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Lack of BIM Training: Investigating Practical Solutions for the State of Kuwait

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Abstract**—**Despite the evident benefits of building information modeling (BIM) to the construction industry, it faces significant implementation challenges in the State of Kuwait. This study investigates the awareness of construction stakeholders of BIM implementation challenges, and identifies various solutions to overcome these challenges. Specifically, the main objectives of this study are to: (1) characterize the barriers that deter utilization of BIM, (2) examine the awareness of engineers, architects, and construction stakeholders of these barriers, and (3) identify practical solutions to facilitate BIM utilization. A questionnaire survey was designed to collect data on the aforementioned objectives from local companies and senior BIM experts. It was found that engineers are highly aware of BIM implementation barriers. In addition, it was concluded from the questionnaire that the biggest barrier is the lack of BIM training. Based on expert feedback, the study concluded with a number of recommendations on how to overcome the barriers of BIM utilization. This should prove useful to the construction industry stakeholders and can lead to significant changes to design and construction practices.

Keywords**—**Building information modeling, construction, challenges, information technology.

I. Introduction

THE evolution of BIM is rapidly transforming the roles of construction engineering and management professionals in the architecture, engineering, and construction (designers) industries. The benefits of BIM adoption touch all project specialties, as they include: improved visualization, better coordination among project stakeholders, better integration of construction drawings, among others. BIM received significant attention from the construction industry around 10 years ago and since then it has been developing with time [1]. It is considered a new approach to enhance the construction process, improve design efficiency, and support decision making, since it enhances visualization and improves communications among project stakeholders [1]-[3].

Construction practitioners, field experts, and researchers have been examining the utilization of BIM as a fundamental information technology tool to support construction efficiency and accuracy. The advantages of BIM technology include: reducing the likelihood of making mistakes on construction sites, improving documentation accuracy/quality, accelerating the rate of construction, and providing the owner with a clear visualization of his/her project and how much it will cost [4]. BIM advantages do not stop at the point of modeling the project in a 3D graphical representation. It enables tracking the construction process by linking the 3D building objects with their corresponding activities in the schedule to create a 4D model, using time as a fourth dimension. The aim of this is to optimize the sequencing of the project activities, and visualize the schedule [5]. BIM could also be utilized to simplify the process of quantity estimation of building materials, especially when the quantities are linked directly to cost databases to estimate cost. Hamm [6] highlighted that BIM can also be integrated with a cost factor for generating 5D simulations. By using this comprehensive information, building design can be facilitated and improved. The most appropriate materials for a particular project can be specifically determined, and value engineering procedures could be implemented in a full visualizing and understanding situation [3].

The transitional period from conventional paper drafting to BIM was not a short term period; it extended over a few decades and featured enormous changes. In 1963 Ivan Sutherland invented Sketchpad, which is considered the origin of CAD. Initially, the technology did not gain rapid support but eventually it became popular [7]. In 1982, ArchiCAD was developed and considered as the first prototype of BIM as it was the first software able to create 3D models as well as store data of all building elements. Later, in the early 1980s, the drafting tables in many design companies were replaced with workstations running CAD software [8]. Recently, object-oriented CAD structure (OOCAD) replaced the two-dimension symbols (which were basically just lines) with "objects" or building elements, with ability of representing the behavior of the building elements [9]. Owing to the uncertainty and uniqueness of construction projects, designers are tasked to build their projects virtually before actual work starts on site. From this premise, BIM technology has emerged and is now one of the leading innovative technologies which adopt a virtual design and construction approach [10]. In 2000, Revit had been developed to utilize a single database for the entire project, in what was considered a revolution in the BIM world [11].

According to Kia [12], BIM software can be categorized into three main groups, depending on the software use. These three groups are: (1) BIM for modeling, (2) BIM for design analysis, and (3) BIM for 4D modeling.

