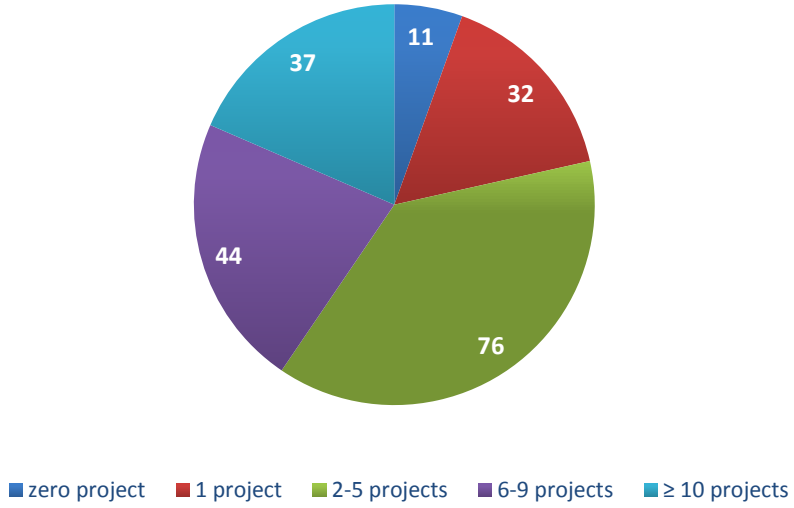

Figure 5: Number of BIM projects that respondents have worked on

The next set of questions focused on determining the stage of the construction project BIM was utilized or implemented. The findings as shown in Figure 6 indicate that 39.5% of the respondents used BIM in the design stage while 24.5% indicated that they implemented BIM in the construction stage of the project. On the other hand, 24% and 11% stated that BIM was used during detailing and prefabrication respectively. Only 4% of the respondents indicated that they used BIM for facility management. Furthermore, the results presented in Figure 7 shows that respondents had the choice of choosing more than one answer for this question making a total number of 436 responses. The most common BIM tool used is Revit which had 108 responses (24.77%) and ranked 1st in the Middle East; AutoCAD was ranked 2nd with 81 responses (18.57%). This corresponds to 'most of the respondents indicating that they use BIM in the design stage of construction projects. Although BIM implementation in the Middle East has increased in the past 5 years on site professionals still use 2D drawings for erection and placement. Navisworks had 66 responses (15.13%), where it was mainly used for construction schedule simulation. Additionally, 7.56% respondents indicated that they use other BIM tools like Solibri, StaadPro, Civil 3D, and Robot structure. However, 7.11% and 10.9% of the respondents selected ArchiCAD and Bentley respectively.

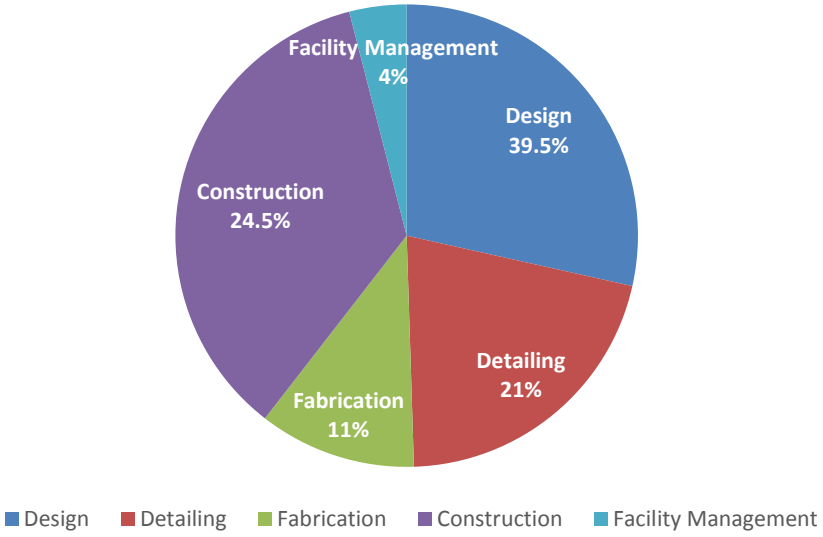

Figure 6: The most common use of BIM in the project life cycle in the Middle East

