The Effect of Using Building Information Modelling (BIM) (Stages: Design, Execution and Post-Execution)

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Abstract: Most applications that already used were not containing enough information to analyse and assess buildings performance, while lately more sophisticated tools appeared representing the building as a perfect basic information from ordered information (in stages: design, execution and post-execution). Despite the fact that the constructional work seems more complicated, albeit the new developments in information sampling techniques of buildings (BIM) made the manners and ways more easy and communications between building information module and analysis tools enable the constructors from evaluating the suggested designs and determination if they can define the intended performance after fine finishing and helping them to perform the projects in more fine, faster and better manners; that is why BIM represent an effective tool in a frame of international works to reform construction sector more perfect and more developed. This research deals with the effect of using BIM (in stages of design, execution and post-execution) and from here the research problem aroused: which is represented by obvious informational deficiency in academic and practical medias in knowledge of the effect of using BIM (in stages of design, execution and post-execution) in more effective, acceptable and beneficial, and the informational deficiency in technical capabilities to define the challenges and the chances through applying BIM, so this research adopted induction approach to reach the aims in building the theoretical frame and then applying this frame to reach conclusions.

1. Introduction
Most applications that already used were not containing enough information to analyze and assess buildings performance, while lately more sophisticated tools appeared representing the building as a perfect basic information from ordered information (in stages: design, execution and post-execution). Despite the fact that the constructional work seems more complicated, albeit the new developments in information sampling techniques of buildings (BIM) made the manners and ways more easy and communications between building information module and analysis tools enable the constructors from evaluating the suggested designs and determination if they can define the intended performance after fine finishing and helping them to perform the projects in more fine, faster and better manners; that is why BIM represent an effective tool in a frame of international works to reform construction sector more perfect and more developed [1,2].
The digital revolution has a great and obvious effect in constructional work, so the result skipped from traditional ways of producing constructional pictures by computers to become a result of different influences and among them were BIM (in stages of design, execution and post-execution) [3], which is represented by obvious informational deficiency in academic and practical medias in knowledge of the effect of using BIM (in stages of design, execution and post-execution) in more effective, acceptable and beneficial, and the informational deficiency in technical capabilities to define the challenges and the chances through applying BIM. This research aims to define the effect of using BIM (in stages of design, execution and post-execution) and definition of technologic capabilities in participating to identify the challenges and chances through applying BIM [4].

The objective of this research suggests that the usage of BIM (in stages of design, execution and post-execution) and definition of technologic capabilities in participating to identify the challenges and the chances through applying BIM has a grave positive influence.

1.1. Definitions of Building Information Modeling (BIM):

- It is a practical system to administer the information and data of a building in digital programming through the whole own life cycle. [5]
- The BIM is not a program, but it is technology and processes that are done by persons of work team, [6] and it is a process of generating and managing buildings data through its life-cycle. [2]
- This technique is considered a key to frame the documentation and design and made a change to the point of views of designers and made a chance in the point of view of designers and executers for the entire building process starting from primary design stage to executive drawing preparation then to the stage of building, and finally to the stage of administration of the building after execution. [4] The concept of this technique involve a group of functions and also involves the following concepts:
  - Building: which is representing the whole life-cycle of the building process.
  - Information: the information and data for building is derived from each stage and linked to building elements.
  - Modeling: this is a tool for mixing and the base that produce and control the resource of these data and information. [3]
- The concept of BIM refers to (according to: The National Building Information Modeling Standards (NBIMS)) the ability to modeling the buildings to three dimensional elements with inclusion of all the information that define their properties aims to prospect the expected faults and problems and reduces risks and keeping on the purpose from design and simplification of goodness observation. [8] The technique of BIM added a lot of design dimensions like the 4th dimension (4D) to study time through provision timing schedule in a way that is compatible and accompanied with design processes and construction where they were separate as previously they did, and the 5th dimension (5D) which study the amount counting and execution cost and prices of terms (articles) directly with the stage of design, and the 6th dimension (6D) that analyze the energy and who long the building lines, and the 7th dimension (7D) represented by using and maintaining the building, wherein, be benefited from design module in the work of idling and maintenance with the ability of applying rehabilitation in easier and more sound on the basis of basic sample, [8,9] see figure 1.
2. Theoretical framework:

2.1. Benefits of using BIM techniques: The idea of BIM depends on virtualizes the executive and design processes in reality through a world of virtual reality, where as it allows studying the projects and passing through it and knowing the problems and difficulties that might face the workers on the project and make benefits at different stages of building. [10, 11] Below are some benefits from using this technique:

- Effective and positive influences to accuracy of amount of project on the life-cycle of project.
- Easy visual identification with respect to the pointing to a specific element, and knowing the amount in accurate way.
- Direct re-ordering on the amount schedule when the sample changed like changing sectors or instruments. [6] We can consider building information modeling as an information reservoir for every detail that happens during project, with regard to technology or other processes. The evolution of technology, represent a basic bar that support BIM in making radical changes in constructing, engineering, and building sector, and in order to be benefitted from BIM techniques, three basic and important elements must be available:
  - Managing the common data environment.
  - Project information management.
  - Collaborative working, information exchange and project team management. [12]

2.2. Properties of BIM: can be summarised as following:-

- Rapid and better performance and high productivity: since the processes of design and document preparation (schedules, properties, amounts, ...etc) become synchronised but not in successions.
- Improved design: during the design process, the architect team needs to follow the possible choices and alternatives and allows the BIM to provide information and possibility of developing and studying design alternatives and comparing between them to choose the best solutions synchronised with the sample.
- Cost control: through the ability of the model (sample) to provide information, schedules and amount of building constituents which follows data base of the building and possibility of counting the amount and cost determination and the same follows in stage of execution since that the sample (model) provide fine details that decreases the cost of building managing process.
- Better work organisation: for the whole specialities involved in the project, so the BIM allows saving most last efforts and improves team communications and focuses on most time on improving design and rapid execution, [1] see Figure 2.

![Figure 1](image-url)
2.3. User of BIM: can be summarized as follows:-
- Integrated Documents.
- Visualization.
- 3D Simulation.
- Materials Database.
- Construction Planning.
- Post Occupancy Management. [4]

3. Pointers of influences of using BIM: can be classified to three stages (design, execution, and post-execution) and can be summarized by the below points, Table 1.

| Demonstrates pointers of influences of using BIM (stages: design, execution, and post execution) | Assessment | Other notes |
|---|---|---|
| Organization of team work between team workers at once. Allows full communication between all engineering specialties. Ability to imagine the project and showing it to the owner. Early discovery of design faults and easy refinement. Provision of enough time and reduces mistakes since we can change all items in all drawings at the same time. Collecting amounts and properties of all articles involved in execution and counting the initial cost. Simulation of shape of building and analyses lifecycle of the building and environment comfort. | + | |
2nd Execution stage
Detection of opposition of construction elements and finalization elements with each other.
Good cooperation between design team and the execution constructor.
Using virtual design to simulate execution process.
Help choosing best execution method.
Reduces time and cost of execution.
Flexibility in documentation and excretion.
Cooperation between team workers.

3rd Post-execution stage
Efficiency provision in managing and administering the building.
Simplification of information exchange and cooperation between the team workers of the function of the building and providing successful administration to the information.
Alarming the project administration to the sites of emergent faults or that requires maintenance, reconstruction and working on scheduling.
Provision a long strategy efficiency in building work and control internal environment.

4. Practical framework

In the way of what previously admitted to the already mentioned concepts of studying the effects of using BIM (in stages: design, execution and post-execution) according the basic research problem and aim of the study and theoretical assumption of this research, so this part will concentrate on design a practical study represented by measuring the presumed pointers from theoretical point of view, through electing practical study sites and through doing questionnaires and testing these environments and the displaying their results and as follows:

4.1. Election of site of practical study: after aligning the pointers of effects of BIM(in stages: design, execution and post execution) we choose a group of projects as elected environments for practical study and allows a great space for comparing BIM effects (in stages: design, execution and post execution) and exiting in subject results more inclusive about the research subject.