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There is no doubt that any client wants his project to be completed on time within target budget and optimum quality [13]; BIM can easily facilitate that, if it is executed in an efficient manner. The implementation of BIM technology on a particular project in the design, construction, and project operation stages should maximize the quality of work, speed up the construction process, improve the productivity, and reduce costs for building industry [14]. To illustrate this precisely, the benefits of BIM can be categorized into four main categories: (1) organizational, (2) design-related, (3) managerial, and (4) construction-related benefits. With respect to the organizational benefits; BIM can facilitate the process for accessing information, improve the coordination process among the different specialties of the same project and improve conflict detection [15]. On the other hand, with respect to the design-related benefits, BIM makes it possible to make early changes when the cost of these changes is minimal [16]. In addition, BIM improves the visualizations by dealing with a 3D model with the details of all building elements which means fewer errors in the design stage [16]. In regards to managerial benefits, BIM reduces errors, RFIs and change orders [16]. Additionally, BIM has several benefits during the construction stage including: fewer construction rework, easier quantity take-off process, improving project planning and monitoring, and facilitating payment processing [15], [17]-[19]. Despite all these benefits, BIM adoption faces some barriers that slow down its implementation. Through this research several barriers were recorded. Human resistance to change is always the first challenge that may face any new technology. In addition, unawareness of BIM technology and its numerous benefits could hinder its utilization and adoption by construction stakeholders. Moreover, it was reported that engineering schools do not commonly offer BIM courses which leads to a shortage of trained personnel who could use BIM. Consequently, extra expenses are associated with BIM implementation to train existing staff or hire new BIM experts. Furthermore, installing new hardware and software cost could cost construction companies huge expenses.

II. Problem Statement

Over the past 50 years, construction projects in Kuwait suffered from various problems, including the need to minimize waste, eliminate inefficiency, improve productivity, while taking on the requirements of new legislation for eco-friendly construction [20]. It is too complicated to achieve such outcomes promptly; however, the adoption of a collaborative and integrated procurement delivery system by using innovative tools could contribute to achieving these goals.

Construction experts worldwide are trying to develop technologies in a way to serve evolution demands in construction projects ending now to BIM technology. Hence, the moment for changing the way of construction in Kuwait has approached and the time to follow up the latest technology is reached. However, BIM adoption is still limited and slow in Kuwait with no much interest about it among in-charge persons in construction projects. Therefore, this research was conducted to investigate the problems associated with the utilization of BIM in Kuwait.

III. Objectives

This study investigates the problems that face BIM utilization in the State of Kuwait and proposes solutions to overcome them through a comprehensive survey of construction industry stakeholders. More specifically, this study aims to: (1) identify the obstacles that can slowdown the adoption of BIM by the construction industry, (2) investigate the perception of project participants of these obstacles, and (3) recommend effective approaches to encourage BIM adoption.

IV. Research Methodology

To accomplish the aforementioned objectives, the study is been divided into two phases, as shown in Fig. 1. The first phase is designed to identify and characterize the barriers that face BIM utilization in Kuwait through a questionnaire survey. The second phase is designed to investigate the approaches that would encourage the utilization of BIM among construction stakeholders.

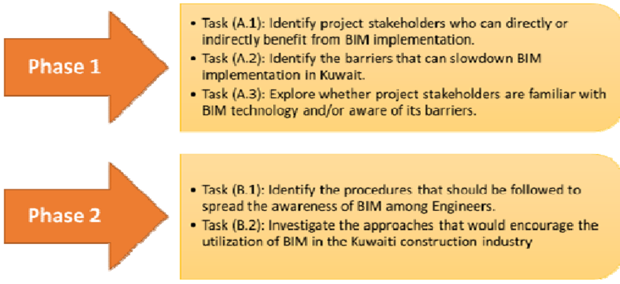

Fig. 1 Summary of research methodology

V. Questionnaire and Sampling

In order to collect data from project stakeholders about their awareness of BIM barriers, a survey was conducted. Through this survey, questionnaires were distributed to all project stakeholders that were identified to include: contractors, subcontractors, consultants, designing firms and construction management firms (CM) in order to get the views from all the parties involved in construction projects.

As the BIM market is relatively new in the region, the population targeted in this survey was relatively limited, and so a sample of respondents was chosen in such a way that they represent the total population as much as possible. The tricky question was "How many people should the sample consist of?" Using a correct sample size is crucial for the survey. After all, a sample that is too big will lead to waste of precious resources such as time and money, while a sample that is too small will not provide reliable results.

One of the factors affecting the sample size is the required degree of accuracy. In this survey, a high confidence level was selected to be the basis of selection. The required number of questionnaires was computed using the following equation

[21]:

$$n^2 = z^2\sigma^2 / E^2. \quad (1)$$

where; n is the sample size, z is the z value corresponding to the level of confidence, σ is the standard deviation of the population, and E is the maximum error.