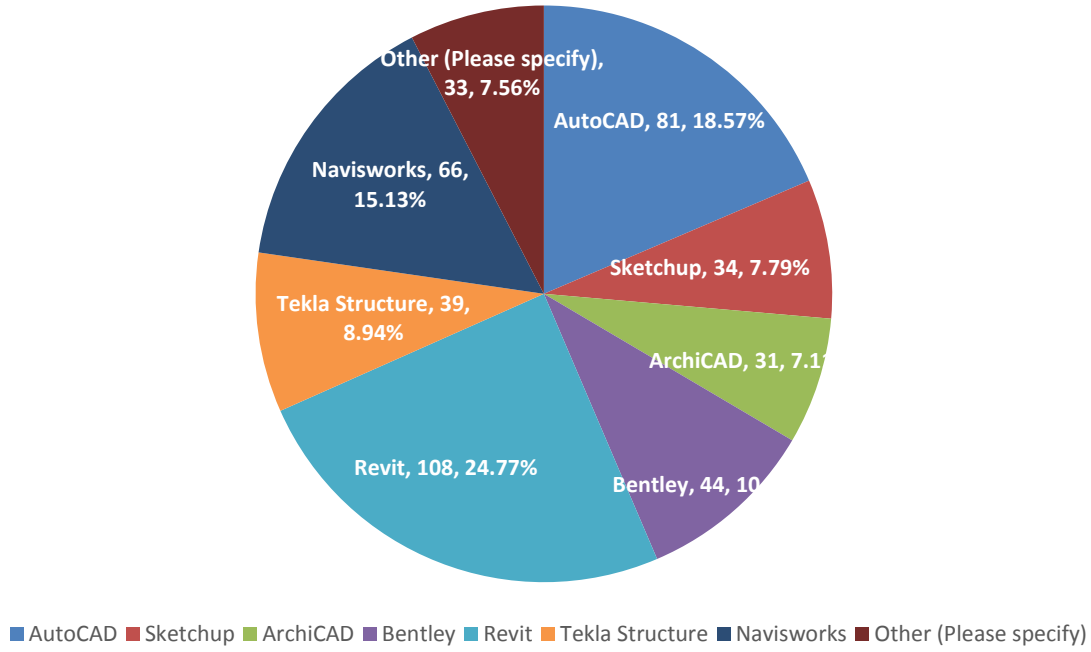

Figure 7: Most common BIM tool used by respondents.

To achieve the research aim, obstacles and barriers of implementing BIM in the Middle East had to be investigated. The respondents were given a list of barriers and obstacles of implementing BIM on projects based on previous research done, where they had to choose the best answer from their point of view. Figure 7 presents the results of responses, where respondents were also allowed to choose more than one answer for the question, making total number responses 448. The main perceived obstacles to BIM implementation was "comparison of BIM to CAD" which scored 18.30% along with "resistance of change" that scored 18.30%. These were identified as the main barriers to the implementation of BIM. Similarly, "contractors looking at BIM as additional cost" was also identified as a major barrier to BIM, with a response percentage of 18.08%. Lack of a BIM specialist in the region was ranked 4th with 14.50%, the factor was ranked 1st in 2010 by BuildingSmart (BuildingSmart, 2011) with 51%. From the findings it can be stated that construction professionals still look at BIM as an advanced AutoCAD tool that gives a 3D model of the structure.

Table 2: Barriers and obstacles of implementing BIM in the Middle East

Responses	Count	Percentage%
People comparing BIM to CAD	82	18.30 %
Resistance of change	82	18.30 %
Contractor looks at BIM as additional cost	81	18.08 %
Lack of BIM specialist in the region	65	14.50 %
Lack of client demand	56	12.5 %
Hardware and Software are expensive	29	6.40 %
BIM introduced by software developers	28	6.25 %
Technology available is enough (no need for more tools)	7	1.56 %
Not suitable for projects	4	0.89 %
Waste of time and human resources	3	0.66 %
Other (Please specify)	11	2.45 %
Total Responses	448	100 %

In addition, resistance to change is major factor that BIM faces in the region. Professionals have been working with AutoCAD (2D drawings) for more than a decade. They argue that by using the traditional way they have managed to complete various size projects without implementing BIM. It is very difficult for them to suddenly learn a new process such as BIM and its tools. This is in relationship with "Lack of BIM specialist in the region" since most specialists are software training centers and not BIM specialist in explaining the process of BIM.

