JOURNAL OF ENGINEERING AND APPLIED SCIENCE, VOL. 67, NO. 2, APR. 2020, PP. 333-352
FACULTY OF ENGINEERING, CAIRO UNIVERSITY

TOWARDS A STRATEGIC ROADMAP FOR A SUCCESSFUL BIM IMPLEMENTATION IN THE EGYPTIAN COMMUNITY

M. R. ABDALLAH[1], A. Z. AHMED[2] AND S. S. ABDALLA[3]

ABSTRACT

Nowadays, the construction industry becomes more challenging and develops rapidly, so new technologies will be needed to face that challenge. Building information modeling considered to be one of the new solutions to face the challenging of the construction industry. The research aims to examine and describe the most important BIM guidelines in the United Kingdom, United States, and Singapore. Furthermore, the BIM guidelines will be categorized in the project delivery phases (planning-design-construction-operation) and will be used to prepare a survey for the Egyptian BIM users. The survey aims to determine the scale of importance of these guidelines as a reference, in order to evaluate and arrange them in terms of importance and detect the most appropriate guidelines that the Egyptian BIM users should count on it as Egypt needs to develop one. As a result of this methodology, the research summarizes a set of the most significant BIM work-steps based on analyzing the international guidelines. In addition, the research provides a proposal for a strategic roadmap for building information modeling implementation in the Egyptian community.

KEYWORDS: Building information modeling, construction industry, BIM guidelines strategic roadmap, Egyptian community.

1. INTRODUCTION

Building information modeling is a new technology which builds a virtual structure to physically construct it and defined as “Integration enables a team of designers and constructors to work together toward a common goal, allowing design and construction activities to unfold in the best way for the project, rather than locking them into separate phases required in over-the-wall delivery” [1]. BIM is not just a software but it is a combination between software and process. Moreover, to apply BIM successfully, countries around the world start to prepare BIM guidelines to lead

[1] Professor, Department of Architecture, Faculty of Engineering, Cairo University.
[2] Associate Professor, Department of Architecture, Modern Academy for Engineering and Technology.
[3] Ph.D Student, Department of Architecture, Faculty of Engineering, Cairo University.
dr.sherif-salaheldin-hamouda@outlook.com

their BIM users and raise community awareness. The research problem is that there are no BIM guidelines in Egypt and the users practice this technology by self-effort or by counting on the international guidelines [2]. One of the most leading countries in BIM adoption is United Kingdom, United States, and Singapore [3]. The reason why this research has been conducted is to guide the Egyptian BIM users to an organized BIM process work plan and move towards a successful BIM implementation in Egypt.

The research methodology divided into three parts. The first one identifies the most important BIM process. The second one gathers and arranges the international guidelines for the three countries that previously mentioned in the project delivery phases in order to make a survey for the Egyptian users to determine the scale of importance of each guideline. The result of the survey will determine the most important guideline that we should use to make the Egyptian guidelines. The third part will analyze the international guidelines to get a plan of work for BIM process steps and a strategic roadmap to guide the Egyptian BIM users for a successful BIM implementation in the Egyptian community.

2. BIM PROCESS AND ROADMAP

The BIM roadmap was created to describe and document the most important process in the building information modeling technology such as (Construction design, modeling, and data exchange). Therefore, the BIM maturity levels have been defined to support a strategic roadmap for the whole building lifecycle and simply to describe the BIM process. The main purpose of BIM maturity levels is to categorize the type of collaborative work between all project participants through the process, tools and technics [4], and it can be described in Fig. 1.

2.1 BIM Project Execution Plan

Information increases along the project lifecycle and needs to be managed so we need to specify uses and goals and make the priorities, policies, and procedures that will be used by the project participants and this is the process of BIM execution plan [6], as shown in Fig. 2.

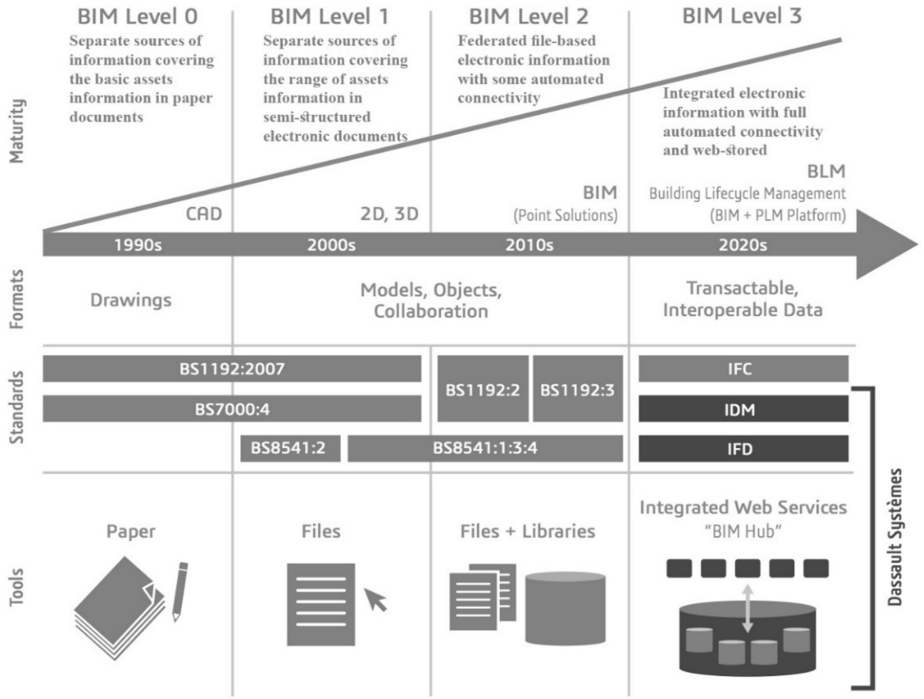


Fig. 1. BIM maturity levels [5].