An initial random sample of 95 questionnaires was collected and the highest standard deviation was calculated from the answers to the various questions. The highest standard deviation was found to be 1.132, thus in the previous equation б= 1.132. The level of confidence was chosen to be 85%, and hence, the corresponding z value is 1.44 and the accepted error was set to be 0.15. Accordingly, the required number of questionnaires will be:

$$n = (1.44^2) * (1.132^2) / (0.15^2) = 118.1$$

Therefore the minimum number of questionnaires should be 119 questionnaires. Thus 95 questionnaires were considered good enough.

VI. Data Analysis

The survey was distributed among several construction industry stakeholders, including contractors, consultants, designers and construction management firms; and 95 completed surveys were collected. The collected data were aggregated in spreadsheets, summarized and analyzed. The following sections present the data analysis in more detail:

A. Staff Attitude and Knowledge

The purpose of this survey section was to poll experts on their assessment of staff attitude toward and knowledge of BIM concepts.

Question (Q.1) was “Have you heard about BIM before?”

About 97% of the respondents indicated that they have heard about BIM which is an important indicator that the results of the survey should be valid to a certain extent. Only 3% of the respondents indicated that they did not hear about BIM. The purpose of this question was to investigate the awareness of various stakeholders about BIM, and as shown by this statistic, many of the respondents, especially those with less than five years of work experience – and who are normally technologically savvy – indicated that they are aware of BIM. However, the majority stated that they did not receive instruction on BIM at the undergraduate or graduate levels. This underlines the importance of introducing BIM into the curriculum of engineering schools in order to better prepare the young engineers for their careers.

Question (Q2) was “To what extent do you evaluate your understanding of BIM?”

The purpose of this question is to tackle the degree of familiarity of the participants with BIM technology. About 32% of the respondents are somehow familiar in the understanding of BIM technology and almost a similar percentage of 31% of the respondents are very familiar with it. Almost equal percentages of 19% and 18% read/heard about BIM and experts in BIM, respectively. This gives a normal distribution about the familiarity of the respondents in BIM.

A lot of participants said that although they heard about BIM and what importance its implementation could bring to a project, they never had the desire or the need to learn this new technology as they have been familiar with traditional working approach for many years and found it useless to learn a new technology.

Question (Q3) was “Have you been involved in projects that utilize BIM technology?”

This question shows the size of the problem that awaits BIM implementation in Kuwait. Around 84% of the respondents were not involved in projects that utilize BIM technology, although they might have heard of the technology, while only 16% of the respondents were involved. Mainly all the involved participants started their BIM experience after 2013 when mega projects kicked off in Kuwait as part of the Kuwaiti economic development plan.

Question (Q4) was “Please specify the years of experience in BIM.”

As mentioned earlier, many of the involved participants started their BIM experience after 2013, when mega projects kicked off in Kuwait, as part of the Kuwaiti economic development plan, except engineers and modelers who had previous experience outside Kuwait. Roughly about 85% have been using BIM for less than five years, 12% and 4% of the respondents have experience in BIM between 5-10 years and 10-20 years, respectively. The last two statistics came from respondents working with international designing firms.

Question (Q5) was “Please specify the number of projects your organization undertook using BIM”

About 84% of the respondents undertook less than five projects using BIM, 14% of the respondents undertook between 5-10 projects using BIM, and only 2% of the respondents utilized BIM in more than 10 projects. The last statistic came from international designing firms. With this limited experience for the participants.

Question (Q6) was “Are you aware of BIM benefits?”

About 90% of the respondents indicated they are aware of BIM benefits, while 10% indicated they are not. Being familiar with the BIM adaptation benefits can encourage firm management to adopt the technology and encourage training and developing its own staff in this regard. However, as many firms’ in-charge personnel are not aware of those benefits, many ambitious employees train themselves on their own which is can be very costly.

Question (Q7) was “Which BIM software do you use for your project?”

About 60% of the users indicated they use Revit (Arch, Struct, MEP) which is very similar to AutoCAD and is easily learnt by those who are familiar with AutoCAD. Navisworks took the second position in the most frequently BIM software used with a 16% usage. Navisworks is frequently used to detect clashes among other things, consequently, companies applying the least BIM requirements may use Navisworks. In addition, Revit and Navisworks are Autodesk productions which are very familiar to engineers. About 8% of the respondents use Tekla, 8% use Robot, and 2% of the respondents use Bentley (Arch, Struct, Mech, Elect).