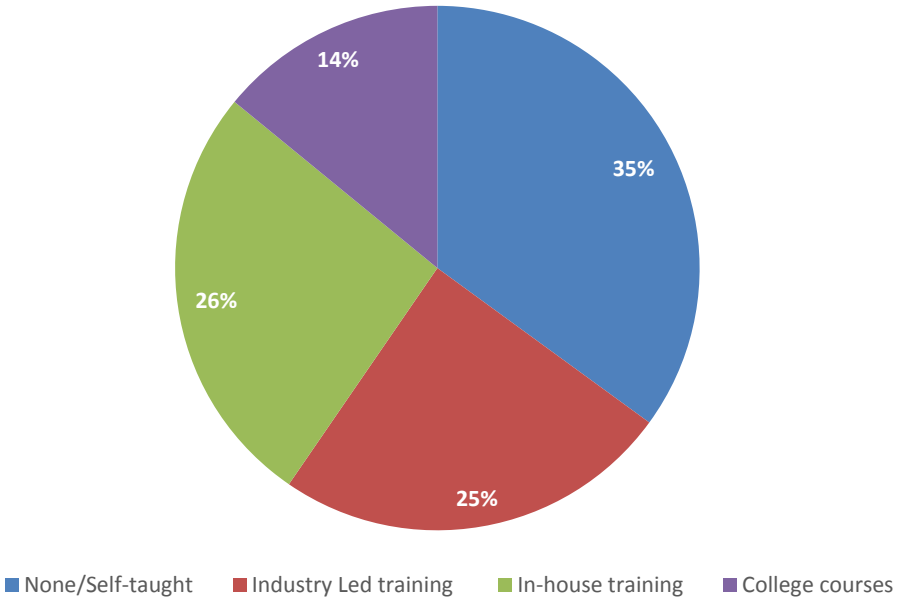

Figure 8: Respondent's training with BIM

Figure 8 presents the findings from the survey, where they were asked if they had any training with BIM. 34.89% respondents are self-taught on BIM. Most of the self-taught professionals are likely to only know the tools of BIM but not the process. Ranked 2nd was "in-house training" with 26.25% and shows that organizations in the region have started providing training for employees to learn the process and its tools. Usually these training courses are more on the use software rather than the process than the process of BIM.

Respondents were also asked on the project delivery method they use in their projects. The findings as documented in Figure 8 shows that the most common delivery method used in the Middle East construction is Design-Bid-Build with 95 respondents (36.53%). Design-Bid Build is the main project delivery method and it has been the delivery method for decades in the region. In the last decade design-build has started to be a popular delivery method especially with mega projects. The delivery method was ranked 2nd with 81 responses (31.15%). The respondents also had the option to choosing more than one answer for this question.

Table 3: Delivery methods respondents use in their projects

Responses	Count	Percentage %
Design-Bid-Build	95	36.53 %
Design-Build	81	31.15 %
GC/CM, CM/GC, CM/Risk	34	13.07 %
Cost Reimbursable / Cost Plus	41	15.76 %
Other (Please specify)	9	3.46 %
Total Responses	260	100 %

Table 4: Respondents' BIM duties and functions

Responses	Count	Percentage %
Analyze models for coordination or clash detection	85	14.55 %
Train others in BIM usage (colleagues, subordinates, subcontractors, owners etc.)	60	10.27 %
Extract estimates from BIM models	49	8.39 %
Create 2D plans using CAD-Drafting	48	8.21 %
Create 4D schedule sequencing	47	8.04 %
Manage other BIM personnel	38	6.50 %
Create site logistics plans or models	31	5.30 %
Document lessons learned or create best practices	30	5.13 %
Assist in making/make decisions about new hardware, software or processes	29	4.96 %
Test new software	28	4.79 %
Creating marketing materials related to BIM (includes visuals, animations, written response to RFPs etc.)	26	4.45 %
Represent your company at technical conferences outreach and learning	26	4.45 %
Set up jobsites with BIM (Hardware and Software)	22	3.76 %
Analyze models for environmental concerns (energy, day lighting etc.)	21	3.59 %
Prepare a facilities management ready model	20	3.42 %
Analyze models for safety	15	2.56 %
Other (Please specify)	9	1.5 %
Total Responses	584	100 %

