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An investigation into Building Information Modelling (BIM) in Architecture, Engineering and Construction (AEC) Industry in Iraq

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Abstract

BIM is a smart technology that allows a project to be built virtually before being built physically, so it is integrated method to manage project information intelligently and detect mistakes before carrying out of project via link the project team to a closed loop in order to achieve the optimization. BIM became essential and necessary part of construction technology in advanced countries for its achievements to the project's optimization. On the other hand, this technology so far not applied in the AEC industry in Iraq, in spite of the problems which AEC industry in Iraq are suffering, also in spite of the construction revolution which had been seen in Iraq after 2003 .So the purpose of this research was to develop a clearly understanding about BIM by identifying the advantages achieved from using BIM initiating from design to facility management phase, proceeding from that, three main objectives have identified (to assess the awareness level of BIM by the professionals in the AEC industry in Iraq, to identify the top BIM benefits that would convince the professionals for adopting BIM in the AEC industry in Iraq, and to investigate and rank the top BIM barriers which face the implementation of BIM in the AEC industry in Iraq.) to reach the research aim, a qualitative and quantitative survey was used in this research to cover the subject completely and accurately.Relative importance index (RII) was used to identify the top BIM benefits from respondents' perspective. The findings indicated that the awareness level of BIM by professionals in the AEC industry in Iraq is very low; actually this is one the reasons for the weak growth in the construction sector in Iraq. From the point of view of respondents there were three benefits of BIM have achieved the top ranking from others, are (Increasing accuracy of cost estimation, accurate visualization at any stage of project, and Reducing change orders) respectively. On the other hand, the findings of the research have demonstrated that BIM barriers are greatly affecting the adoption of BIM in the AEC industry in Iraq. The top three barriers to BIM adoption in the AEC industry in Iraq were (No clients demand, Lack of the awareness of BIM by stakeholders, and Lack of training) respectively.

KEYWORDS

Building Information Modeling, Awareness, Benefits, Barriers, Professionals, AEC, Iraq

1. Introduction

In the past several years, BIM adoption has grown significantly in AEC industry (Abidrad and Dossick, 2016).BIM is one of the most promising recent developments in (AEC) industry. With BIM technology, an accurate virtual model of a building is digitally constructed. (Azher, 2011).BIM applications have the potential to revolutionize the quantity surveying practice (Fung et al., 2014).

Quantity, time, and cost are the three most important elements in any construction project. Building information that comes timely and accurately in multiple dimensions will facilitate a refined decision making process which can improve the construction quality, time, cost. the whole process starts with developing drawings(2D)into digital model, and is followed by incorporation of time(4D)and cost(5D).(Lee et al.,2016).Construction industry has recognized BIM implementation as a best practice that provides a new set of processes and technologies in construction projects.(Abdirad 2015).professionals, organisational and educational institutions have started to adopt BIM software tools and adopt their existing delivery systems to satisfy evolving market requirement.(Succar et al.,2013).

Many construction projects suffer from poor design and inconsistent time and cost management. This situation has led to rethinking of the industry's performance and how it could be impeoved.BIM improves technical work at the design stage by creating 3D models that integrate all building's features and it better represents the infrastructure's requirements. Those models can also be enhanced if linked with schedule (4D)

and cost (5D); the construction can thus be better planed almost entirely at the design phase.(Jrade and Lessard,2015).

BIM application spans over the project lifecycle including pre-construction, construction and post construction.(Mehran,2016).BIM ,in both four- and five-dimensional(5D)forms, has recently attained widespread attention in the Architectural ,Engineering and Construction industries.(Fan et al.,2015).The BIM model of construction object is completed by upgrading the 3D model with defined scheduling and cost data.(Pučko et al.,2014).

The main stream for development of software, that can simultaneously manage building, scheduling and cost data as well as to be suitably applied in AEC industry, originated in the year 2004 with the introduction of BIM.(Eastman et al.,2011).BIM has emerged as a very powerful approach and set of information technologies that allows the project stakeholders to work collaboratively on highly technical and comprehensive models using parametric design components and visualize design in 3D.(Sunil et al.,2016).

BIM is a smart technological tool that allows a project to be built virtually before being built physically. The BIM tools is to be helps for design, defining the building from and spaces, visualisation to analysing costs, time and energy performance. (Metkari and Attar,2013).BIM technology has arrived and is being used by designers, contractors, and suppliers to reduce their costs, increase quality, and in some instances, achieve designs that would be impossible without digital design and fabrication.(Ashcraft 2008).

BIM is providing broad benefits and becoming an essential construction document component for large projects. A comparison between the traditional estimating methods and the automated estimating method (AEM) shows that greater accuracy can be obtained through AEM. However ,the cost, time in developing the model, corporate structure and appropriate staff training can hamper the implementation of AEM among contactors.(Franco et al.,2015).The primary objective of BIM is to support the whole-of-life-cycle.(Edirisinghe et al. 2016).