Question (Q8) was "Do you believe that implementing BIM will solve construction problems in Kuwait?"

Although 69% of the respondents thought that implementing BIM will solve major problems in Kuwait construction, this percentage could have been much higher if employees were familiarized with the benefits a BIM technology could bring. Only 15% thought that BIM will solve non-major problem. This is mainly due to being involved in projects implementing BIM only as a contractual requirement, again the wish of contractors. About 14% of the respondents were not sure how effectively BIM may contribute in solving construction problems. Only 1% believed that BIM will not solve any construction problem in Kuwait.

Question (Q9) was "Do you think implementing BIM will be required in the future in construction contracts in Kuwait?"

The majority of the respondents (about 86%) think that implementing BIM will be required in the future in construction contracts in Kuwait. Since BIM is gaining a worldwide interest and it is rapidly growing; all participants believe that Kuwait should adopt this technology. In order to encourage implementing BIM, it should be required in construction contracts in Kuwait. About 14% of the respondents were not sure about that idea.

Question (Q10) was "What do you think BIM actually is?"

This question was asked because there is a huge misunderstanding among project stakeholders about the actual concept of BIM. BIM is beyond the fact of a tool that produce a 3D model, instead it is a complete process for information management that starts at the design stage and lasts till the end of the maintenance period.

Although 74% of the respondents think BIM is a process for information management, they gave wrong answers and information when asked in detail about the nature of these processes. A lot of respondents who answered that BIM is a process for information management believed that BIM is just a 3D presentation of regular shop drawings, while others thought that BIM is a presentation tool. About, 25% believe that it is a tool/software.

B. Barriers of BIM Implementation in Kuwait

The purpose of the second section of the survey is to identify and assess the barriers that would deter implementing and utilizing BIM technology. Respondents were asked to give their opinion on a prepared list of barriers that were initially identified from the literature, and to what extent they agree that the identified item is a barrier on a 5-point Likert scale (strongly agree, agree, neutral, disagree and strongly disagree). Highlighting the most significant barriers should help in identifying the approaches to facilitate BIM utilization.

The analysis of BIM barriers was carried out on three different levels:

1. On the first level, descriptive statistical analysis was carried out on the Likert responses collected for each barrier in order to identify whether there is a consensus among respondents or not.
2. On the second level, a comparison among the anticipated barriers was conducted in order to identify those barriers that most experts agree upon. The analysis was conducted by lumping the respondents who either agreed or strongly agree upon a certain barrier into one group, and determining the percentage of those respondents to the total number of surveyed stakeholders.
3. On the third level, the survey examined whether there is a difference in opinion about the barriers among the two groups of contractors and designers (this group includes architects, engineers and consultants). This should highlight the most significant barriers for the vast majority of stakeholders.

The following sections discuss the aforementioned levels of analysis in more detail:

Analysis Level 1: Respondents answers for each individual barrier:

This section highlights the top three barriers that gained agreement among the participants (M-1, M-2, and M-3), and the three barriers with the least agreement (L-1, L-2, and L-3).

M.1. Lack of BIM Training

The participants were asked to evaluate "Lack of BIM Training" as a perceived barrier of BIM. As shown in Fig. 2, about 42% of the respondents strongly agree that it is a perceived BIM barrier. In addition, about 48% of the respondents just agree that it is a barrier. About 8% of the respondents were neutral in their opinion, and only 2% disagreed that it is a barrier of BIM. No respondents disagreed strongly to this barrier. Hence, it is concluded that lack of BIM training is a significant barrier of BIM implementation.

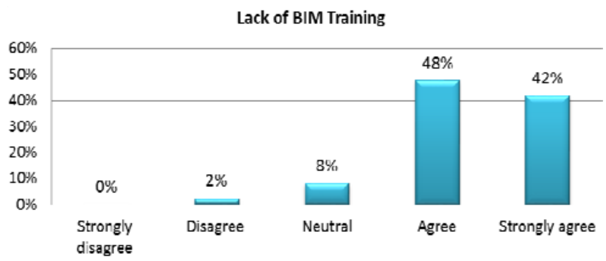

Fig. 2 Impact of lack of BIM training

M.2. Lack of Skilled Personnel

The participants were asked to evaluate "Lack of Skilled Personnel" as a perceived barrier of BIM. As shown in Fig. 3, about 47% of the respondents strongly agree that it is a perceived BIM barrier. In addition, about 38% of the respondents just agree that it is a barrier. About 14% of the respondents were neutral in their opinion, and only 1%

disagreed that it is a barrier of BIM. No respondents disagreed strongly to this barrier. Hence, it is concluded that lack of skilled personnel is a significant barrier of BIM implementation.