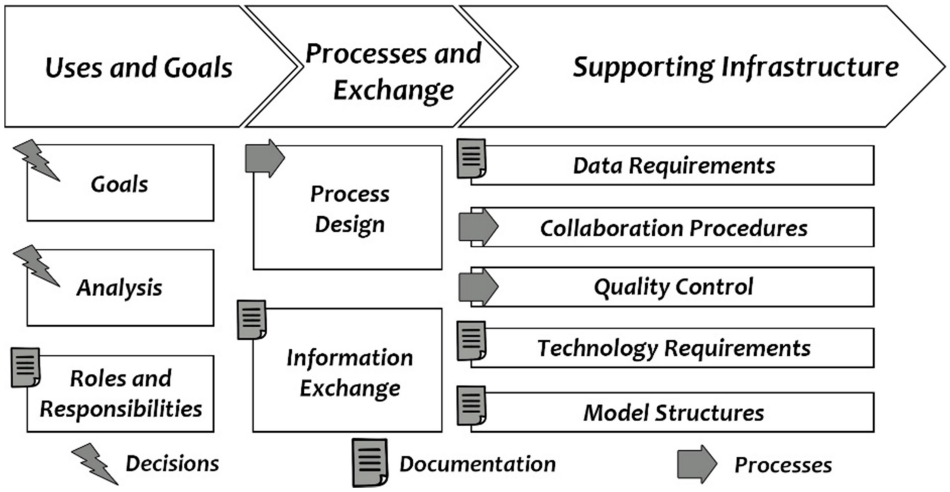


Fig. 2. Illustration of a BIM project execution plan process and structure [7].

2.2 BIM Model Development

The BIM model develops through the process of the project with a Level of detail which refers to how much details are included in the BIM model, so it's an input process.

Level of development refers to which level of building elements have been developed and how much of information have been attached to the BIM model so it's an output process [8], and Fig. 3, shows the LOD specification processes.

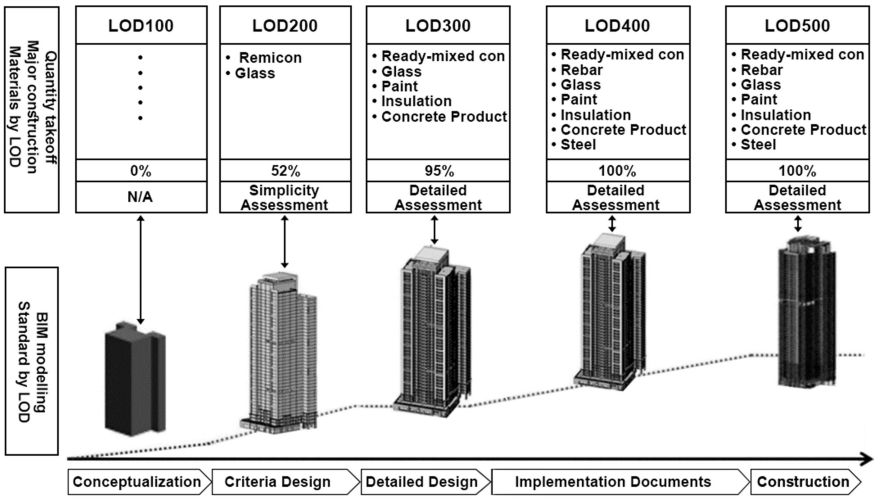


Fig. 3. Level of BIM model development specifications process [9].

3. GLOBAL BIM ADOPTION

There are many countries over the world that implement BIM with standards and guidelines. One of many countries that pushing to be a BIM leader is United Kingdom by making an effective BIM program. Although there are other countries like Denmark**,** Norway, and Sweden that put their standards for almost a decade, but there is also China, Hong Kong, Singapore that have their regulations in place before the UK [10], and the problem here is that Egypt isn't in the global BIM adoption map as shown in Fig. 4.

3.1 Egypt Current BIM Adoption Status

Currently, in Egypt, the awareness of BIM technology increased and the construction companies start to search the best practices for successful BIM implementation. And as a result of a questionnaire made for the construction companies in the middle east with total responding 200 participants, the results show that Egypt comes in the second place after the United Arab Emarat with 19% for BIM adoption [12], as shown in Fig. 5.

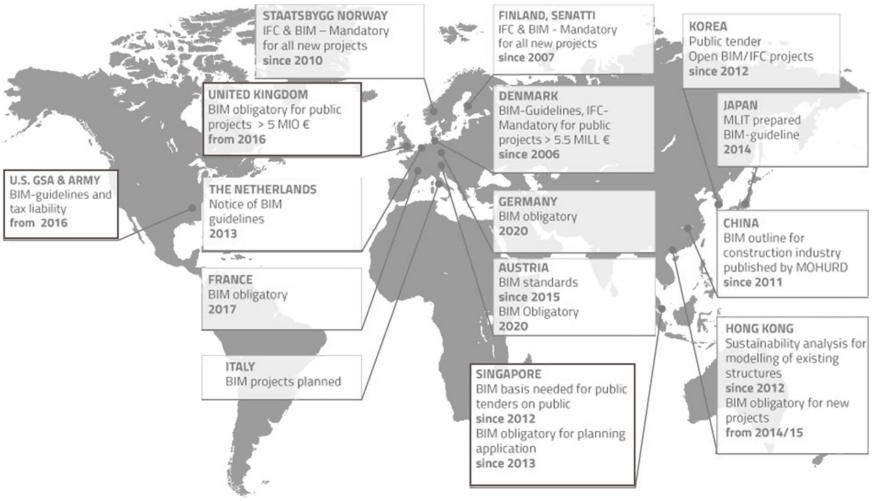


Fig. 4. BIM adoption around the world [11].

In addition, the Egyptian government moves towards BIM through the housing and national research center and drafted a BIM code in June 2018 which will be published soon, it's a code of practice which is based on the British codes and guidelines [13].

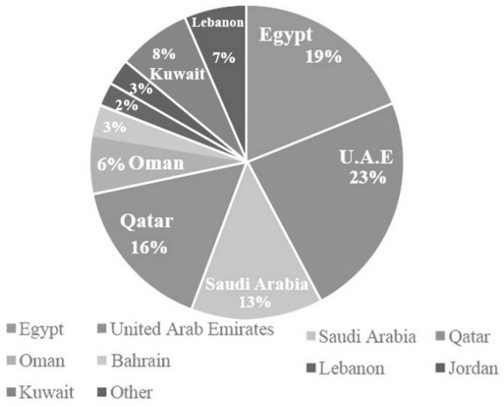


Fig. 5. BIM adoption in the Middle East [12].

4. BIM GUIDELINES OVER THE WORLD

In this part of the research, there is the most important BIM guidelines in United Kingdom [14], United States [15] and Singapore [16]. The research integrated the international guidelines in the project delivery phases (planning, design, construction, operation) in order to survey and determine the scale of importance of these international guidelines in Egypt.

4.1 BIM Guidelines in the Planning Phase

The international BIM guidelines in the planning phase for the three countries have been gathered and described in one table as shown in Table 1.