2. Level of awareness

There is a pressing demand for improved knowledge and understanding of BIM across the AEC industry, according to many studies related to BIM. Lack of knowledge regarding BIM has led to a slow uptake of this technology and ineffective management of adoption (Mitchell and Lambert, 2013; NBS, 2013, 2015). In general, many studies had conduced, such as Khosrowshahi and Arayici(2012);Hosseini et al(2016); and Mehran(2016),they founded that. There is a lack of the awareness of BIM and its benefits in the field of construction industry .also; they found that there is a lack of the awareness in the business value of BIM from a financial perspective. More precisely, there is a large lack of understanding of BIM (the core concept of BIM) and its practical applications throughout the life of projects. Also, there is a lack of knowledge of how to implement the BIM software to be helpful in construction processes. In the south Australian, Newton and Chileshe (2012) found through their study that a significant proportion of respondents have a little or no understanding of the concept of BIM, and the usage was found to be very low. The same finding was shown by Mitchell and Lambert (2013), where they said that people in Australia suffer from a lack of knowledge about BIM and its distinctive capabilities in the field of construction industry.Gu et al., (2008) said that BIM is quite misunderstood across the board. Only 48% of the architectural practices are currently aware of BIM (NBS, 2015).

Löf and Kojadinovic (2012) said that there is a lack of guidelines on how to use and align BIM in the production phase of construction projects in Sweden. Kassem et al. (2012) found through their study in the UK that there is an overall lack of knowledge and understanding of what BIM is. Thurairajah and Goucher, (2013) study in the UK agreed with Kassem et al. (2012), but they found too that cost consultants in the UK are aware of BIM. Also a study conducted by Hosseini et al. (2016)in Iran to assess the level of awareness of BIM by Iranian companies, they found that 28% from their respondents are using BIM knowing that the highest level of BIM using in the Middle East is 40% according to Buildingsmart (2011) .

3. Benefits of Building Information Modeling

BIM is one of the most promising recent developments in the AEC industry. With BIM technology, an accurate virtual model of a building is digitally constructed. This model, known as Building Information Model, can be used for planning, design, construction, and operation of the facility. It helps architects, engineers, and constructors visualize what is to built in a simulated environment to identify any potential design, construction, or operational

issues.BIM represents a new paradigm within AEC industry, one that encourages integration of the roles of all stakeholders on a project. Azher, (2011). BIM simulates the construction project in a virtual environment. With BIM technology, an accurate model of a building, known as a Building Information Model, is digitally constructed. When completed, the building information model contains precise geometry and relevant data needed to support the design, procurement, fabrication and construction activities required to realize the building (Eastman et al.2008). BIM is to build a structure virtually prior to physically constructing it. This allows project participants to design, analyze, sequence, and explore a project through a digital environment where it is far less expensive to make change than in the field during construction, where changes are exponentially more costly. The value of BIM in construction comes in many shapes and sizes. Whether it's ability to save money because better information is available earlier to make cost effective decision, they all have the same focus. (Hardin and McCool, 2015). Major benefits from BIM implementation in all type of projects are: accurate and precise takeoff that subcontractors can rely on confidently early in the design phase, return on investment, reduction of change orders, reduction of requests for information, time saving, easier communication and collaboration between all stakeholders resulting in a successful project. (Franco et al.2015).

Hosseini et al .(2016)conducted a study to assess the level of awareness of BIM in Iran by a questionnaire distributed on construction practitioners ,explained that visualization is the most significant benefit if using BIM with other benefits as shown in figure 1.

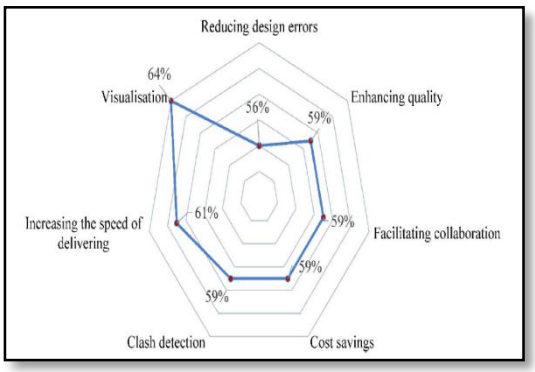

Figure .1.BIM benefits source (Hosseini et al.2016)

BIM is a technology which produces and manages various information for construction activities throughout the life cycle of a building, from the initial planning to the maintenance stage. Away from the limitation of the existing CAD technology, BIM features a broader and more aggressive approach throughout the building life cycle. A significant change is required in the conventional construction process for BIM to be introduced and utilized appropriately. Therefore, BIM education is a vital key for students as well as practitioners (Ahn and Kim, 2016).

Stanley and Thurnell(2014)found that 5D BIM provides advantage over traditional forms of quantity surveying by increasing efficiency ,improving visualization of construction details ,and earlier risk identification .more precisely,

After gathering data on 32 projects, Stanford University's center for Integrated Facilities Engineering report the following benefits of BIM (cited in CRC construction innovation 2007):

- Up to 40% elimination of unbudgeted change,
- Cost estimation accuracy within 3% as compared to traditional estimates,
- Up to 80%reduction in time taken to generate a cost estimate,
- A saving of up to 10% of the contract value through clash detections, and
- Up to 7% reduction in time project.

4. Barriers and challenges to implementing BIM in construction industry

There are several problems when implementing BIM in the very fragmented AEC industry, and this is connected with many different barriers hindering effective adoption of BIM (Mandhar and Mandhar,2013).some of these barriers are quite simple to be removed, while others could be considered impossible to even mitigate (Gökstorp, 2012).many studies were conducted to identify these barriers of BIM adoption in the construction industry in different countries .the result of some studies will be presented below.