M.3. The Concept of BIM is not Well Understood

The participants were asked to evaluate "The Concept of BIM is not Well Understood" as a perceived barrier of BIM. As shown in Fig. 4, about 31% of the respondents strongly agree that it is a perceived BIM barrier. In addition, about half of the respondents (51%) just agree that it is a barrier. About 13% of the respondents were neutral in their opinion, and 2% disagreed that it is a barrier of BIM. Only 2% of the respondents disagreed strongly to this barrier. Hence, it is concluded that not understanding the concept of BIM is a significant barrier of BIM implementation.

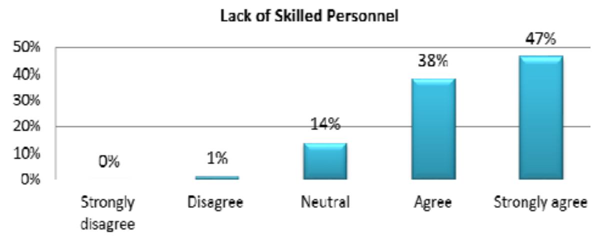

Fig. 3 Impact of lack of skilled personnel

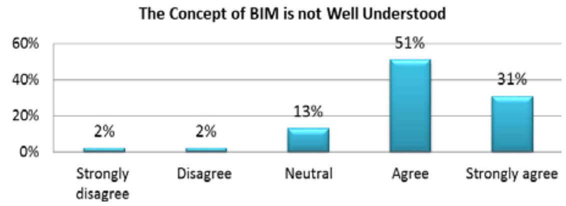

Fig. 4 Impact of misunderstanding BIM concepts

L.1. Time to Setup BIM Technology Requirements

The participants were asked to evaluate "Cost of Hardware and Networks" as a perceived barrier of BIM. As shown in Fig. 5, about 12% of the respondents strongly agree that it is a perceived BIM barrier. In addition, about 38% of the respondents just agree that it is a barrier. About 33% of the respondents were neutral in their opinion, and 20% disagreed that it is a barrier of BIM. About 15% of the respondents disagreed strongly to this barrier. Hence, it is concluded that time to setup BIM Technology requirements is not considered as a significant challenge of BIM implementation since there is no consensus among the participants that it is a barrier.

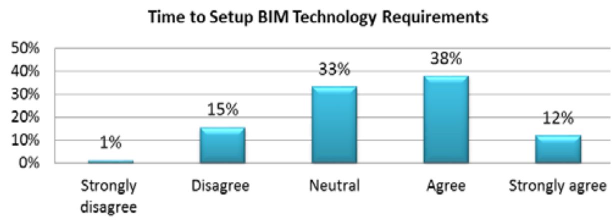

Fig. 5 Impact of setup time requirement

L.2. Time Required to Produce the Models

The participants were asked to evaluate "Cost of Hardware and Networks" as a perceived barrier of BIM. As shown in Fig. 6, about 20% of the respondents strongly agree that it is a perceived BIM barrier. In addition, about 30% of the respondents just agree that it is a barrier. About 28% of the respondents were neutral in their opinion, and 20% disagreed that it is a barrier of BIM. Only 2% of the respondents disagreed strongly to this barrier. It is recognized that the opinions of the respondents are almost divided equally between the five answers. Hence, it is concluded that time required to produce the models is not considered as a significant challenge of BIM implementation since there is no consensus among the participants that it is a barrier.