Likewise, the research sort to investigate if the basic duties and functions of BIM in the region was clearly understood. Hence, 16 duties and functions for BIM were identified and the respondents were asked to choose what they felt were the basic duties and functions of BIM. Table 4 presents the results for the respondents who made a total number of 584 responses. From the list, "Analyze models for coordination or clash detection" was ranked 1st with 85 responses (14.55%), while the 2nd was "train others in BIM usage (colleagues, subordinates, subcontractors, owners etc.) with 10.27%, the 3rd was "extract estimates from BIM models" and it had 8.39%. However, the least ranked was "analyses models for safety" and it had only 2.56% (15 responses). Since all respondents indicated that they were currently using BIM or had used BIM on previous projects, it was important to get an understanding of how much time they spent on BIM duties. Hence they were to select the percentage of time they spent working on BIM projects. Figure 9 represents the results. Here it was indicated that 34% of respondents use 61-90% of their time on BIM duties, while only 9.5% reported that they spend 91-100% of their time on BIM duties. Respondents were asked if their organization was investing in BIM. Here, the respondents had to choose one answer from a scale of Strongly Agree to Strongly Disagree. Table 5 presents the results of respondents.

Table 5: Respondent's company investing in BIM

Responses	Count	Percentage %
Strongly Agree	35	17.5 %
Agree	49	24.5 %
Neutral	78	39 %
Disagree	27	13.5 %
Strongly Disagree	11	5.5 %
Total Responses	200	100 %

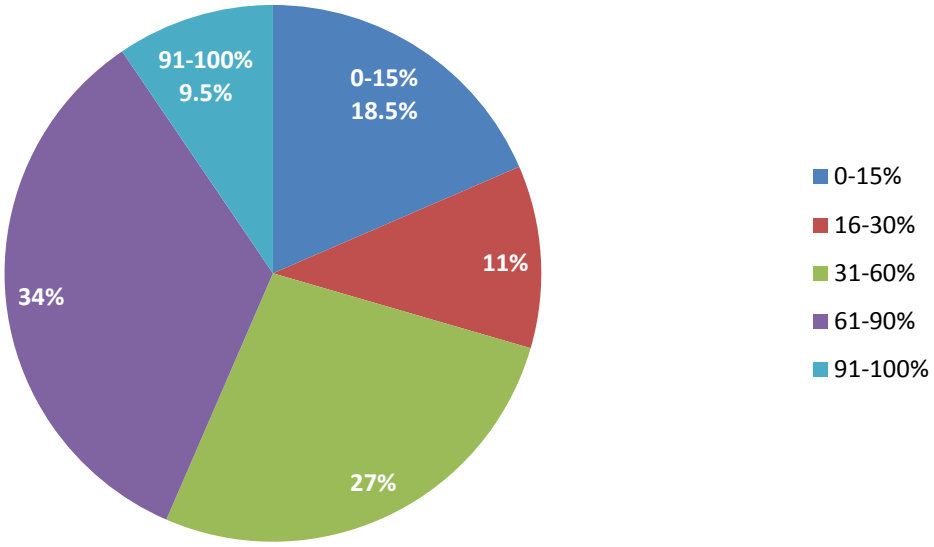

Figure 9: Respondent's time using BIM in projects

6. RESEARCH DISCUSSION

From the findings of the survey, when compared to the statistics obtained by Building SMART (BuildingSmart, 2011), it can be stated that BIM adoption in the Middle East is on the rise, and is currently being implemented in certain aspects within construction projects. It was found that, amongst all Middle Eastern countries, United Arab Emirates (UAE) leads as the country that has the most projects using BIM, which also reasons latest research efforts (Mehran, 2016). Egypt follows UAE in terms of implementing BIM and this is due to infrastructure projects. This can perhaps be reasoned due to the 37% of respondents who stated that although their companies are based in Egypt, they simultaneously working on International project where BIM is implemented. Qatar was next, after UAE and Egypt, who have seen an increase in BIM implementation in projects since 2010 moving ahead of Saudi Arabia, which was ranked 4th with 43 respondents. Similar to UAE, research has acknowledged BIM implementation in Qatar, for instance (Ahmed, 2014) undertook a research on the barriers of implementing BIM and 4D in Qatar construction Industry. Within that research, 65% of respondents have reported the implementing of BIM on mega projects (over 1 billion dollars' budget), followed by 23% on large scale projects. It is expected that BIM implementation will continue to increase in Qatar due to the growing population and demand for making the capital city as a host center of many international organizations (Ahmed, 2014). Kuwait has followed after Qatar, where there has been a significant increase in BIM implementation (Gerges). Indeed, BIM implementation has increased Kuwait in the last five years when compared to the results published by BuildingSmart (BuildingSmart, 2011). This can be realized as Kuwait has