Table 1. Guidelines of BIM in the planning phase.

Guidelines of BIM implementation in the planning phase	
Code	**Name and Description**
A1	RIBA Plan of Work 2013
Provides a shared framework for construction industry projects and also defines the work stages of using a process map and BIM managing tools, moreover, it integrates sustainable design principles with the BIM project team.	
A2	PAS 1192-2:2013 (Specifications for the BIM model delivery stages)
Determines the responsibilities of the project team work and also propose a work plan for the model delivery method by gathering all the project information and documents in one place called CDE (Common Data Environment).	
A3	BS 1192:2007 + A2:2016
It's a management British code of practice to support collaborative work, in addition, it Filters and classifies the information to be easily exported from the project.	
A4	GSA BIM Guide for Building Elements
Technical guidance for using BIM to create IFC (industry foundation class) models and defines the LOD (Level of details) of the model it also outlines the main requirements for BEP (the BIM execution plan). This guide provides a QCR (quality control report) to ensure that the submitted BIM model meet the project contract requirements.	
A5	National BIM Guide for Owners
Explains how to identify the Employer's information requirements (EIR) using BIM and explains how to include these requirements in the project contract.	
A6	BIM Essential Guide for BIM Adoption in an Organization
Lead construction companies to a quick start towards BIM and making templates. It will also Create a clear vision and goal for the company, besides identifying the BIM programs.	
A7	BIM Essential Guide for BIM Execution Plan
This guide describes in Detail how to prepare a BEP at the different stages of a project it also contains the BIM deliverables and the process work steps through which the deliverables are created, maintained and shared with others, in order to reach a set of project goals.	
A8	BIM Essential Guide for Land Surveyors
It contains instructions about how to use the 3d scanner in land surveying, it also determines the BIM requirements in all its levels by using land surveying programs.	

By analyzing and summarizing the guidelines from the previous table the research illustrates the most important process work steps in the planning phase as shown in Fig. 6.

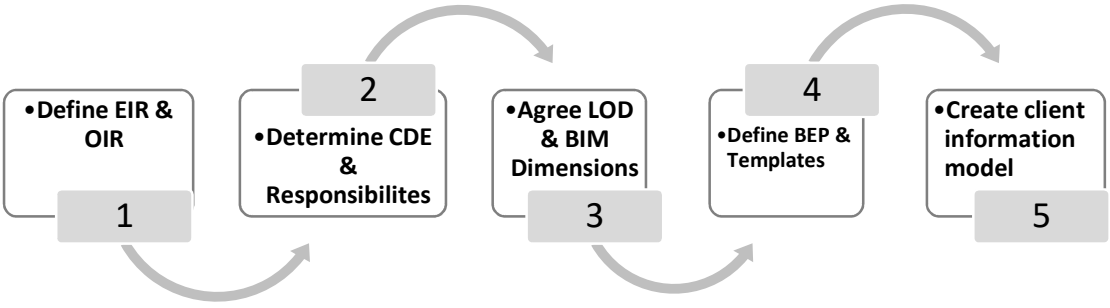


Fig. 6. BIM process steps in the planning phase.

4.2 BIM Guidelines in the Design Phase

The international BIM guidelines in the design phase for the three countries that mentioned earlier have been gathered and described as shown in Table 2.

Table 2. Guidelines of BIM in the design phase.

Guidelines of BIM implementation in the design processes	
Code	**Name and Description**
B1	BS 1192-4:2014 (Specifications for Construction Operations Building Information Exchange (COBIE))
Describes a standardized method to extract project data from the BIM model by making a document worksheet includes all the asset information.	
B2	BIM Guide for Spatial Program Validation
Describes how to validate the architectural spaces before the final concept design stage and make sure that the BIM model is identical to the country standards and codes.	
B3	BIM Guide for 3D-4D BIM Overview
Guides BIM engineers in the process for adopting and integrating 3-dimension (3D model) and 4-dimension (cost model) BIM technologies in the design process and suggests some of the BIM applications that they should use.	
B4	GSA BIM Guide for 3D Imaging
Illustrates the importance of this 3D scanning technology and describes how to deal with the scanned model to convert it to the BIM model. The guide also specifies the deliverable specifications required for the project team in the design phase.	
B5	BIM Guide for Energy Performance
Explains how to achieve sustainability by making energy BIM models and describes how to extract energy data from the BIM model and help to choose the best concept model in the design process.	

Table 2. Guidelines of BIM in the design phase (Cont.).

B6	BIM Guide for Courts design and security validation
This guide ensures that the design will reflect the functional requirements of the courts and the relationships between spaces to achieve safety and security where the conceptual BIM model will help in the designing process.	
B7	BIM Essential Guide for Architectural Consultants
Specifying the rules of the consultants in the BIM process by providing a sort of analysis that shows the possible use-cases of BIM and it also assists architects to develop the BIM models in their project.	

By analyzing and summarizing the previous table the research provides a set of BIM process work steps in the design phase and can be shown in Fig. 7.

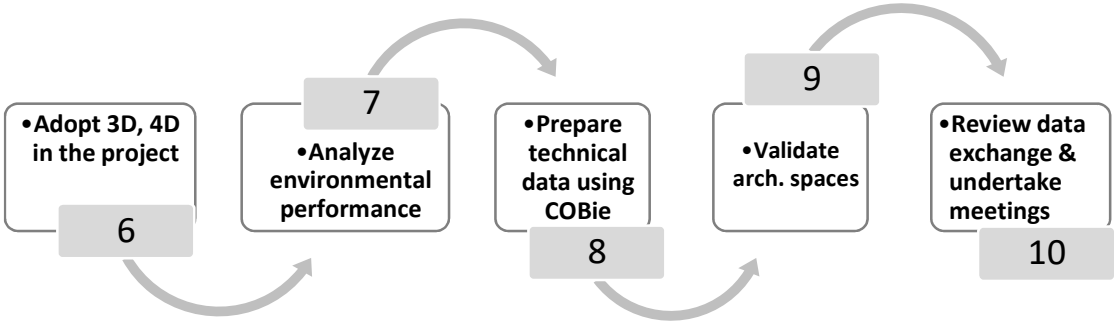


Fig. 7. BIM process steps in the design phase.

4.3 BIM Guidelines in the Construction Phase

The international BIM guidelines in the construction phase for the three countries that mentioned earlier have been gathered and described as shown in Table 3.

Table 3. Guidelines of BIM in the construction phase.