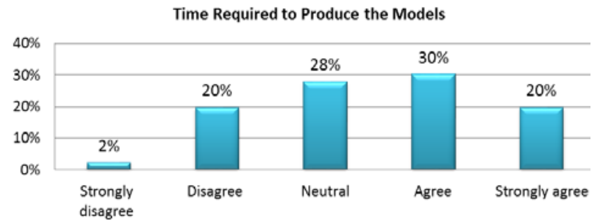

Fig. 6 Impact of required modeling time

L.3. People Refusal to Learn New Software

The participants were asked to evaluate "People's Refusal to Learn New Software" as a perceived barrier of BIM. As shown in Fig. 7, about 26% of the respondents strongly agree that it is a perceived BIM barrier. In addition, about 26% of the respondents just agree that it is a barrier. About 29% of the respondents were neutral in their opinion, and 19% disagreed that it is a barrier of BIM. Only 1% of the respondents disagreed strongly to this barrier. Hence, it is concluded that people's refusal to learn new software is not considered as a significant challenge of BIM implementation since there is no consensus among the participants that it is a barrier.

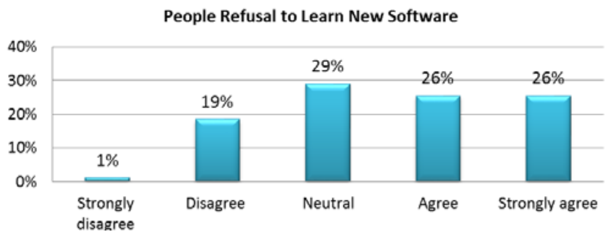

Fig. 7 Impact of resistance to learning new software

Analysis Level 2: barriers vs. percentages of the respondents who agreed and strongly agreed:

On this level of analysis, the categories "agree" and "strongly agree" were lumped. It is concluded that the lack of BIM training was the most significant barrier that faces BIM implementation, as 90% of the respondents agreed. About 85% of the respondents agreed that lack of skilled personnel is a challenge that slowed down the adoption of this technology. BIM users may be found, however most of them are not skilled enough to apply BIM efficiently. On the other hand, the concept of BIM is not well understood; consequently, its benefits are not clear enough to motivate construction companies to adopt this technology, as 82% of the respondents agreed. As discussed before, BIM is not a tool or software as some people believe, instead it is a complete management process that was created in the first place to benefit the project and enhance the constructability. Additional costs and time related to implementing BIM creates a strong barrier that prevent construction companies to adopt it; cost of employing additional staff took 77% agreement, cost of training existing staff took 75% agreement, time required to train existing staff took 72% agreement. 69% of the respondents agreed that cost of new software and updates is a challenge that faces BIM and 62% agreed on the cost of hardware and networks. Almost half of the respondents agreed on the following as barriers to BIM implementation: not requiring BIM in contracts in Government project (55%), human nature to resist changes (52%), people's refusal to learn new software (51%), time required to produce the model (50%) and finally, time to setup BIM technology requirements (50%). It is clear that most of the barriers that were included in the questionnaire gained significant agreement from the respondents; thus, it can be concluded that all of them are effective challenges that must be overcome to enhance the adoption process of BIM in construction companies.

It was expected that refusal to learn a new software would get a higher percentage than 51%, as many employees in the construction field are far away from being up-to-date with modern technology in general. This was an encouraging sign that employees especially of a young age are willing to learn the new technology.

Cost of training obtained high percentage, although most of the participants were not aware of the actual cost of training. It is well known that the savings made by implementing BIM technology is much higher than the cost of training; especially with regard to in-house staff.

This poll also shows the importance of familiarizing the employees with the benefits of BIM, as 82% agreed that being unfamiliar with those benefits is a huge barrier.

Analysis Level 3: Contractors' opinions vs. Designers' opinions:

Respondents were grouped into two groups: contractors and designers (this group included architects, engineers and consultants). The opinions of the two groups were compared to point out any differences. This was accomplished by comparing the means of the two groups, after converting the Likert scale into a number scale, where "Strongly agree" was assigned five points, "agree" was assigned four points, "neutral" was assigned three points, "disagree was assigned two points, and "strongly disagree" was assigned one point. The purpose of this analysis is to clarify the views for each group. The calculations were done according to the following steps:

1. It was assumed at the beginning that the means for the answers of both contractors and designers are equal and accordingly the calculations were carried out. It was assumed that the decision criterion is $\alpha=0.05$
2. The number of observations was calculated and the mean, in addition to the sum of squares of each group, were calculated. Also the pooled variance estimate 〖S^2〗(pooled) was calculated and was followed with the calculation of $S\_((X1)^{-}-(X2)^{-})$. After that the statistical t ratio and the degree of freedom (df) were calculated.
3. Identify the acceptable/ rejection range. This was done through obtaining the critical t0.05 from the standard tables. In order to obtain the data from the mentioned tables, three parameters are considered: The Hypothesized Mean Difference which equals zero, $\alpha=0.05$ and the degree of freedom df.
4. The t0.05 value obtained from tables, determines one positive and one negative value; these two values define a region of accepted possibilities. If the calculated t ratio falls in that region, no significant statistically difference will be observed in the means of the two samples, otherwise the equality is rejected. Some examples are presented below.

