Application of Building Information Modeling (3D and 4D) in Construction Sector in Iraq

Kadhim Raheem Erzaij
Assistant Professor
Collage of Engineering-University Of Baghdad
E-mail: kadhim1969@yahoo.com

Ayad Abbas Obaid
MSc student
Collage of Engineering-University Of Baghdad
E-mail:eng.ayad89@gmail.com

ABSTRACT

Building Information Modeling (BIM) is becoming a great known established collaboration process in Architecture, Engineering, and Construction (AEC) industry. In various cases in many countries, potential benefits and competitive advantages have been reported. However, despite the potentials and benefits of BIM technologies, it is not applied in the construction sector in Iraq just like many other countries of the world.

The purpose of this research is to understand the uses and benefits of BIM for construction projects in Iraq. This purpose has been done by establishing a framework to application of BIM and identifying the benefits of this technology that would convince stakeholders for adopting BIM in the construction sector in Iraq.

Through this research, the use of this technology has been clarified by using the proposed framework (application Revit software and linking it with the MS Project and Navisworks Manage software on the case study) to identify the important benefits to be the beginning to apply the Building Information Modeling technology in the construction sector in Iraq.

The research results indicated that such proposed framework can greatly improve the performance of the current state of project management through improving the project quality, cost saving and time-saving.

Keywords: Building information modeling, Architectural Engineering and Construction (AEC) industry, BIM knowledge, BIM benefits, The construction sector in Iraq.

تطبيق نمذجة معلومات البناء (3D و4D) في قطاع الانشاء في العراق

د. كاظم رحيم ارزيج
استاذ مساعد
كلية الهندسة-جامعة بغداد

اياد عباس عبيد
طالب ماجستير
كلية الهندسة-جامعة بغداد

الخلاصة

أصبحت نمذجة معلومات البناء (BIM) وسيلة تعاون بين أعضاء الفريق الهندسي في صناعة التصميم وتشييد البناء (AEC) في عدة بلدان، وتم معرفة الفوائد المحتملة والمزايا التنافسية. ومع ذلك وعلى الرغم من إمكانيات وفوائد تكنولوجيا نمذجة معلومات البناء، لا يتم تطبيقها في قطاع البناء والتشييد في العراق مثل العديد من البلدان الأخرى.

ان الغرض من هذا البحث هو فهم استخدامات وفوائد نمذجة معلومات البناء للمشاريع الانشائية في العراق، وقد تم ذلك الغرض من خلال انشاء إطار عمل لتطبيق نمذجة معلومات البناء والتعرف على فوائد هذه التكنولوجيا التي من شانها ان تقنع أصحاب المصلحة من اجل اعتماد نمذجة معلومات البناء في قطاع البناء والتشييد في العراق.

وقد تم توضيح استخدام هذه التكنولوجيا (بتطبيق برنامج (Revit) على حالة دراسية لتكوين نموذج ثلاثي الابعاد وربطه مع الجدول الزمني المتولد من (MS Project) في برنامج (Navisworks Manage). للتعرف على الفوائد المهمة لتكون بداية لتطبيق تكنولوجيا نمذجة معلومات البناء في قطاع البناء والتشييد في العراق.

وأشارت نتائج البحث ان إطار العمل المقترح يمكن ان يحسن كثيرا من أداء الوضع الحالي لإدارة المشروع من خلال تحسين نوعية المشروع، توفير الوقت والتكاليف.