Yan and Damian (2008) said, according to the result of a questionnaire, that the barriers to implementing BIM in the UK and the USA are shown in figure 2.

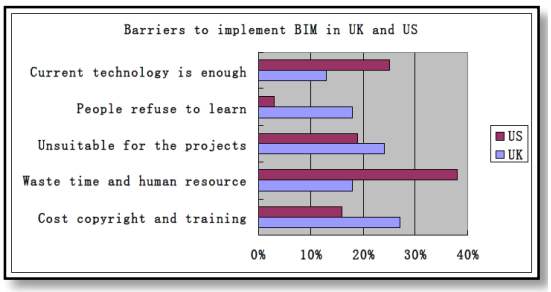

Figure .2.Barriers of BIM source Yan and Damian 2008

Through the online survey within national and regional a construction companies ;(Ku and Taiebat, 2011) asked question about the barriers to BIM implementation. The answers categorized as follows:

Factors were concerned with internal company resource aspects:(Lack of skilled personnel and learning curve of new tools, and The investment cost of BIM in terms of time resources.

Factors related to sharing BIM with external stakeholders:(The difficulty of sharing BIM with external teams/reluctance of others(e.g., Architects, Engineers, Owners, and Subcontractors),Lack of collaborative work processes with the external team and modeling standards, Interoperability issues between software programs, and The lack of legal and contractual agreements.)

Khosrowshahi and Arayici (2012) identified the most significant reasons to failure to implement BIM in the UK, Finland as following:(Firms are not familiar enough with BIM use, Reluctance to initiate new workflows or train staff , Benefits from BIM implementation do not outweigh the costs to implement it , Advantages of BIM are not tangible enough to warrant its use , BIM does not offer enough of a financial gain to warrant its use , Lack of the capital to invest in having started with hardware and software, BIM is too risky from a liability standpoint to warrant its use, Resistances to culture change, and No demand for BIM use.)

Kassem et al. (2012) investigated the barriers to adopting BIM and 4D through a web-based questionnaire. It was submitted to a selected sample of 52 consultants and 46 contractors within the UK civil and building industry. The most of barriers were non-technical such as: (The inefficiency in the evaluation of the business value of BIM and 4D ,The shortage of experience within the workforce, and The lack of awareness by stakeholders).

Crowley (2013) conducted a questionnaire survey to ascertain the current position of the QS profession in Ireland directly related to BIM use and awareness .when asked on scale of (very important to not important)in relation to the potential barriers to BIM ,the following responses were received (majority response very important):

- Lack of training/education,
- BIM use by Irish designers,
- Lack of client demand,
- Lack of government lead/direction and lack of standards.

Lack of in-house expertise and lack of client demand are still the two biggest barriers to BIM in Canada, according to survey of NBS international BIM report 2015.other barriers that ranked as being important were the cost of BIM adoption, the lack of training and time to get trained, and a lack of standardized tools and protocols. Lack of collaboration. Lack of industry awareness and adoption (as well as uncertainty over the future of BIM in publicly procured)

Hosseini et al. (2016) conducted a study; this study draws upon a questionnaire survey distributed amongst SME in Australia to offer an insight into the main barriers to BIM adoption within Australia SMEs. The findings showed that lack of knowledge is the first barrier and others barriers as shown below according their ranks:

- Sub-contractors do not have enough knowledge about BIM and expertise in BIM,
- Our clients do not have sufficient knowledge about BIM and its benefits,
- There is a significant BIM implementation cost to our firm,
- Sub-contractors are not interested in using BIM ,
- The cost of BIM training is significant to our firm,
- Our clients are not interested in using BIM on their building projects,
- There are no official standards for adopting and using BIM on building projects,
- Our firm believes that it takes too much organizational efforts to adopts BIM,
- There is no or low benefits in adopting BIM on our building projects,
- Our firm does not have the skills and expertise for BIM adoption,

- The current technologies we are using are enough, so we do not need BIM,
- Our firm is reluctant to adopt BIM because we do not know how to adopt BIM, and
- BIM is not suitable for our building projects.

Sheikh et al. (2016) conducted a study had involved the awareness, barriers and adoption of BIM in the city of Mumbai among the construction professionals like Builders, Contractors, Site Engineer, Design Engineers and among the professors and students of different civil engineering colleges under University of Mumbai for which a quantitative and qualitative questionnaire survey was conducted, the findings were as following:

- Barriers to BIM adoption is due to high cost and its timely update ,
- Lacking due to non-expert staff, and
- Lacking due to exchange and interoperability.

Thurairajah and Goucher (2013) conducted research to identify the challenges and usability of BIM for cost consultants, and its likely impact during cost estimation in the UK. Data collected through questionnaire survey and expert interviews. The respondents were approximately 20% of cost consultants and 40% of general construction professionals that having previously used BIM. The result showed a low level of BIM experience amongst the respondents. They mentioned several obstacles to BIM implementing as the following:

- Overall lack of knowledge and understanding of what BIM is ,
- A high training requirement associated with BIM implementation to gain the full advantages from it , and
- The need for detailed understanding of cost consultants' challenge during implementation of 5D BIM in the construction project.