Guidelines of BIM implementation in the construction processes	
Code	**Name and Description**
C1	BS 8536-2:2016
This standard is a code of practice which defines the work stages in the project using BIM especially in the design and construction phases it also helps to determine the building assets that will be needed in the operation phase such as (energy use, recycling, capacity,	
C2	PAS 1192-6:2018
Provides guidance on how health and safety information can be created it also Determining the time, place and level of risk in the project environment to minimize accidents using BIM programs. This PAS reduces construction costs due to studying site safety.	
C3	GSA BIM Guide for 4D Phasing
Contains instructions and process about using 4d BIM programs which allows the team to visualize and evaluate the stages of the construction sequence.	

Table 3. Guidelines of BIM in the construction phase (Cont.).

C4	BIM Essential Guide for Collaborative Virtual Design and Construction
The main objective of this guide is to provide an overall framework for VDC (virtual design and construction) on a project basis, in addition, it includes how to handover the BIM model to start the operational phase.	
C5	BIM for DfMA (Design for Manufacturing and Assembly)
Explains how we can extract the information from the BIM models using the BIM tools in the design phase and before the operational stage for manufacturing so it will help to improve site safety, environmental performance, higher productivity and reduce costs.	
C6	BIM Essential Guide for Civil & Structural Consultants
This guide assists the structural engineer to develop the BIM model and determine the BIM deliverables in the different project phases, in addition, it shows a structural analysis of some projects that implemented and used BIM software.	
C7	BIM Essential Guide for MEP Consultants
This guide a work process for the MEP (Mechanical, Electrical, and Plumbing) consultants in the BIM projects and suggested some of BIM deliverables and the right way to use MEP programs in the different project phases.	
C8	BIM Essential Guide for Contractors
Guide the contractors to determine the BIM uses in Tender, pre-construction and construction stages by analysis some BIM projects using MEP programs	

The guidelines from the previous table summarized to provide a set of BIM process work steps in the construction phase and can be shown in Fig. 8.

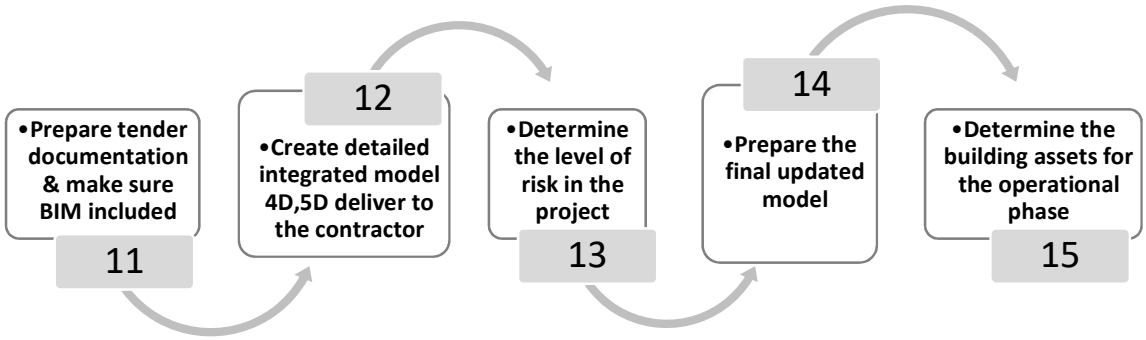


Fig. 8. BIM process steps in the construction phase.

4.4 BIM Guidelines in the Operational Phase

The international BIM guidelines in the operational phase for the three countries have been gathered and described as shown in Table 4.

Table 4. Guidelines of BIM in the operational phase.

Guidelines of BIM implementation in the operational processes	
Code	**Name and Description**
D1	Specification code PAS 1192-3:2014
This PAS focuses on the operational phase of assets it includes specifications for (AIM) asset information management while using BIM. It also refers to the organizational information requirements (OIR) that create the asset information requirements (AIR) to acquaints the employer information requirements (EIR). Following this PAS will help reduce costs due to the automatic transmission of information and make Better decisions about operation and maintenance costs based on the actual performance and condition of the project.	
D2	Specification code PAS 1192-5:2015
This PAS Determine the requirements for the security-minded management of BIM projects, it also Manages any information related to the building materials where they are stored, processed and displayed in a digital format.	
D3	BIM Guide for Facility Management
This is implementation guide for BIM which includes the requirements data for facility management such as accurate As-Built Geometry and Spatial Program BIM, Equipment inventory for operation, As-designed BIM with energy analysis and the use of open standards for data transfer. Using this guide will Increase customer satisfaction and improve the operation and maintenance of our building systems to reduce energy use.	
D4	BIM Guide for Asset Information Delivery
This Guide1 provides a framework for building and facility owners to define their information requirements to be captured using BIM application at design and construction stages and enable the owner to use the information for operations and maintenance.	

The guidelines from the previous table summarized to provide a set of BIM process work steps in the construction phase and can be shown in Fig. 9.

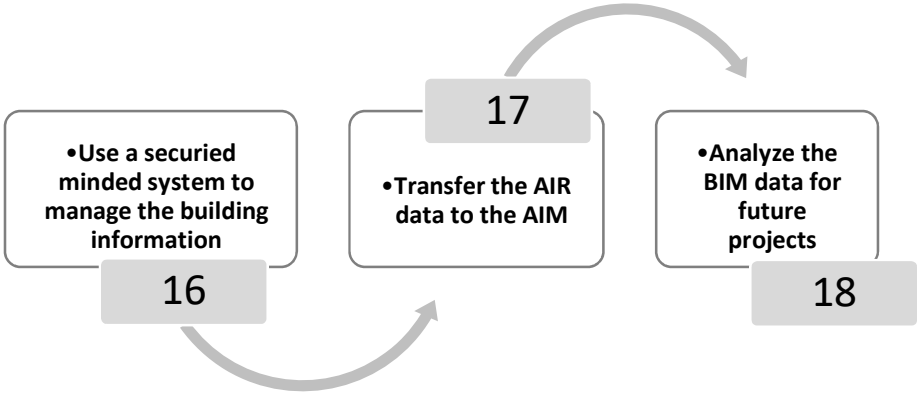


Fig. 9. BIM process steps in the operational phase.

5. APPLICATION OF QUESTIONNAIRE SURVEY

In this part of the research, a questionnaire was applied for the BIM users in Egypt at a workshop in the big 5 construct Egypt exhibition, which considered one of the biggest shows in build and construction industry sector. The main purpose of this questionnaire is to measure how the BIM users in Egypt aware of the importance of the international guidelines after including it in the project delivery phases. In order to monitor the highest assessment guidelines, moreover, use it to develop Egyptian BIM codes, and include it within a strategic roadmap for the best BIM implementation in the Egyptian community.