1. INTRODUCTION

1.1 General

The benefits of Building Information Modeling (BIM) are being realized by construction firms around the world. However, in Iraq it is not applied until now. The Researcher will explore how the engineers in construction sector can take advantage of the benefits that BIM allows. BIM is more than just a process; it paves the way to a new form of project procurement and delivery. To realize the full potential of BIM and work with the models in the most productive way it needs to have the correct tools and knowledge.
BIM is a technological system to conveying and storing information for the buildings, with an ability to visually display buildings parts in a 3-D view. The 3-D capability is enhanced by the parametric modeling engine, which automatically interrelates building objects to other objects and coordinates changes and revisions across the project deliverables, Rundell **and Stowe, 2005.** For instance, a change to the length of a wall in a building drawing is automatically reflected in the walls that connect to it. The idea is that the BIM produces a faster, cheaper, more accurate, and better-coordinated project experience during design, construction, and future use. With the growth of information technologies in the field of construction industry over the last years, numerical building information modeling and process simulation has evolved to a fully accepted and widely used tool for the project life circle management. Building information is present through the whole life cycle of the engineering and construction phases. Due to the long time and the numerous contractors, the phenomena of mass information and information attenuation occur throughout the life cycle. The traditional methods of information exchange cannot meet the mass information processing requirements of modern large-scale construction projects, **Ding, L. and X. Xu, 2014.**

1.2 Definitions

Due to the different perceptions, overview and experiences of researchers and professionals in the AEC industry, they can define BIM in different ways **Khosrowshahi and Arayici, 2012**. For example, **Gu and London, 2010** said that BIM is an information technology (IT) enabled approach that involves applying and maintaining an integral digital representation of all building information for different phases of the project lifecycle in the form of a data repository. On the other hand, **Eastman et al., 2008** emphasized that BIM is not only a tool, but also a process that allows project team members to have an unprecedented ability to collaborate over the course of a project, from early design to occupancy. **Stebbins, 2009** agreed that BIM is a process rather than a piece of software. He clearly identified BIM as a business and management decision. BIM implementation is strongly related to managerial aspects of professional practices for different working styles and cultures, **Ahmad et al., 2012**. BIM has a broad range of applications cross the design; construction; and operation process ,**Baldwin, 2012**. BIM is important to develop the design process by managing the changes in the design. It is efficient in checking and updating all the views (plans, sections and elevations) when any changes occur, **CRC construction innovation, 2007**. BIM is a new way of approaching the design and documentation of building projects.

1.3 Objective

The aim of this research is to develop a clear understanding about BIM for identifying the different factors that provide useful information to consider adopting BIM technology in projects by practitioners in the construction sector in Iraq. In achieving this aim, two main objectives have been outlined as follows:

A. To identify the BIM system.

B. To identify the top BIM benefits that would convince professionals for adopting BIM in the construction sector in Iraq.

2. UNDERSTANDING OF BIM CONCEPT

BIM has been in use internationally for several years, and its use continues to grow. It is one of the most promising developments in the Architecture, Engineering, Construction (AEC) industry and it has the potential to become the information backbone of a whole new AEC industry **Stanley and Thurnell, 2014**. BIM is continuously developing as a concept because the boundaries of its capabilities continue to expand as technological advances are made, **Joannides et al., 2012**. BIM is now considered the ultimate in project delivery within the AEC industry. It is motivating an extraordinary shift in the way the construction industry functions. This fundamental change involves using digital modeling software to more effectively design, build and manage projects, **Azhar et al., 2008**.

3. TYPES OF BIM

Many new terms, concepts and BIM applications have been developed such as 4D; 5D; six-dimensional (6D); and seven-dimensional (7D). The (D) in the term of 3D BIM means “dimensional” and it has many different purposes for the construction industry. **Wang, 2011** explained BIM types as the following:

- 3D: three-dimensional means the height, length and width.
- 4D: 3D plus time for construction planning and project scheduling.
- 5D: 4D plus cost estimation.

Recent advances in BIM have disseminated the utilization of multidimensional nD CAD information in the construction industry. In addition to the parametric properties of 3D BIM, the technology also has 4D and 5D capabilities. Recent advancements in software have allowed contractors to add the parameters of cost and scheduling to models to facilitate value engineering studies; estimating and quantity take offs; and even simulate project phasing.

4. DIFFERENCES BETWEEN BIM AND CAD

The differences between BIM and computer-aided design (CAD) is that a traditional CAD system uses many separate (usually 2D) documents to explain a building. CAD output is essentially a collection of lines, numbers and text on a page. Because CAD documents are created separately, there is little to no correlation or intelligent connection among them. For example, a door is represented as a line or a curve, without a detailed understanding of its basic attributes and without any inherent understanding. A wall in a plan view is represented by two parallel lines, with no understanding that those lines which represent the same wall in a section. The possibility of uncoordinated data in a CAD based work environment is very high, **Eastman et al., 2008.**

BIM takes a different approach in comparison with CAD. The BIM model serves as a central database, by collecting all information into one location and cross-linking that data among associated objects, **Azhar et al., 2008**.