5. Methodology

5.1. Target population and sampling of the questionnaire

The questionnaire survey was conducted in 2016 (January).research population includes professionals (Architects, civil engineers, mechanical engineers , electrical engineers, and any other professional with related specialization)in the AEC industry in Iraq .

According to the Association of Engineer (2015) there are (154304) engineer register in the Association of Engineer divided as 44226 civil engineer, 5500 architecture engineer, 40585 mechanical engineer, 41636 electrical engineer and 22357 other specializations till 1/10/2015. The number of engineering offices register in the Association of Engineer is 825 which categorized as consultant office, engineering A offices, engineering B office and engineer office. About 1000 engineer which was divided as 25% civil engineer, 25% architecture engineer, 25% mechanical engineer and 25% electrical engineer.

This research will focus also on the designer engineers who working at consultant office, public and governmental organization, nongovernmental organization (NGOS), contractors companies and municipalities

5.2. Sample size

Kish (1965) showed that the sample size can be calculated as following equation for 94% confidence level

$n = n'/ [1 + (n'/N)]$
Where:
N=total number of population
n=sample size from finite population
n'=sample size from infinite population = S^2/V^2; where S^2 is the variance of the population elements and V is a standard error of sampling population. (Usually S = 0.5 and V = 0.05) (Assaf et al. 2001, Israel, 2003, Moore et al., 2003).
So, for 1000 engineers:
$n = n'/ [1 + (n'/N)]$
$n' = S^2/V^2 = (0.5)^2/(0.05)^2 = 100$
N = 1000
$n = 100/ [1 + (100 / 1000)] = 91$
This means that the questionnaire should be distributed to (91) engineers in order to achieve 94% confidence level.

5.3. Data Measurement

The level of measurement must be understood and simple. Within the questionnaire in many questions, ordinal scales were used in the fourth part as well as fifth part of the questionnaire. Ordinal scale is a ranking or a rating data that normally uses integers in ascending or descending order. The numbers assigned to the agreement or degree of influence (1, 2, 3, 4, and 5) does not indicate that the intervals between scales are equal, nor do they indicate absolute quantities. They are merely numerical labels.

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Based on Likart scale researcher has the following:

Table .1.Likart scale

Level	Unimportant	Slight important	Average important	Important	Very important
Scale	1	2	3	4	5

5.4. Calculating of Relative Importance Index (RII) of factors

In order to study the importance of BIM advantages and barriers; a list of each was taken from a literature review and presented to the respondents to evaluate each item. The relative importance index was used to determine the ranks of items as perceived by respondents in each of part 4 and part 5 .the relative importance index was computed as (Sambasivan and Soon, 2007):

Where

W = the weighting given to each factor by the respondents (ranging from 1 to 5),

A = the highest weight (i.e. 5 in this case), and

N = the total number of respondents.

The RII value had a range from 0 to 1 (0 not inclusive), higher the value of RII, very important factor

5.5. Validity of the questionnaire

Using expert validity, the questionnaire may be sent to experts in a particular field of research across the area for their evaluation of the content (Burns and Grove 1995). After preparing the questionnaire in its initial form, the researcher presents it to five experts to examine its validity. The five experts are two lecturers in a University, two contractors and one expert in construction management field. The experts generally manifest comforting complacence toward the questionnaire. However, they provide the researcher with some comments and suggestions which are taken into consideration while modifying the questionnaire structure

5.6. Questionnaire design and data collection

Based on the nature of the data to be collected, and the available time, it was found that the most appropriate approach to investigate the amount of awareness in BIM in the Iraqi construction sector is the "questionnaire"; therefore an electronic questionnaire formula was designed.

6. Results and discussion

After publishing the questionnaire's link for (two months) ,the researcher had got (106) respondents according to the way that previously mentioned , the part one of the questionnaire related to general information about the respondents ,among the respondents ,a large majority had "less than 5 years " of work experience in the AEC industry ,with (41 %) .The experience for the rest of the respondents was "from 5 to less than 10 years", and " 10 years to less than 15 " with (31%) and (9%) respectively. as shown in figure 3.

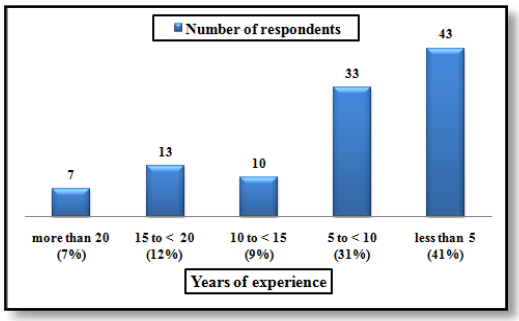

Figure 3.Years of experience of respondents

With respect to the respondents' educational qualification, a large percentage of the respondents were have B.SC certificate (82%), the second large percentage of the respondents were having M.SC certificate (12%), the lowest percentage of respondents were having PhD, diploma, (5%) and (1%) respectively, as illustrated in figure 4.