Although the questionnaire targeted 75 engineers, only 50 responded. The engineers divided into (15 BIM junior, 15 BIM academics, and 20 BIM managers).

The questionnaire based on Likert scale (1= Not important, 2 = Slightly important, 3= Moderately important, 4= Important, 5= Very Important), and Table 5, shows the statistics result for all the questionnaire respondents.

Table 5. Questionnaire statistics.

Professional background	Years of experience	No of questionnaire sent	Percentage to all questionnaire sent [%]	No of responses	Percentage of responses [%]
BIM juniors	0-3 y	25	33.33%	15	20%
BIM Academics	3-6 y	25	33.33%	15	20%
BIM Managers	> 10 y	25	33.33%	20	26.6%
TOTAL		75	100%	50	66.66%

5.1 Survey Findings in the Project Delivery Phases

The survey illustrated that the awareness in terms of importance for BIM technology has increased and the BIM users in Egypt can evaluate the international BIM guidelines.

The results for the planning phase show that the BIM juniors preferred at the first place the USA guidelines (A4:A5) with mean score (4.5) and secondly the Singapore (A6:A8) guidelines with mean score (4.1) and finally the UK guidelines (A1:A3) with mean score (3.3). The BIM academics preferred USA guidelines with

mean score (4.5), then in the second place, the UK and Singapore came with an equal score (4.2).

The BIM managers choose firstly the USA guidelines (4.8) and the UK score result was too close from it (4.7). Finally, Singapore takes (4.1). The finding of the survey in the planning phase can be shown in Fig. 10.

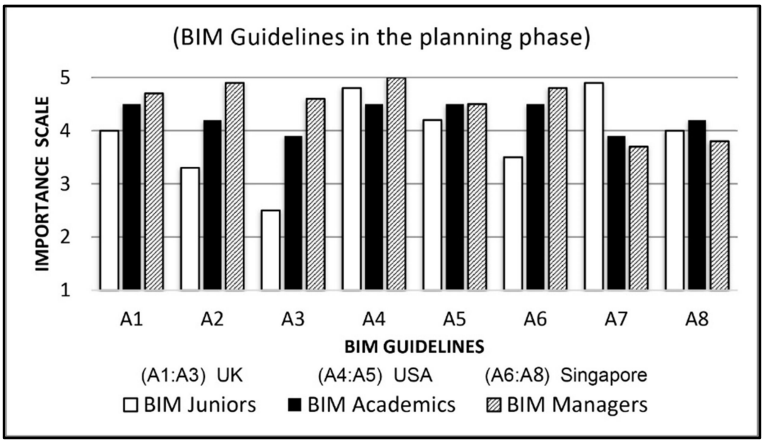


Fig. 10. Importance scale of BIM guidelines in the design phase.

The results for the design phase show that the BIM juniors preferred firstly the Singapore guideline (B7) with score (4.8) and secondly the USA (B2:B6) with mean Score (4.3) and at last the UK (B1) with score (3.2). The BIM academics preferred the USA and the Singapore guidelines with an equal score (4.5) then comes the UK with score (3.7). The BIM managers choose the UK (4.5) then the USA (4.3) and at last Singapore with score (4) and all the results in the design phase can be shown in Fig. 11.

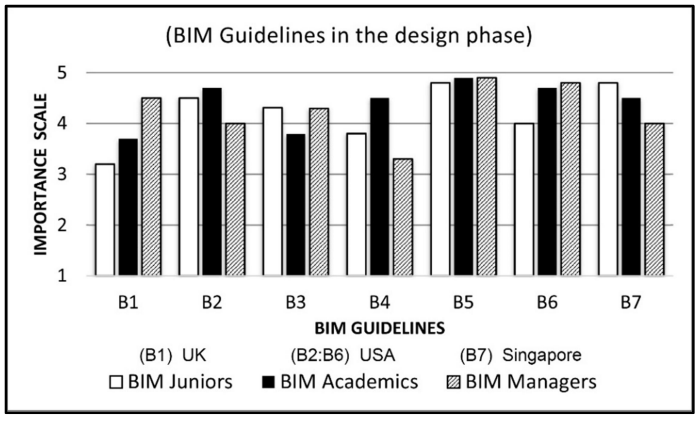


Fig. 11. Importance scale of BIM guidelines in the design phase.

The results for the construction phase for the BIM juniors show that USA (C3) and Singapore (C4:C8) guidelines take a mean score (4) in equal and then the UK (C1:C2) takes (3.4). The BIM academics preferred the USA (C3) with score (4.5) and secondly the UK and Singapore with equal mean score (4.2). The BIM managers choose the UK with (4.9) then Singapore with score (4.3) and at last the USA with score (3.9), all the results for the construction phase can be shown in Fig. 12.

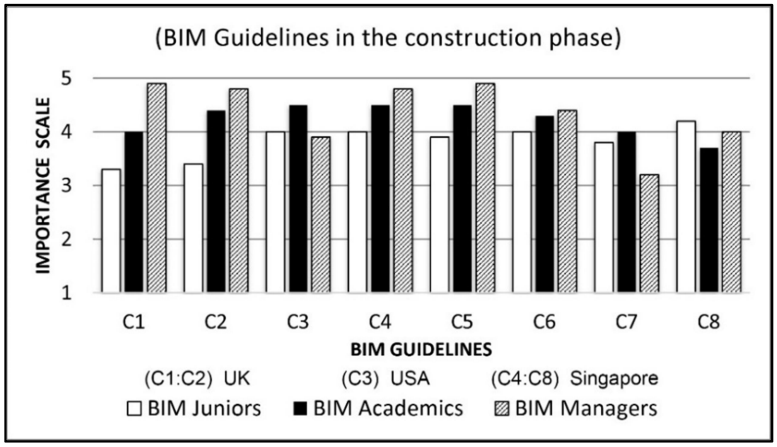


Fig. 12. Importance scale of BIM guidelines in the construction phase.

The results for the operational phase for the BIM juniors show that they adopt at the first place the USA (D3) and the Singapore (D4) with mean equal score (4.6) and then comes the UK (D1:D2) with score (3.2). The BIM academics select firstly the USA guide with score (4.8), and then secondly pick the UK and Singapore with an equal mean score (4). The BIM managers picked the firstly the UK (D1:D2) guidelines with mean score (4.7), then comes secondly the Singapore (D4) guide with score (4.3) and at last the USA with mean score (4), all the results for the operational phase showed in Fig. 13.