4.2. Data collection method: the obtained information from questionnaire the workers in the fields, where they were twenty two big sites in UAE and then analyzing these data and testing the effects of BIM (in stages: design, execution and post execution) each one alone with the fixation of each item (other notes) in the questionnaire reaching to the major obstacles in application BIM and then final testing reaching the results.

4.3 Results of analysing pointers of the effects of using BIM (in stages: design, execution and post execution): results of analyzing these pointers revealed (according to the questionnaire) the presence of positive results in percentages: 97% in design stage, 91% in execution stage and 94% in post-execution.
This means that these results proved that the effects of using BIM (in stages: design, execution and post execution) will be 94% positive, see figure 3.
Figure 3. Represent the effects of using BIM (in stages: design, execution and post-execution).

While this field (other notes) revealed a group of obstacles in applying BIM, which can be summarized in the following Table 2.

| No. | Obstacles of applying BIM                                                                 | Degree of appreciation |
|-----|------------------------------------------------------------------------------------------|------------------------|
| 1   | The responsibilities were not limited to data content.                                    | Very important         |
| 2   | The need to limit the role "project manager" in projects.                                 | Important              |
| 3   | Revision of institute to accept the idea of BIM.                                          | Important              |
| 4   | Need for standard properties to the subject.                                              | Important              |
| 5   | No knowledge of benefits of BIM to institute.                                             | Important              |
| 6   | Strain of the owner (ignorance of important).                                            | Important              |
| 7   | The need for emerging specialized contracts to BIM.                                       | Important              |
| 8   | Unavailability of effective documented contracts.                                         | Important              |
| 9   | Obstacles made by owner because of high cost.                                            | Important              |
| 10  | Deficient efficient staff in BIM.                                                        | Important              |
| 11  | Changing institute's attitude toward teamwork                                            | Important              |
| 12  | Decreased clarity of the subject of allocating the authorities between all sites.         | Important              |
| 13  | Deficient training on BIM.                                                               | Important              |
| 14  | Costs of adding extra staff.                                                             | Important              |
| 15  | Difficult to learn.                                                                     | Intermediate           |
| 16  | The time consumed in applying BIM.                                                       | Intermediate           |
| 17  | Employee rejection to learn (or unwilling).                                               | Intermediate           |
| 18  | Cost of sample (models).                                                                 | Intermediate           |
| 19  | Time needed to produce a model.                                                          | Intermediate           |
| 20  | Increased costs of training the engineers working in construction sector.                 | Intermediate           |
| 21  | Increase time for programming to train the engineers.                                    | Intermediate           |
| 22  | The need for trade models admitting from reality.                                        | Intermediate           |
| 23  | Unsuitability of some building projects to apply BIM.                                     | Intermediate           |
| 24  | Costs of new and more developed programs.                                                | Intermediate           |
| 25  | Necessary synchrony of digital design data.                                               | Intermediate           |
| 26  | No enough available information to provision series.                                     | Intermediate           |
| 27  | Unauthorized re-use to copy-rights.                                                     | Little important       |
After subjecting the results of analyzing the pointers of using BIM (in stages: design, execution and post execution), their use in previous stages revealed, as well as the definition of the capabilities of technology in participating to recognize the challenges and chances through applying BIM, a great positive effect and this prove this hypothesis.

From what we disclosed before and exposing the final tests, revealed the conformance of these results with presented hypotheses subjected by this research and its validity.

5. Conclusions:
• The study revealed a bias toward BIM. Philosophy to the new generation of engineers, where they became able to develop and study synchronized, diverse alternatives with the models with the possible imagination and measurement and analysis of design choices and provision of new properties to the building during stages of architectural work.
• The observation, monitoring and control of data to the information models of building and the operations and activities linked to this model is very necessary to ensure follow up of better acts to process of building a model from the start of the project and through developing it reaching to the end of the project to become a product liable for use and finally, we should re-check product standardization before delivering it to any site of project through project development.
• Adding a lot of information from the designer to the digital model leads to more creative solutions. As such that the accuracy of the model depends on the accuracy of data that the designer enters them into the model data base.
• This type of modeling works on simplification of a lot of missions like extraction and classification of amount and properties to the used matters and also we can work partially for every person in the team work, each work, on his/her own in the same central sample.

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