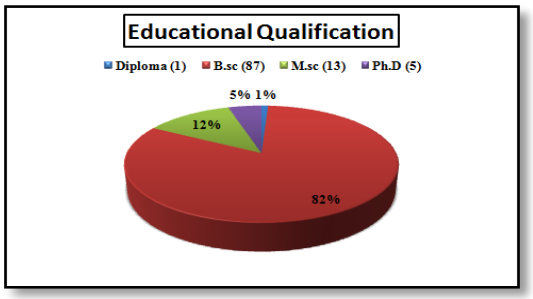

Figure 4.Educational qualification of respondents

With respect to the respondents' specialization, there were (88) civil engineers with (83%), (8) architects (7%), (6) mechanical engineers (6%), (4) electrical engineers (4%) as illustrated in figure 5.

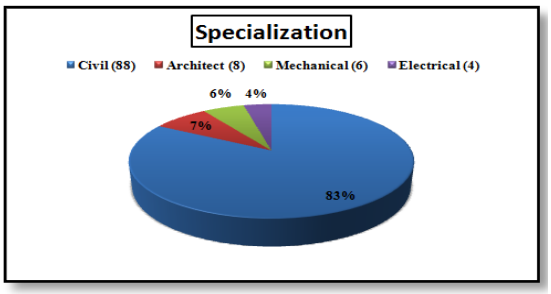

Figure 5.Specialization of respondents

The respondents working sector was classified into two categories, private sector and public sector, as illustrated in figure 6.

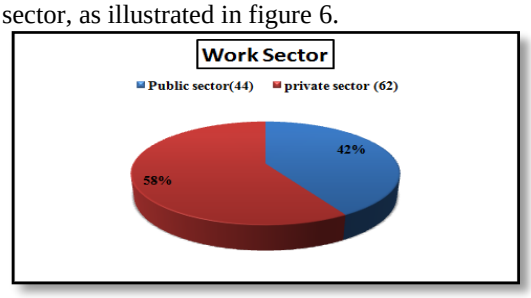

Figure 6.Work sector of respondents

The first part of the questionnaire has included a question about the current use of the respondents to AutoCAD programs either three-dimensional or two-dimensional to give a first impression about the level of knowledge and progress in the use of modern technology ,which is somewhat related to the three-dimensional programs .there were (78 %) of the respondents are still using two-dimensional CAD programs to complete their work and (22 %) of the respondents using three-dimensional cad programs as shown in figure 7.This demonstrate that the traditional methods are still dominant and the conversion to modern methods through a three-dimensional programs are very weak

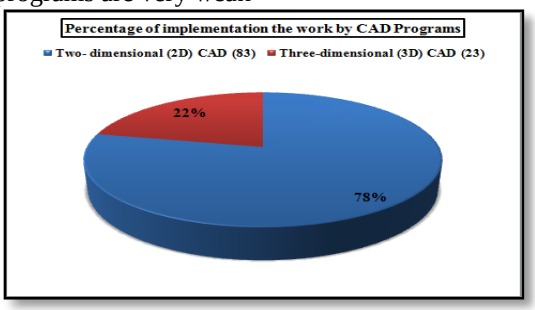

Figure 7.Percentage of implementation the work by cad programs of the respondents

This part summarizes the responses received from survey respondents based on their idea of BIM and level of BIM knowledge among the Iraqi construction industry. Also, this segment uses the percentage frequency to indicate the results. As shown in Figure 8. (24%) of the survey's respondents have heard of the BIM solution and application, whereas (76%) of the respondents were unaware of BIM.

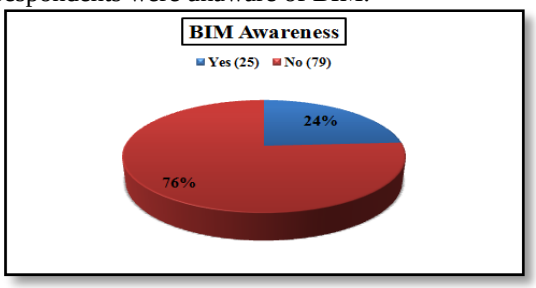

Figure 8.BIM awareness of respondents

in fact that the results of the respondents indicated that the level of awareness of BIM is too low, and these results were expected through the question in the first part about the using of three-dimensional programs where the use of 3D programs of the respondents was too low ,and this is logical to be the level of awareness of BIM also low because of the enter to the 3D systems automatically will get the knowledge about the new technologies and programs that related to it including software that use BIM process.

Based on previous results, the awareness level of BIM by professionals in the AEC industry of Iraq is too low .these results also agree with the results obtained by Thuraiajah and Goucher (2013) claimed that there is an overall lack of the knowledge and the understanding of what BIM is in the UK despite there are some destinations have adopted BIM in their work.Newton and Chileshe (2012) conducted a field study in the south Australian construction industry about the awareness and usage of BIM .the findings indicated that a significant proportion of respondents have little or no understanding of the concept of BIM and the usage was found to be very low. The same result was shown by Mitchell and Lambert (2013), where they said that people in Australia suffer from a lack of the knowledge about BIM and its distinctive capabilities in the field of construction industry. In addition to the presence of the other studies and reports that support this result, where Gu et al.,(2008) and NBS (2012)said that BIM is entirely misunderstood across the board. Only (48%) of the architectural practices are currently aware of BIM (NBS, 2015).