All documents within the BIM model are interdependent and share intelligence. A change anywhere in the BIM model is propagated throughout all relevant views and documents for the project. The BIM application has an intelligent understanding of the fact that objects created by users represent real-world components of building such as windows, walls, doors and roofs. Thus, BIM objects have characteristics similar to their real-world counterparts such as windows, which can only exist in a wall, and walls always have a thickness attribute. Use of such intelligent objects distinguishes the geometry created by BIM from a 3D model, **Joannides et al., 2012.**

5. AWARENESS LEVEL OF BIM

There is a pressing demand for improved awareness 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**.

In general, many studies, such as **Arayici et al., 2009**, **Khosrowshahi and Arayici 2012** and **Elmualim and Gilder, 2013** who concluded that there are a lack in the awareness of BIM and its benefits in the field of construction industry as well as the business value of BIM from a financial perspective. More precisely, there is a large lack in understanding of BIM (the core concepts of BIM) and its practical applications throughout the life of projects. In addition, there is a lack in technical skills that professionals need to have for using the BIM software as well as lack in knowledge of how to implement the BIM software to be helpful in construction processes, **Azhar et al., 2008.**

6. DEVELOPMENT AND IMPLEMENTATION OF THE BIM MODEL

The researcher selected a case study to describe the results obtained from using the software's. The case study chosen is State Company for Industrial Design and Implementation (SCIDC)/ Ministry of Industry and Minerals because the researcher has cooperation contract with this organization and because of the ability to access data necessary.

This section will illustrate the benefits of BIM tools for construction projects through applying these tools on a project completed by using AutoCAD software. The project sample is the project named “Administration Building for the industrial compound at Dhi-Qar” province in southern Iraq, which is one of many projects the State Company for Industrial Design and Implementation executes over the country (Iraq), and it was completed by the company in November (2012). The total area of the building is 1840 m^2 with (11 m) height.

6.1 The proposed framework to Create BIM model (3D and 4D)

The proposed framework to create 3-D and 4-D by using BIM tools can be described as shown in **Fig.1**

6.2 Evaluation of the proposed framework

The researcher gave a training course about the application of Building Information Modeling by taking the administration building of industrial complex in Dhi-Qar province in southern Iraq as a case study to evaluate the proposed framework. Participated in this course 31 engineers with different managerial positions and experiences belonging to State Company for Industrial Design and Implementation from the various disciplines. The aim of the training course is to evaluate the efficiency of the BIM technology through its impact on quality, cost and time of the project. After the end of the training course was evaluated the benefits of BIM system by engineers through the questions set. **Figure 2** and **Fig.3** show the engineering fields and years of experience respectively.

As for the result, the researcher has concluded by using simple statistics for each item of evaluation form that are distributed after interviewing to get the most important results as shown in **Table 1** the percentage regarding evaluating BIM system as shown in **Table 2**.

According to the analysis and results of the evaluation which are presented in the researcher's conclusions that the use of the BIM system is high useful for engineers in the construction sector and will help them to make their mission easier, faster and more accurate.

7. CONCLUSIONS

The extensive review of the literature was conducted to achieve the object of the study. The object of this study was to improve a clear understanding about Building Information Modeling system for finding the different factors that provide suitable information to consider utilizing BIM tools in projects by a stockholder in the construction sector in Iraq. The research leads to the following conclusions:

1. The study shows that the awareness level of BIM system is low and not satisfactory. This is because of many reasons, for instance:
    a. The lack of education for Building Information Modeling and programs to implement it in universities and organizations.
    b. The lack of adequate training for the application of the Building Information Modeling in the construction projects.
    c. The lack of demand for this system by the customer or the government.
    d. The lack of publicity and awareness for this system.
    e. Lack of clarity of the benefits of BIM system.
    f. The cost of staff training for BIM system.
    g. The lack of standards and clear guidelines for the application of this system.
2. It is required to improve the knowledge level of engineers with respect to BIM software.
3. According to the study, the proposed framework can improve and develop the performance of project management through the many solutions, benefits and features the proposed framework provides, for instance:
    a. Achieving integration, cooperation, and communication between the work teams.
    b. Submission designs without error.
    c. Improving productivity of the work.
    d. Improving the quality of the work.
    e. Improving information of security management.
    f. Facilitating the preparation and management of documents and consolidated.
    g. Reducing the risks for the project.
    h. Generating drawings and construction details with high accuracy.

i. Improving communication between different parties of the project.
j. Improving accounts of the necessary quantities of materials.
k. Cost savings.
l. Reducing waste of materials.
m. Reducing change orders.
n. Reducing the need to re-work of the design.
o. Time saving.
p. Improving logistics.
q. Early involvement of the owner to make quick decisions.
r. The arrangement of needs for off-site prefabrication.

4. Adopting such system does not mean moving completely and immediately from the current state to the new state, but the process should happen gradually to ensure integrating the system with the operations and procedures in the organizations and projects and in order for the employees and project members to be familiar with the new system.
5. The information that is extracted from Revit software requires skill in the management and understanding of databases for the program, optimum management for databases within the program Revit to fit with any other project, all information entered to configure the model in BIM Revit is available for use in Navis work manage.

8. RECOMMENDATIONS

Based on the achieved purposes of this study as stated earlier, the recommendations below were drawn as a result of the research findings. The recommendations are as follow:

1. Education And Training To Increase BIM Awareness And Interest

a. The use of BIM system should be encouraged through educational and training courses to get the precision and clarity, speed and a high standard in the construction industry and to implement the terms of the sustainability of access to green building.
b. Academic institutions and universities must take the lead to highlight new ways to engage BIM in the construction industry.
c. Improving and developing the cooperation, coordination, and interaction between the construction organizations and scientific and research organizations largely.

2. Government support to apply this system

The government agencies must take progressive steps to apply BIM in the construction sector in Iraq such as:

a. Through developing a guide to BIM that will be a reference for all parties involved in the construction sector in Iraq.
b. Providing legal benchmarks for business improvement, where the absence of standard BIM contract documents is preventing people from adopting and utilizing BIM with security in the construction sector.
c. Supporting and developing incentives and rewards systems.
d. Supporting and developing incentives and rewards systems for the effective employee.

REFERENCES

- Ahmad A. M, Demian P and Price A.D.F, 2012, *BIM implementation plans: A comparative analysis In: Smith, S.D (Ed) Procs 28th Annual ARCOM Conference, 3-5 September 2012*, Edinburgh, UK, Association of Researchers in Construction Management, 33-42.
- Arayici, Y., Khosrowshahi, F., Ponting, A. M., and Mihindu, S., 2009, *Towards implementation of building information modelling in the construction industry*, Proceedings of the Fifth International Conference on Construction in the 21st Century "collaboration and integration in Engineering, Management and Technology". Istanbul, Turkey: Middle East Technical University and Florida International University, PP. 1342-1351.
- Azhar, S., M. Hein, and B. Sketo, 2008, *Building Information Modeling (BIM): Benefits*, Risks and Challenges. McWhorter School of Building Science. Auburn University. Auburn. Alabama, AL.
- Baldwin, M., 2012, *BIM implementation & execution plans, BIM Journal*, Vol. 3, No. 35, PP. 73-76.
- CRC for Construction Innovation, 2007, *Adopting bim for facilities management: solutions for managing the Sydney opera house*, Brisbane, Australia: Cooperative Research Centre for Construction Innovation, Icon.Net Pty Ltd.
- Ding, L. and X. Xu, 2014, *Application of Cloud Storage on BIM Life-cycle Management,* International Journal of Advanced Robotics Systems, 11, PP. 129.
- Eastman, C., Teicholz, P., Sacks, R., and Liston, K., 2008, *BIM handbook " a guide to building information modeling for owners, managers*, designers, engineers, and contractors". Hoboken, New Jersey: John Wiley & Sons, Inc.
- Elmualim, A., and Gilder, J., 2013, *BIM: innovation in design management, influence and challenges of implementation*. Architectural Engineering and Design Management, Vol. 10, No. 1080, PP. 1745-2007.
- Gu, N. and K. London, 2010, *Understanding and facilitating BIM adoption in the AEC industry, Automation in construction*, Vol. 19, No. 8, PP. 988-999.
- Joannides, M. M., Olbina, S., and Issa, R. R., 2012, *Implementation of building information modeling into accredited programs in architecture and construction education*, International Journal of Construction Education and Research, Vol. 8, No. 2, PP. 83-100.
- Khosrowshahi, F. and Y. Arayici, 2012, *Roadmap for implementation of BIM in the UK construction industry. Engineering*, Construction and Architectural Management, Vol. 19, No.6, PP. 610-635.