After adding the total mean assessment score for all the guidelines in all the project delivery phases the Final results showed some difference in terms of importance for the international BIM guidelines. This means that Egypt should consider this variance and begin to prepare and develop BIM guidelines on three professional levels, and Table 6 illustrates the final results for the questionnaire.

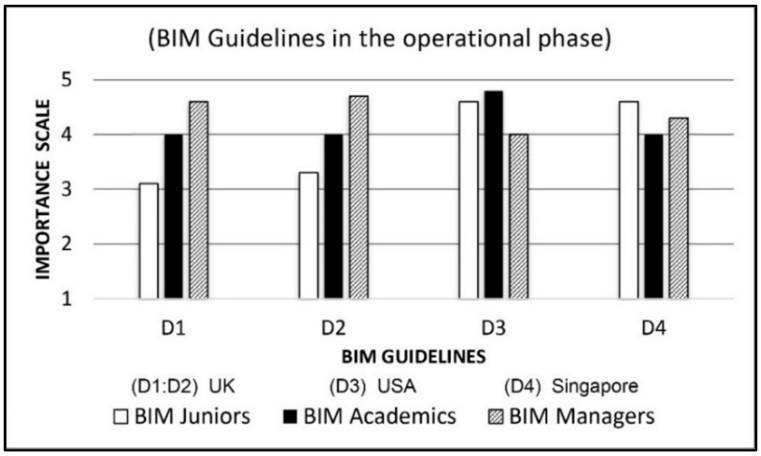


Fig. 13. Importance scale of BIM guidelines in the operation phase.

Table 6. Questionnaire final results.

Phases/ Guides	BIM Juniors			BIM Academics			BIM Managers		
	UK	USA	Singapore	UK	USA	Singapore	UK	USA	Singapore
Planning	3.3	4.5	4.1	4.2	4.5	4.2	4.7	4.8	4.1
Design	3.2	4.3	4.8	3.7	4.5	4.5	4.5	4.3	4.0
Construction	3.4	4.0	4.0	4.2	4.5	4.2	4.9	3.9	4.3
Operation	3.2	4.6	4.6	4.0	4.8	4.0	4.7	4.0	4.3
Total score	13.1	17.4	17.5	16.1	18.3	16.9	18.8	17	16.7
Results in terms of importance	1st Singapore Guides 2nd USA Guides 3rd UK Guides			1st USA Guides 2nd Singapore Guides 3rd UK Guides			1st UK Guides 2nd USA Guides 3rd Singapore Guides		

6. BIM PROCESS STEPS IN THE PROJECT DELIVERY PHASES

Based on the theoretical and analytical parts the research proposes a BIM process steps in the project delivery phases as shown in Fig. 14, to guide the BIM users in Egypt towards a successful BIM implementation and unifying the plan of work.

7. A STRATEGIC ROADMAP FOR THE EGYPTIAN COMMUNITY

From the previous study, the research proposes a strategic roadmap for the Egyptian community to move towards a successful BIM implementation, as shown in Fig. 15.

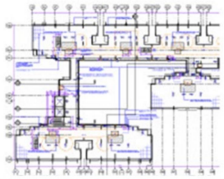
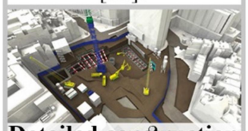
Phases		BIM Process Steps	Model Development
Planning	Brief Preparation	1- Prepare the project brief and determine the employer information requirements EIR and the organization information requirements OIR. 2- Determine the information management, common data environment CDE and the responsabilities of the project team. 3- Agree the Level of details LOD and BIM dimensions that will be used int the project (4D,5D,6D).	 Prepare model documents and site constrains
	Concept	4- Define the BIM Execution Plan BEP which includes uses, goals, process exghange and supporting infrastructure and setup a BIM project templates. 5- Enable the design team to accsess the BIM data to create the client information model with basic elements.	 Massing model [17].
Design	Development	6- Adopt and integrate 3D and 4D BIM technologies in the project to make assessment. 7- Start using the BIM data to analyze the environmental performance of the building. 8- Prepare technical data and design specifications using COBie work sheets to make assesment to start the construction stage safely.	 BIM model [18].
	Technical	9- Validate the architecture spaces to the country standards and codes. 10- Review data exchange and undertake regular model review meetings.	 Detailed design model [18].
Construction	Pre Construction	11- Preparation of tender documentaion and choosing the best tender offer. 12- Create detailed integrated model and deliver it to the contractor to start reviewing the project and determine the construction sequence and costs by using 4D,5D programs. 13- Determine the level of risk in the project environment to minimize accidents.	 Detailed construction model [19].  Construction model [20].
	As-Built	14- Prepare the final updated BIM model (architecture - structure - MEP) and deliver it to the building owner. 15- Determine the building assets that will be needed for the operational phase.	 As-built model [21].
Operation	In Use	16- Use a secuired minded system to manage the building information. 17- Transfer the asset information requirement AIR data to the asset information model to statrt management AIM. 18- Analysis of BIM data for future projects and assist building users during occupation.	 Final model with attach specifications [22].

Fig. 14. BIM process steps in the project delivery phases.