managed to have ongoing projects using BIM more than Oman and Bahrain who were ranked higher in 2010. In addition, Lebanon and Jordan are ranked the least in BIM implementation on projects since the construction industry not growing due to contractors' financial issues and political reasons. Figure 3 and Figure 4 showed respondents' years of experience in the industry, their experience working with BIM, and the number of BIM projects they have been involved in. Comparing the results with BuildingSmart (BuildingSmart, 2011) report, it can be stated that there has been an increase in the number of professionals using BIM on projects. In this research, it was recorded that 76 respondents (38%) currently implemented BIM on 2-5 projects, followed by 44 respondents (22%) implemented BIM on 6-9 projects. Whereas, "there is a still large number of companies in the testing phase", since 13% of respondents in the report implemented BIM on only one project. However, it can be observed that in five years the implementation of BIM has increased with 32 respondents (16%) expressing that they have implemented BIM on one project (BuildingSmart, 2011). Furthermore, companies in the region (Middle East) have started to test BIM on smaller scale projects and have seen the advantages that it brings to the design or construction phase. Some respondents who implemented BIM on only 1 project commented on the implementation process by stating that "*we were not sure of the process, but we have managed to learn through-out the project. Although we haven't implemented BIM process and just used its tools we have still seen an increase in productivity, in reducing design errors, and better communication amongst project members*". Consequently, it can be inferred that the return in BIM investment was a motive for implementing BIM in more than three BIM projects, since companies had learned from previous projects enjoying the benefits of BIM.

7. CLASSIFICATION OF BIM IMPLEMENTATION IN THE MIDDLE EAST

Although 37 respondents indicated that they have implemented BIM on 10 or more projects this was due to the fact that they were working on local and international projects. Similarly, six out of the fifteen interviewed companies adopted BIM in their projects (Awwad, 2013). In addition, 75% of the surveyed BIM users were currently using BIM on international projects (Awwad, 2013) . In Lebanon, for example, BIM is at its early stages and the industry mainly uses it for clash detection, 3D visualization, quantity surveying and 2D extractions (Awwad, 2013) . Depending on the professionals, BIM was implemented at different stages during the project life cycle as seen when looking at the results presented in figure 6. Construction and design phases were the two main stages where respondents indicated that they implemented BIM. When compared with other research, in Malaysia, it was found that 48.8% of surveyed respondents use BIM in the design phase. Facility management ranked the least with 4% as respondents' stating that BIM implementation is at an early stage (Memon, 2014). Table 1 presented the barriers and obstacles of BIM indicated by respondents and these are the 5 most common obstacles identified by respondents: "Comparison of BIM to CAD", "Resistance of Change", "Contractors look at BIM as additional cost", "Lack of a BIM specialist in the region" and "Lack of client demand" were the top five factors that stopped BIM from being implemented in the region. On the other hand, in 2010 BuildingSmart (BuildingSmart, 2011) identified barriers such as: "availability of skilled staff", "cost of software", cost of implementation", "availability of training", and "senior management buy in". In most of the Middle East region's projects, the client was the government, but BIM was implemented by most of the private sector clients. BIM has not been used on many of the public projects. Besides the UAE and Qatar, there have not been any governments insisting on the use of BIM for governments' projects. In addition, the findings from the questionnaire showed that 11 respondents answered "Other" and specified that the main barriers from their opinion is that BIM could not tell them anything more than what they already knew. Based on the results gathered, it can be argued that BIM in the Middle East can be classified as 'Incremental to Modular' innovation model (Slaughter, 1998) within the construction industry. (Slaughter, 1998) has classified innovation models to: Incremental, Modular, Architectural, System and Radical. 'Incremental' innovation is defined as a small improvement to standard practice based on existing experience and knowledge whereas 'Modular' innovation is described as a significant change in concept within a component but leaves the links to other components and systems unchanged (Slaughter, 1998). This can be reasoned by looking at the current application of BIM within different Middle Eastern countries, which often focus on design and construction phases. Countries such as the UK, USA and other European countries can be classified as 'System' in terms of BIM implementation where BIM can be described as an integrated set of innovations, which complement each other to achieve new functions or levels of performance.