In general ,many studies ,such as Arayici et al.(2009); Kassem et al.(2012);Khosrowshahi and Arayici(2012); Löf and Kojadinovic (2012); Hosseini et al(2016); and Mehran(2016),conducted that there are a lack of

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the awareness of BIM and its benefits in the field of the construction industry as well as the business value of BIM from a financial perspective.

When asked the respondents to describe the current knowledge level about BIM among the construction industry. The larger percentage of the respondents answers was "low" with (75 %) ,followed by the second percentage of the respondents answers "None" with (14 %) as shown in figure 9. this result is logical and has enhanced the previous answers about the level of awareness of BIM . this result demonstrate that there is not adoption by the public and private sectors depending on the percentage of the respondents from the two sectors . in fact this result is disappointment with respect to adopt of the new technologies in the construction industry with knowing that the recent years have seen construct a lot of projects in Iraq but it is obvious they have constructed depending on the traditional methods.

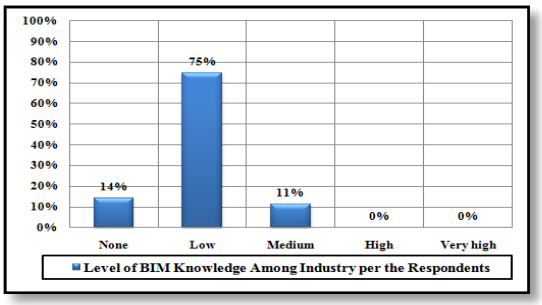

Figure 9.Level of BIM knowledge among industry per the respondents

when asked whether BIM should become a mandatory process in the industry, as is the case in developed countries such as the UK and so on, surprisingly, (72%) of the respondents replied “yes,” and (23%) responded “don’t know,” revealing ambiguity among the industry as shown in figure 10. This acceptance and desire to be BIM mandatory in the construction industry by the respondents resulting from the belief it will solve all the current problems in this sector, and it is truth.

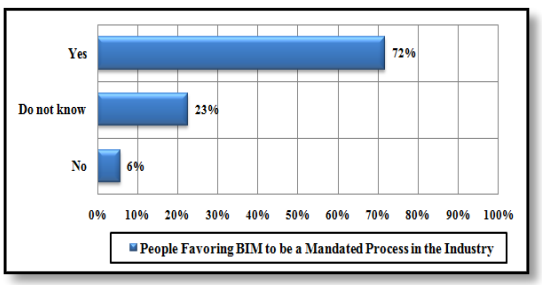

Figure 10.People favoring BIM to be a mandated process in the industry

When asked regarding if the academic curriculum had included course about BIM technology or not, the percentage of the respondents answers were (91%) with 'NO' as shown in figure 11. and the remaining percentage of answers were "YES" with (9 %).

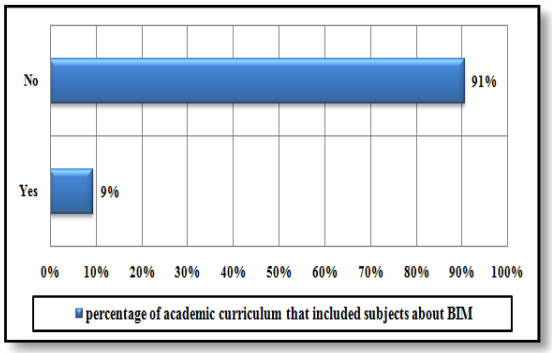

Figure 11.Percentage of academic curriculum that included subjected about BIM

Based on this results .it can be observed the absence of interest of educating BIM through courses in universities .thus, the lack of the awareness of BIM is logical and expected result.

whereas there was a clear desire in the respondents that they would like to be there courses about BIM technology in the academic curriculum for engineering collages, with percentage (86%) as shown in figure 12. This result agreed with (Ahn and Kim, 2016) where they said that BIM education is a vital key for students as well as practitioners.

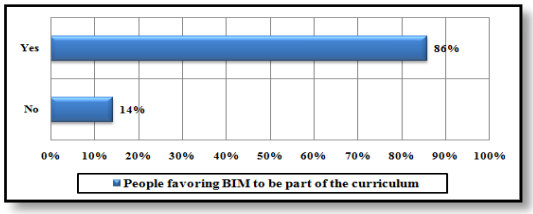

Figure 12.People favoring BIM to be part of the curriculum

A list of building information modeling software was presented to the respondents to specify all the software they worked on, the largest percentage of the respondents answers had given to "never used any of them " with (76%) as was expecting, as illustrated in figure 13.

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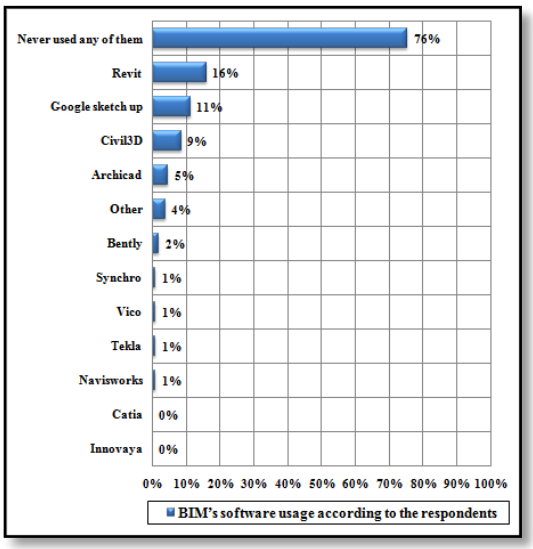

Figure 13.BIM's software usage according to the respondents

Regarding of question twenty from the third part which related in the second part of the thesis. The second part of the thesis related to 5D of BIM to prove the extent of effect of BIM applications on quantity take-off and compare it with traditional methods which represented the 2D.