1. The Concept of BIM Is Not Well Understood

The opinions of contractors and designers meet since the obtained statistical t ratio (0.066) is less than t0.05 (1.989), so the statistical t ratio falls in the retention region. Hence, there is no significant difference between the means of the two groups. It can be concluded that the opinions of contractors and designers both fall in the region of "agree" that not understanding the concept of BIM is a barrier of BIM.

2. Lack of Skilled Personnel

The opinions of contractors and designers do not meet since the obtained statistical t ratio (2.492) is greater than t0.05 (1.993), so the statistical t ratio falls in the rejection region. Hence, there is significant difference between the means of the two groups. It can be concluded that the opinions of contractors fall in the region between "agree" and "strongly agree", while the opinions of the designers fall in the "agree" region that lack of skilled personnel is a barrier of BIM.

It was concluded from the questionnaire that contractors' and designers' opinions meet on all of the listed barriers except the following:

1. Lack of skilled personnel.
2. Cost of training existing staff.

VII. Recommendations

The last section of the questionnaire was an open question to give the experts the chance to recommend actions and strategies in order to overcome the barriers of implementing BIM and encourage adopting BIM in Kuwait. These recommendations were categorized into three main groups: (1) spread the awareness of BIM among engineers, (2) prepare construction firms to adopt BIM, and (3) improve the implementation mechanism.

With respect to spreading the awareness of BIM, engineering schools should offer BIM courses in their graduate plans. In addition, seminars and presentations should be conducted to educate the engineers about BIM as well as encouraging BIM through social media and multimedia. However, different actions should be followed to prepare construction firms to adopt BIM including hiring expert BIM managers and conduct in-house training programs.

Finally, the implementation mechanism should be improved by taking serious actions such as giving much support from governments, requiring BIM in contracts and creating a public database with BIM information and models of all industrial projects involved in construction process.

VIII. Summary and Conclusion

This research was conducted to investigate the barriers of utilizing BIM in Kuwait construction projects. The main objectives of the research were to investigate the awareness of project stakeholders about the BIM concept and its benefits, identify the challenges that face BIM adoption in Kuwait and recommend the best solutions to overcome these challenges and encourage the utilization of BIM in Kuwait construction sector. In order to accomplish these objectives, a detailed survey was conducted where 95 questionnaires were distributed among different project parties. Detailed analyses were carried out to highlight the most significant benefits of BIM as well as the most significant barriers that affect BIM implementation.

Finally, recommendations were reported to encourage the implementation process through spreading the awareness about BIM, preparing construction firms to adopt it and facilitating the implementation mechanism in construction firms.

It was concluded from this study that BIM adoption is still new and limited in Kuwait since the majority of the respondents (84%) and (85%) have not been involved in projects utilizing BIM and have less than five years experience in BIM, respectively. However, the level of awareness about BIM benefits is high, as 90% of the respondents confirmed. It was concluded from the questionnaire that the most significant benefits of BIM utilization are improved conflict detection, better visualization and easier quantity take-off measures; on the other hand, the most significant barriers that face the adoption of BIM are lack of BIM training, and lack of skilled personnel and misunderstanding the concept of BIM. In the end, some serious action should be followed to encourage the implementation of BIM including offering BIM courses at engineering schools, and conducting in-house training programs and requiring BIM in construction contracts.

Every new technology or process needs time to be adopted properly, yet the most important thing is to understand its benefits deeply and have the desire to learn about it in order to find the most suitable approaches to implement it successfully.

References

[1] Wang, L., and Leite, F. (2014). Process-Oriented Approach of Teaching Building Information Modeling in Construction Management. J. Prof. Issues Eng. Educ. Pract. Journal of Professional Issues in Engineering Education and Practice,140(4), 04014004.