- Mitchell, D., and Lambert, S., 2013, *BIM: rules of engagement. CIB World Building Congress (Cib Bc13),* Brisbane, Australia: Cibwbc, PP. 1-5.

- Rundell, R. and Stowe, K., 2005, *Building Information Modeling and Integrated Project Delivery-Design-Build Synergy in Action,* Design-Build Dateline, June 2005: 20-23.

- Stanley , R., & Thurnell, D., 2014, *The benefits of, and barriers to, implementation of 5d BIM for quantity surveying in new Zealand*, Australasian Journal of Construction Economics and Building, Vol. 14, No. 1, PP. 105-117.

- Stebbins. J, 2009, *Successful BIM Implementation: Transition from 2D to 3D BIM*, “Digital Vision Automation”.
- Wang, M. 2011. *Building information modeling (BIM): site-building interoperability methods. MSc Thesis*, Interdisciplinary Construction Project Management, Faculty of the Worcester Polytechnic Institute, U.S.A.

List of abbreviations

Abbreviation	*The interpretation of the abbreviation*
BIM =	building Information Modeling
AEC =	architecture, Engineering, and Construction
MEP =	mechanical, Electrical and Plumbing
OM =	operation and Maintenance
D =	dimensional
2D =	two dimensions: x, y
3D =	three-dimensional: x, y, z (the height, length and width)
4D =	four-dimensional; 3D model connected to a time line
5D =	five-dimensional; 4D model connected to cost estimations
6D =	six-dimensional; 6D model which is 5D plus site
7D =	seven-dimensional; 7D model: BIM for life cycle facility management
nD =	a term that covers any other information
CAD =	computer Aided Design