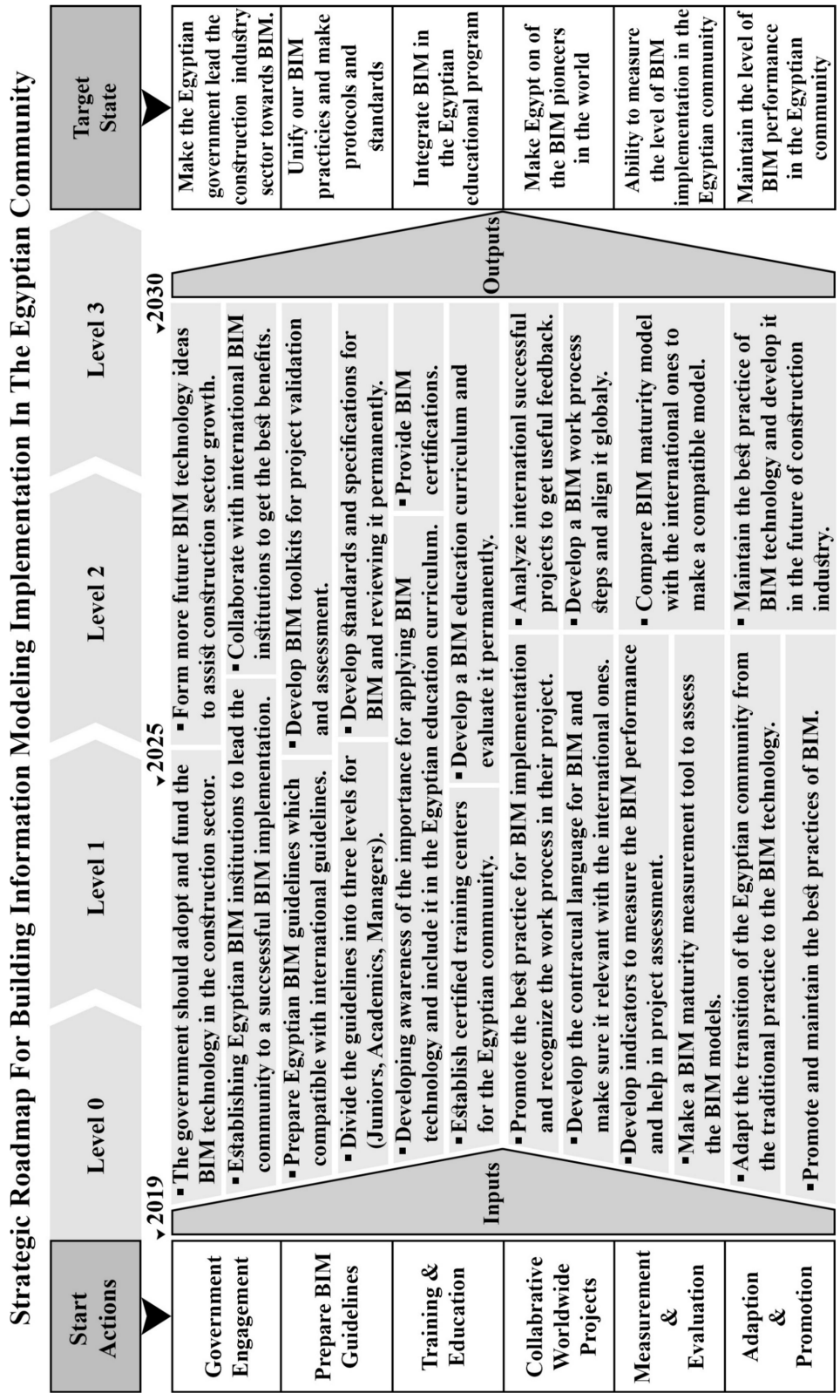


Fig. 15. A strategic roadmap for BIM implementation in Egypt.

8. APPLICATION OF BIM ON EGYPTIAN MEGA PROJECTS

Applying the BIM process steps and the strategic roadmap on mega projects can save up to 50% in design, 33% in construction and 20% in operations [23].

The most important examples of mega projects that applied BIM in Egypt is Egyptian museum and Mall of Egypt and Fig.16 describes the BIM work strategy, BIM software's, difficulties and challenges through the two projects.

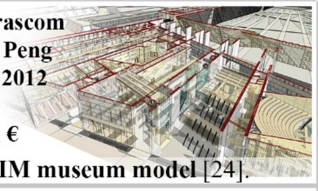
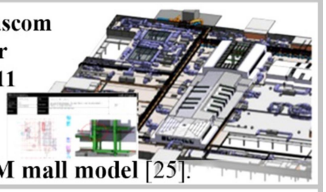
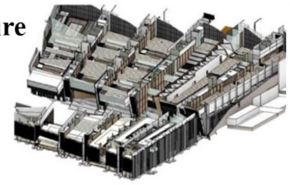
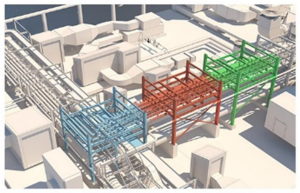
	Grand Egyptian Museum	Mall of Egypt
Description	Company: Besix-Orascom Architect: Henegan Peng Year of the project: 2012 Area: 471000 m2 Budget: 810 Million €  Detailed BIM museum model [24].	Company: BESIX-Orascom Architect: Tarek Beshir Year of the project: 2011 Area: 165000 m2 Budget: 400 Million €  Detailed BIM mall model [25].
BIM Work Strategy	1- Start the BIM model from the tender drawings and send all the RFI to the consultant to solve the design problems. 2- Detect the clashes between architecture, structure and MEP models. 3- Define CDE and team responsibiliteis. 4- Update the LOD of BIM model and coordination drawings. 5- Make workshop drawings with all details to serve the construction site. 6- Use digital fabrication & maintenance strategy.	1- Define EIR and start the conceptual BIM model to take employer approval. 2- Identifying project team capability and trainning them if needed. 3- Identifying project team capability and initiate CDE for data exchange. 4- Modeling procedures should follow LOD matrix. 5- Run automated clash detection to monitor and solve the conflicts. 6- Utilize BIM for model Prefabrication in order to significantly reduce the installation works duration.
BIM Software	- Revit Architecture - Revit Structure - Revit MEP - Tekla STAAD - Navisworks - Inventor  3D section BIM model [25].	- Revit Architecture - Revit Structure - Revit MEP - Tekla Structures - Navisworks - Inventor  3D BIM model [26].
Difficulties & Challenges	- Difficulty in collaboration with traditional CAD technical office. - BIM Software needed more updated computer hardware. - shop drawing revision was so hard because of complex geometries. - interoperability issues between subcontractors. - BIM standards are not available yet.	- Lack of knowledge and skilled engineers. - Collaboration issues between BIM team. - Model division and complexity. - Quantifications and reduce waste was so hard to achieve. - MEP works and workshop drawings was so difficult to review. - Many corrections was done in BIM models.

Fig. 16. Examples of applying BIM on Egyptian mega projects.

9 CONCLUSIONS

Egypt started its first steps towards BIM through beginning to prepare a set of exhibitions, workshops and conferences, in addition, the Egyptian government initiates a draft code of BIM practice to guide the Egyptian community [27].

Generally, in order to achieve a successful BIM implementation in Egypt, the research started to analyze and survey the international BIM guidelines and the results can be shown as follows:

- The BIM juniors who have a few experiences preferred the Singapore guidelines.
- The BIM academics with medium experience preferred the USA guidelines.
- The BIM managers with a professional level preferred the UK guidelines.

The Egyptian government should consider this variance and start to prepare and develop the BIM guidelines on three professional levels.