When asked the respondents about if they used the BIM Software for estimating, the largest percentage of the respondents answers were "NO" with (84%) and the remaining answers were "yes" with (16%) as shown in figure 14.

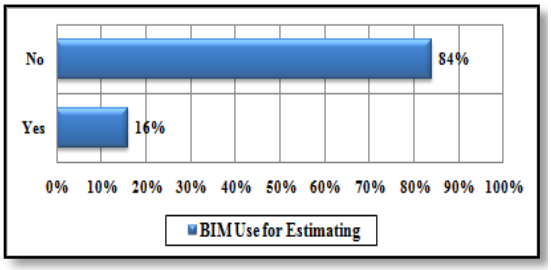

Figure 14.BIM usage for estimating by respondents

Regarding the previous question, the respondents were asked if they have the plan to use the BIM software for estimating in the future, the most answers of the respondents were "yes" with (71%) and the remaining percentage (29%) with "NO" as shown in the figure 15.

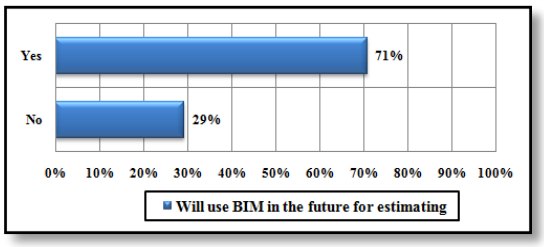

Figure 15.Percentage of the respondents who will use BIM in the future for estimating

RII was calculated to weight each benefit of BIM (from 1 to 25) according to the numerical scores obtained from the questionnaire responses by the professional in the AEC industry in Iraq and rustles have been ranked from the highest degree (the most valuable benefit of BIM) to the least degree (the lowest valuable benefits of BIM).Table 2. Provides RIIs and ranks of BIM benefits, respectively.

Table 2.The value of BIM benefits

NO.	BIM benefits	RII (%)	Rank
1	BIM helps to give accurate 2D plans at any stage of project	89	5
2	Accurate visualization at any stage of project	94	2
3	Reducing change orders	93	3
4	Reducing rework time	86	7
5	Improve of clash detection	76	25
6	Reducing design errors	86	7
7	Increasing accuracy of cost estimation	99	1
8	Increasing accurate of scheduling and planning of project	90	4
9	Improve communication among project parties	85	11
10	Reduce overall project duration	81	17
11	Reduce overall project cost	81	20
12	Enhance work coordination with sub-contractors and suppliers	81	18
13	Reduce claims among project parties	78	24
14	Enhance sustainable design and lean construction	82	16
15	Enhance energy efficiency and sustainability the building	84	12
16	Ease of information retrieval for the entire life of building through as-built 3D model	86	9
17	Support design decision making by comparing the 3D design alternatives	82	14
18	Enhance design team collaboration (Architectural, Structural ,Mechanical ,and Electrical)	88	6
19	Speed up projects delivery	80	22
20	Facilitate quantitative survey	84	13
21	Energy consumption analysis	86	9
22	Enhance operation and maintenance management	82	14
23	Improve document management	79	23
24	Improve safety management	80	21
25	Enhance productivity through time and cost savings	81	18

The findings indicates that "increasing accuracy of cost estimation" it has been ranked as the first most valuable BIM benefits with (RII= 99%) according to overall respondents. This result is consistent with a lot of researchers as mentioned in literature review who have found that, Cost estimation accuracy within 3% as compared to traditional estimates (CRC construction innovation 2007), Stanley and Thurnell (2014)found that 5D BIM provides advantage over traditional forms of quantity surveying by

increasing efficiency,. Major benefits from BIM implementation in all type of projects are: accurate and precise takeoff that subcontractors can rely on confidently early in the design phase. Franco et al. (2015).

"Accurate visualization at any stage of project" was ranked as the second most valuable BIM benefit with (RII= 94%).this result is consistent with those reported by Becerik-Gerber et al.(2011),and Ku and Taiebat(2011), whose research studies determined this function as the most important function of BIM for the construction companies in southern California, the U.S., respectively .in addition to that ,this outcome corroborates the findings of the studies of Ashcraft(2008) and Eastman et al.(2008). "Reducing change orders" was ranked as the third position with (RII= 93%). This result is consistent with Eastman et al. (2011) , where they said that one of the BIM's benefits is Quick reaction to design changes (change orders improvement). (Franco et al.2015), has listed a major benefits of from BIM implementation in all type of projects, one of these benefits is reduction of change orders.

The top three benefits to BIM adoption, which were rated by the respondents, are logical and acceptable to be the most valuable benefits of BIM that would convince the professionals for adopting it in the AEC industry in Iraq.

RII was calculated to weight each barrier of BIM (from 1 to 15) according to the numerical scores obtained from the questionnaire responses by the professional in the AEC industry in Iraq and rustles have been ranked from the highest degree (the strongest BIM barrier) to the least degree (the most vulnerable BIM barrier).table 3. Provides RIIs and ranks of BIM barriers, respectively.