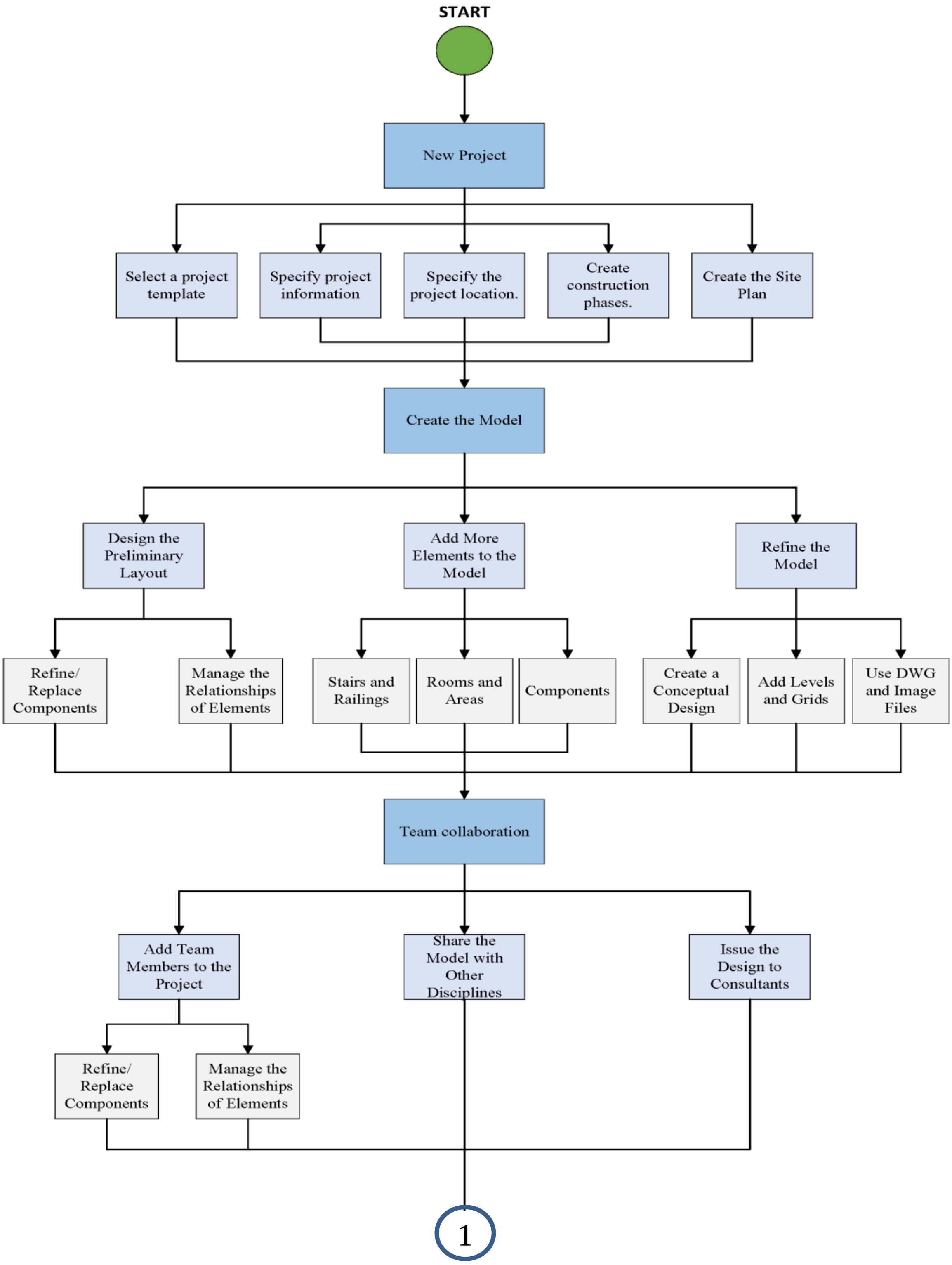

Figure 1. Flowchart of The proposed framework (by researcher).