8. GAPS OF BIM IMPLEMENTATION IN THE MIDDLE EAST

Two respondents indicated that BIM models were not deliverable on most projects because they felt contractors were not able to manage BIM especially when the design was handed over to them in a non-editable software format and they found it difficult editing the designs. Similarly, (Ahmed, 2014) has studied the barriers of implementing BIM in Qatar, which were "availability of skilled professionals", "knowledge about BIM", "disruption to current process/resistance to change", "absence of contractual requirement for BIM implementation", and ROI (Return of Investment) of using BIM not clearly defined. (Jung, 2015) pointed out that the Middle Eastern region is an early adopters of BIM and finding BIM experts within the region was a major challenge. The region according to the study uses BIM for "3D coordination and design authority". Correspondingly, in Lebanon, (Awwad, 2013) indicated that the biggest obstacle to BIM was resistance to change. His was primarily because professionals found it difficult to learn and adapt to new technologies. It was reported that 70 engineers have been trained to use the Revit software, and only 6 could use it effectively, which indicates that many of the engineers in this region are still working with the traditional design methods. Similarly, (Memon, 2014) in Malaysia, stated that the barriers to implementing BIM was the lack of competent staff to operate the software; unawareness of the technology; expensive software; and longer time to develop the software. While in Hong Kong similar results to the Middle East were found (Chan, 2014), since the main barriers were lack of qualified in house staff to carry out the BIM related works, lack of training/education, lack of client demand, and lack of government leads/direction. One important aspect of the survey carried out in this research was respondents indicating what they used BIM to achieve, in terms of duties and functions. The respondents were given 16 BIM duties and functions as presented in table 4. The top ranked BIM duties and functions were indicated to be used during the design phase. For example, "analyze models for coordination or clash detection", "extracting estimates from BIM models", and "creating 2D plans using CAD drafting". Comparing these results with the findings of NBS (NBS, 2015) research in the United Kingdom, it was found that 83% professional used BIM to produce 2D digital drawings, while 75% of respondents stated that BIM was used for work collaboration on design. Furthermore, 54% of respondents indicated that they shared models with design team members outside their organization. However, within the research carried out here, this was not the case in the Middle East as design teams do not share models outside their organization expect on rare occasions where it was based on client's request. Hence, shop drawings are still presented in AutoCAD 2D for site use (erection and sequence). Based on the results, it can be claimed that competency is one of the major factors influencing BIM implementation in the Middle East. In BIM, according to (Migilinskas, et al 2013) and (Steel, et al 2012), competency can be related to 'information and communication competence', 'Technical knowledge competence' and 'cost management competence'. The results show that both 'information and communication competence' and 'technical knowledge competence' still lack in the Middle East, which influence BIM implementation. 'cost management competence' can be argued as a later step, as it deals with what activities need to be considered during the design phase in order to improve the overall cost of the project. This can be investigated when BIM is implemented on a moderate level across the Middle Eastern region, or alternatively in some countries where BIM is on a rapid increase such as UAE, Egypt and Qatar.

9. CONCLUSION

Building Information Modeling (BIM) is an expansive knowledge domain within the Design, Construction and Operation industry and a great deal with Architectural and Construction Engineering industry. It can be stated that BIM implementation and adoption has slowly increased in the Middle East compared to previous research. However, in the Middle East, the state of BIM adoption is not satisfactory because only 20% of AEC organizations are using BIM or are involved in BIM adoption process in any capacity. While the remaining 80% organizations are neither using BIM nor involved in BIM adoption process in any capacity.

In summary, it can be stated that the country having highest number of BIM projects in the Middle East from this research are United Arab Emirates. While, the countries having the least number of BIM projects are Lebanon and Jordan. Although the research identified other countries such as Algeria, Iraq, Libya, Sudan, Iran, Tunisia, and Yemen where the adoption of BIM could not be fully accounted.

The research also identified the most common BIM tool used in this region; this was Revit followed by AutoCAD. Even though BIM implementation in the Middle East has increased in the past 5 years, on site professionals still use 2D drawings for erection and placement. Other software and BIM technologies such as

Navisworks was identified to be used essentially for construction schedule simulation, While Solibri, StaadPro, Civil 3D, and Robot structure were scarily used.

Furthermore, the main perceived obstacles to BIM implementation was “comparison of BIM to CAD” this was followed by “resistance of change” and “contractors look at BIM as additional cost”. Another obstacle which from previous research was identified as the main obstacle was “Lack of a BIM specialist in the region”. Hence it can be inferred that more professionals are beginning to adopt BIM although most professionals within this region still look at BIM as an advanced AutoCAD tool that gives a 3D model of the structure.

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