[2] Eastman, C. M., Teicholz, P., Sacks, R., and Liston, K. (2008). BIM handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers, and Contractors, Wiley, Hoboken, NJ, USA.

[3] Krygiel E., and Nies B. (2008). Green BIM: Successful Sustainable Design with Building Information Modeling. New York: Wiley Publishing. P25-51.

[4] Ahn, Y., Kwak, Y., and Suk, S. (2015). "Contractors' Transformation Strategies for Adopting Building Information Modeling." J. Manage. Eng., 10.1061/(ASCE)ME.1943-5479.0000390, 05015005.

[5] Jigsawcad Corporation. (2009). Building Information Modeling (BIM) and its Return on Investment. Available: http://www.jigsawcad.com/articles/october- 2008/building-information-modelling-(bim)-and-its-return-on-investment.aspx. (Accessed October 1, 2015).

[6] Hamm J. (2008). Transforming Construction Industry Performance through the application of revolutionary virtual design and construction technologies, and the essential role for education in this happen. Jenko Cad Education Consultancy: UK.Available: http://ctiweb.cf.ac.uk/news/events/beecon2006/pdf/P17_Jenny_Hamm.pdf.

[7] Leondes, C. T.. (2005). "Intelligent Knowledge-Based Systems: Business and Technology in the New Millennium." USA: Kluwer Academic Publishers.

[8] Kymmell W. (2008). Building Information Modeling: Planning and construction managing construction projects with 4D CAD and Simulation. USA: McGraw- Hill Companies. P1-87.

[9] Howell I., Batcheler B. (2008). Building Information Modeling Two Years Later – Huge Potential, Some Success and Several Limitations. USA. Available: http://www.laiserin.com/features/bim/newforma_bim.pdf.

[10] Yan, H., Damian, P. (2008). "Benefits and Barriers of Building Information Modeling." Department of Civil and Building Engineering, Loughborough University, UK.

[11] Quirk, V. (2012). A Brief History of BIM. Retrieved February 16, 2016, from http://www.archdaily.com/302490/a-brief-history-of-bim.

[12] Kia, S. (2013). Review of Building Information Modeling (BIM) Software Packages Based on Assets Management. In Introduction to Building Information Modeling (BIM) (pp. 101-139). Amirkabir University of Technology.

[13] Winch, G. (2002). "Managing Construction Projects: An Information Processing Approach." Oxford: Blackwell Science.

[14] Kessinger, K. (2008). Recognizing the benefits of Building Information Modeling. Available:http://www.constructionsoftwarereview.com/blog/2008/09/05/recognizing-thebenefits-of-building-information-modeling. (Accessed September 6, 2015).

[15] McNell et al., 2009. Building Information Modeling. Retrieved from http://www.infocomm.org/cps/rde/xbcr/infocomm/Brochure_BIM.pdf.

[16] Productivity Benefits of BIM. (n.d.). Retrieved from http://www.mbie.govt.nz/about/whats-happening/news/document-image-library/nz-bim-productivity-benefits.pdf.

[17] Aranda-Mena, G., Crawford, J., Chevez, A., & Froese, T. (2009). Building information modeling demystified: does it make business sense to adopt BIM? International Journal on Managing Projects in business, 2(3), 419-434.

[18] Talebi, S. (n.d.). "Exploring Advantages and Challenges of Adaptation and Implementation of Bim in Project Life Cycle." Retrieved from http://usir.salford.ac.uk/32275/3/S_Talebi_-_Exploring_Advantages_and_Challenges_of_Adaptation_and_Implementation_of_BIM_in_Project_Life_Cycle_(1).pdf.

[19] Karppinen, A., Törrönen, A., Lennox, M., Peltomäki, M., Lehto, M., Maalahti, J., et al. (2012). Common BIM Requirements 2012: Series 13: Use of models in construction. Retrieved from Building Smart Finland: http://www.en.buildingsmart.kotisivukone.com/3 (Accessed November 25, 2015).

[20] Koushki, P. A., Al-rashid, K. & Kartam, N. (2005) "Delays and cost increases in the construction of private residential projects in Kuwait." Department of Civil Engineering, Kuwait University. Retrieved from http://www.tamu.edu/faculty/choudhury/articles/22.pdf.

[21] Mann, P. S., "Statistics for Business and Economics", John Wiley & Sons, Inc., 1995.