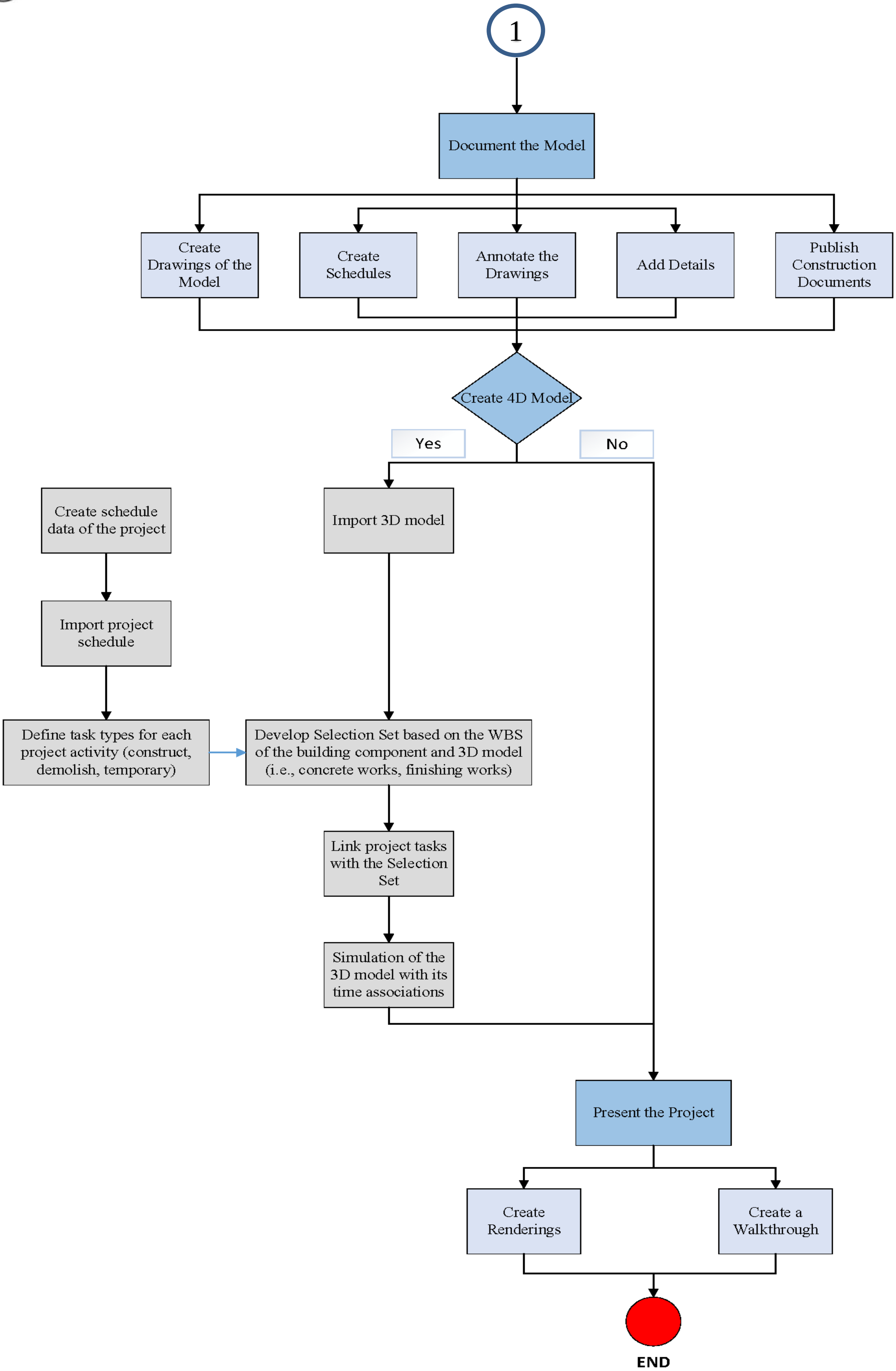

Figure 2. Continued.