Table 3.The Strength of BIM barriers

NO.	BIM barriers	RII (%)	Rank
1	High costs to purchase BIM software and costs of hardware updates	10	74
2	Lack of the awareness of BIM by stakeholders	2	95
3	Lack of skilled staff in BIM	4	92
4	Lack of training	3	94
5	No clients demand	1	98
6	Lack of standardized tools	9	75
7	Lack of awareness of the benefits of BIM	5	91
8	Lack of effective collaboration among project stakeholders to exchange necessary information for BIM applications	8	76
9	Lack of education on the use of BIM in the university or any governmental centers	6	90
10	Lack of the governmental regulations to support the implementation of BIM	7	84
11	Do not see benefits of BIM implementation	13	61
12	Disruptions to implement new process	12	64
13	Resistance by companies for any change and the refusal of adopting new technology	11	68
14	There is no time to learn new technologies	14	55
15	The current technology is enough	15	55

The findings indicated that "no clients demand" is the strongest barrier to BIM adopting in the AEC industry in Iraq .it has been ranked as the first position with (RII=98%) according to overall respondents. This result is consistent with Kjartansdottir and Arayici (2012); Crowley (2013); NBS (2015),and Hosseine et al (2016) who have said there is Lack of demand and disinterest regarding BIM from clients and the other project team members.

"Lack of the awareness of BIM by stakeholders" was ranked as the second strongest barrier to BIM adopting in the AEC industry in Iraq with (RII =95%) according to overall respondents. This result indicates that a significant proportion of respondents have little or no understanding of the concept of BIM. this finding is consistent with the result which has been found by Kassem et al.(2012).according to their studies, lack of the awareness of BIM was recognized by the professionals in the construction industry as the primary barrier to BIM and 4d adoption in the UK also, this result is in line with the research of Thurairajah and Goucher (2013),where it has shown that while the cost consultants in the UK are aware of BIM ,there is an overall lack of knowledge and understanding of what it is.The lack of knowledge regarding BIM has led to slow uptake of this technology and ineffective management of adoption (Mitchell and lambert,2013;NBS,2015)

"lack of training " was ranked as the third position with (RII=94%). this result is agreed with those reported about barriers to BIM adoption such as Crowley (2013) where conducted a questionnaire survey to identify the use and awareness of BIM in Ireland where he has found that the lack of training /education is

one of the major barriers to adopt BIM technology.

The top three barriers to BIM adoption, which were rated by the respondents, are logical and acceptable to be the strongest barriers to BIM adoption in the AEC industry in Iraq.

7. Conclusions and Recommendations

The study findings of the questionnaire indicated that the awareness level of BIM by the professionals in the AEC industry in Iraq is very low. Most practitioners of the AEC industry have not heard about BIM and did not realize the concept of it.

A lot of questions have been presented to the respondents in order to assess the awareness level of BIM in order to cover all sides and reduce the percentage of the error. when the respondents were asked about their current programs used whether it is three-dimensional or two-dimensional programs, the largest percentage of the practitioners are still using two-dimensional programs and this consider a clear indication that the awareness level of BIM is very low because the author believes that there is a correlation between BIM and three-dimensional programs concept. In the fact despite the lack of awareness of the respondents but there was a clear desired to be a compulsory process in the AEC industry.

Any change of technology or process to the other accompanied by problems and this is normal because of the change the level of thinking and introduction of new tools of technology, so the process of change accompanied by a lot of risks and the top of these risks are the financial risks, in order to avoid such risks it is preferable to apply BIM technology on small projects with a medium cost or a few after an comprehensive study of BIM application and expected results.

Government agencies must take the lead role in the application of BIM in AEC in Iraq, for example.

- Generate a comprehensive roadmap /plan to implement of BIM and issue instructions and guidelines to be a reference to apply the BIM properly in the organizations.
- Update of construction contracts in keeping with of the concept of BIM technology and its applications

The Engineer association should play a vital role in the process of change from traditional to modern technology through introducing of a specific strategy and in cooperation with government agencies through of dissemination of the concepts of BIM and the areas of its application and benefits resulting from its application. This can be achieved through workshops and provide free courses on the technology and benefits of its application and how to resolve the obstacles that Prevent its implementation.

The most important institutions that keep abreast of the scientific development in the world are universities and academic institutes. Therefore, it must take the vital role in highlighting and developing awareness on modern technology, particularly BIM , by encouraging researchers to research in BIM and its benefits, also encourage of companies and consulting offices to adopt BIM technology via applied the training workshops for implementation of their projects by using BIM process properly.

Insertion of courses on the BIM during the academic curriculum in engineering colleges.

Regarding technology, it is critical to choose the appropriate BIM tools that suit the practice's way of work. It is recommended to test our trail versions of vendors and subject them to several functions to evaluate the appropriateness of the tools before making a final decision on which to use. Also, hardware requirements must be suitable for new software. Train the right professionals and assign them to tasks, roles, and responsibilities in the line with new BIM workflow implementation and be patient with the learning process. A user cannot suddenly become advanced and proficient; the user requires experience and continuous exposure to the new tools to become an expert.

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