The paper was able to recapitulate the BIM process work steps in the project delivery phases to guide the BIM users in Egypt and the results showed that:

1. The planning phase should consider the employer requirements EIR and the organization requirements OIR, furthermore, define the BIM execution plan and the level of details LOD.
2. The design phase should adopt and integrate the 3D and 4D BIM technology and prepare COBIE worksheets to validate the architecture spaces.
3. The construction phase was counted to create a detailed integrated construction model and determine the construction sequence with 5D BIM programs.
4. The operational phase showed that a secured minded system needs to be prepared to manage the building information and transfer it to the asset information model AIM.

Thus, the research suggests a strategic BIM roadmap which needs eleven years to achieve it and reach level three of BIM implementation and it can help in as follows:

- Make the Egyptian Government lead the construction industry sector.
- Unify BIM practices and make protocols with international leading countries.

- Integrate BIM in the educational programs to create pioneers.
- Maintain the level of BIM performance in the Egyptian community.

Finally, the Egyptian mega projects that implemented BIM encountered some difficulties such as the lack of BIM guidelines, skilled engineers and spread sufficiently, however, there is a successful percentage of implementing BIM which will increase in the near future.

DECLARATION OF CONFLICT OF INTERESTS

The authors have declared no conflict of interests.

REFERENCES

1. Hardin, B., and Mccool, D., "BIM and Construction Management", 2nd Edition Wiley, Canada, pp. 2-4, 2015.
2. Khoudeir, L.M., and Nessim, A.A., "BIM2BEM Integrated Approach: Examining Status of the Adoption of Building Information Modelling and Building Energy Models in Egyptian Architectural Firms", Ain Shams Engineering Journal, Vol. 9, pp. 1781-1790, 2018.
3. https://www.geospatialworld.net/article/bim-adoption-around-the-world-how-good-are-we/ (Accessed 1/4/2019).
4. Eynon, J., "Construction Managers BIM Handbook", 1st Edition, Wiley, United Kingdom, p. 63, 2016.
5. https://thebimhub.com/2014/11/01/what-is-bim-level-3/#.W_OuyeRReIw (Accessed 3/4/2019).
6. https://www.constructioncanada.net/bim-pxp-knowing-the-execution-plan-essentials/ (Accessed 4/4/2019).
7. http://imguramx.pw/The-Institute-for-BIM-in-Canada-IBC-has-developed-a-BIM-toolkit.html (Accessed 4/4/2019).
8. Reinhardt, J., and Bedrick, J., "Level of Development Specification Guide", BIMForum, United States, p. 9, 2017
9. https://www.srinsofttech.com/bim-level-of-development-lod-300-400-500.html (Accessed 3/4/2019).
10. Brewer, G., Gajendran, T., and Legoff, R., "Building Information Modelling (BIM): An Introduction and International Perspectives", The University of Newcastle, Australia, p. 14, 2012.
11. https://www.cadenas.de/en/products/bimcatalogs-perfect-product-data-AEC-BIM (Accessed 5/4/2019).
12. Gerges, M., Austin, S., Mayouf, M., Ahiako, O., Jaeger, M., Saad, A., and El Gohary, T., "An Investigation Into the Implementation of Building Information

Modeling in the Middle East", Journal of Information Technology in Construction, Vol. 22, pp. 1-15, 2017.
13. Marzouk, M., "The Egyptian Code for Building Information Modeling", Draft Edition, Housing and Building National Research Center, Egypt, 2018.
14. https://shop.bsigroup.com/Browse-by-Sector/Building--Construction/BIM-/ (Accessed 5/4/2019).
15. https://www.gsa.gov/real-estate/design-construction/3d4d-building-information-modeling (Accessed 5/4/2019).
16. https://www.corenet.gov.sg/general/bim-guides/bim-essential-guides.aspx (Accessed 5/4/2019).
17. http://www.thomaschow.com.hk/bim/ (Accessed 5/4/2019).
18. http://www.bimservicesindia.com/blog/bim-level-of-detail-lod-get-ideas-of-each-stage-of-a-bim-modeling-process/ (Accessed 5/4/2019).
19. https://leienoch.wixsite.com/star (Accessed 5/4/2019).
20. https://architizer.com/blog/practice/tools/young-architect-guide-bim-intro/ (Accessed 5/4/2019).
21. http://bimcap.com/services/ (Accessed 5/4/2019).
22. https://www.gsa.gov/real-estate/design-construction/3d4d-building-information-modeling/guidelines-for-bim-software/document-guides/level-of-detail (Accessed 5/4/2019).
23. https://www.lodplanner.com/bim-execution-plan-bep/ (Accessed 18/5/2019).
24. https://k3llyonline.files.wordpress.com/2013/10/grand-egyptian-museum.jpg (Accessed 18/5/2019).
25. https://www.slideshare.net/secretaryIfma/bim-ifma-besixweb(Accessed 17/5/2019).
26. https://www.virtualprojects.build/showcase (Accessed 17/5/2019).
27. Abdallah, M. R., "The Role of Advanced Modern Technology in the Re-utilization of Heritage Buildings, Journal of Engineering and Applied Science, Vol. 63, No. 3, pp.159-181, 2018"

نحو خارطة طريق استراتيجية ناجحة لتطبيق نمذجة معلومات البناء فى المجتمع المصرى

يهدف البحث إلى دراسة ووصف اهم الكتيبات الإرشادية فى المملكة المتحدة والولايات المتحدة وسنغافورة وتصنيف الكتيبات الإرشادية الخاصة بنمذجة معلومات البناء داخل مراحل تسليم المشروع (مرحلة التخطيط ومرحلة التصميم ومرحلة التنفيذ ومرحلة التشغيل)، هذا وقد تم استخدام تلك المعلومات فى إعداد استبيان لمستخدمين نمذجة معلومات البناء (البيم) فى مصر يهدف إلى قياس مدى أهمية إستخدام هذه الكتيبات الاسترشادية كمرجع للتقييم والترتيب من من حيث الأهمية والحصول على أفضل الكتيبات الارشادية التى يجب أن يعتمد عليها مستخدمى البيم فى مصر كنتيجة لهذه المنهجية ويلخص البحث مجموعة من أهم خطوات العمل بالبيم بناءً على تحليل الكتيبات الارشادية العالمية، هذا بالإضافة إلى تقديم مقترح لخارطة طريق إستراتيجية لتطبيق نمذجة معلومات البناء فى المجتمع المصرى.