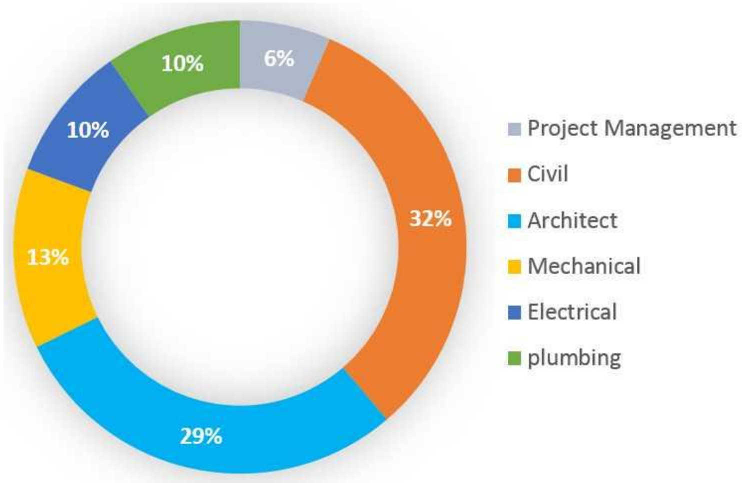

Figure 3. Engineering Fields**.**

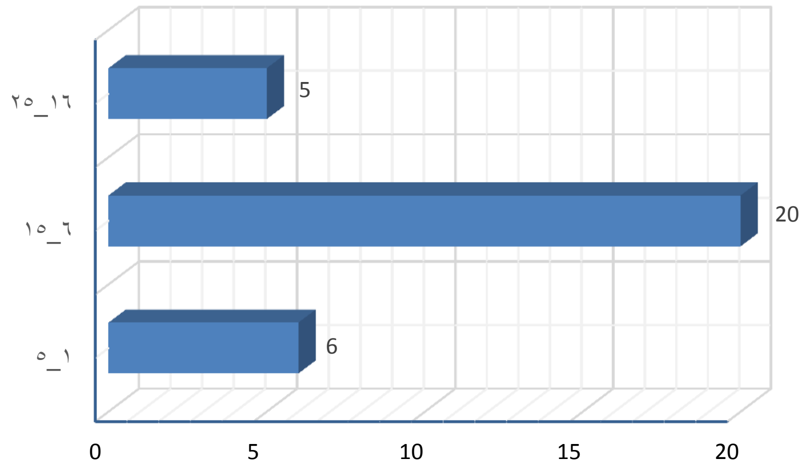

Figure 4. Years of experience**.**

Table 1. The answers regarding evaluating BIM system**.**

Firstly	Impact on project quality	Excellent	Very Good	Good	Medium	Acceptable
1	Achieve Integration and cooperation and communication between the work teams	20	8	3	0	0
2	Submission designs without error	21	7	3	0	0
3	Improve productivity of the work	20	9	2	0	0
4	Improve the quality of the work	21	7	3	0	0
5	Improving information security management	25	4	2	0	0

6	Facilitate the Preparation and management of documents and consolidated	24	6	1	0	0
7	Reduce the risks for the project	22	7	2	0	0
8	Generate drawings and construction details with high accuracy	23	7	1	0	0
9	Improve communication between different parties of the project	23	6	2	0	0
Secondly	Impact on project cost	Excellent	Very Good	Good	Medium	Acceptable
1	Improve accounts of the necessary quantities of materials	18	10	3	0	0
2	Cost savings	22	8	1	0	0
3	Reduce waste of materials	18	12	1	0	0
4	Reduce change orders	23	8	0	0	0
Thirdly	Impact on project time	Excellent	Very Good	Good	Medium	Acceptable
1	Reduce the need to re-work of the design	23	8	0	0	0
2	time saving	25	5	1	0	0
3	Improving logistics	13	12	6	0	0
4	Early involvement of the owner to make quick decisions	22	9	0	0	0
5	the arrangement of needs for off-site prefabrication	17	11	3	0	0

Table 2. The answers percentage regarding evaluating BIM system.

Firstly	Impact on project quality	Excellent	Very Good	Good	Medium	Acceptable
1	Achieve Integration and cooperation and communication between the work teams	64.5%	25.8%	9.7%	0	0
2	Submission designs without error	67.7%	22.6%	9.7%	0	0
3	Improve productivity of the work	64.5%	29%	6.5%	0	0
4	Improve the quality of the work	67.7%	22.6%	9.7%	0	0
5	Improving information security management	80.6%	12.9%	6.5%	0	0
6	Facilitate the Preparation and management of documents and consolidated	77.4%	19.4%	3.2%	0	0
7	Reduce the risks for the project	71%	22.6%	6.5%	0	0
8	Generate drawings and construction details with high accuracy	74.2%	22.6%	3.2%	0	0
9	Improve communication between different parties of the project	74.2%	19.4%	6.5%	0	0
Secondly	Impact on project cost	Excellent	Very Good	Good	Medium	Acceptable
1	Improve accounts of the necessary quantities of materials	58.1%	32.3%	9.7%	0	0

2	Cost savings	71%	25.8%	3.2%	0	0
3	Reduce waste of materials	58.1%	38.7%	3.2%	0	0
4	Reduce change orders	74.2%	25.8%	0	0	0
Thirdly	Impact on project time	Excellent	Very Good	Good	Medium	Acceptable
1	Reduce the need to re-work of the design	74.2%	25.8%	0	0	0
2	time saving	80.9%	16.1%	3.2%	0	0
3	Improving logistics	41.9%	38.7%	19.4%	0	0
4	Early involvement of the owner to make quick decisions	71%	29%	0	0	0
5	the arrangement of needs for off-site prefabrication	54.8%	35.5%	9.7%	0	0