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Potential and Benefits of Building Information Modeling (BIM) During Pre-Construction, Construction and Post Construction Stage

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The construction industry is the main economic support for all countries around the world in which continually adapting to meet competitive challenges around the global market. Nevertheless, the construction project is becoming much more complex and difficult to manage. This is because the construction project involves a large number of stakeholder, for example, the consultant companies, architects, engineers, building surveyors and quantity surveyors. The technology currently used in the construction industry is the AutoCAD (Automatic computer-aided design). AutoCAD is a commercial software application for 2D and 3D computer-aided design (CAD) and drafting develop by Autodesk. Generally, all the drawing design from Autocad will be exchanged among the stakeholder in the form of paper. Information exchanged among them mostly involves a lot of documents and drawings. This practice creates errors because of documents and drawings are mostly in a paper-based format that is not properly managed which results in miscommunication among them. Having wrong information in the construction process could hinder the productivity of projects because in a construction project information is one of the important construction materials. Building Information Modeling (BIM) is one of the newly software in the architecture, engineering, and construction (AEC) industries to ensure all parties receive the right information. BIM technology is also an intelligent model of a building constructed digitally in the way of 3D. The software will generate model containing the information needed to support the construction, fabrication, and procurement activities that needed to realize the building. This paper will discuss on potential and benefits of BIM during pre-construction stage, construction stage and during post construction stage.

Keywords: *computer-aided design, Building Information Modeling, software, construction, engineering, architecture*

1. Introduction.

Notion of Building Information Modeling (BIM) has existed since the 1997s while the comparable research and development happened throughout the late 1970s and early 1980s in UK and Europe. However, during the early 1980s, this method was described as "Building Product Model" and "Product Information Models" until the mid-to-late 1980 this method is renamed as Building Information Modeling and is widely promote in the sector of Architecture, Engineering, and Construction (AEC) industry. Building Information Modeling (BIM) is a digital representation of physical and functional characteristics of a facility. A BIM is a shared knowledge resource for information about a facility forming a reliable basis for decision during its life-cycle, defined as existing from earliest conception to demolition. BIM is an integrated process that allows professionals to explore a projects key physical and functional characteristic digitally before it is built [1].

The characteristics of BIM are the components found in BIM model include data that described how they behave. For example, taking-off, energy analysis and specifications. In addition, data in BIM model are consistent and non-redundant such as changes to the components data are represented in all views of the components. Coordinated data also one of the characteristics in BIM model due to the model in BIM system are represented in a coordinated way. Figure 1 shows the potential of BIM holistically in which cross-functional project teams share intelligent models to better plan, design, build, and manage building and infrastructure projects.

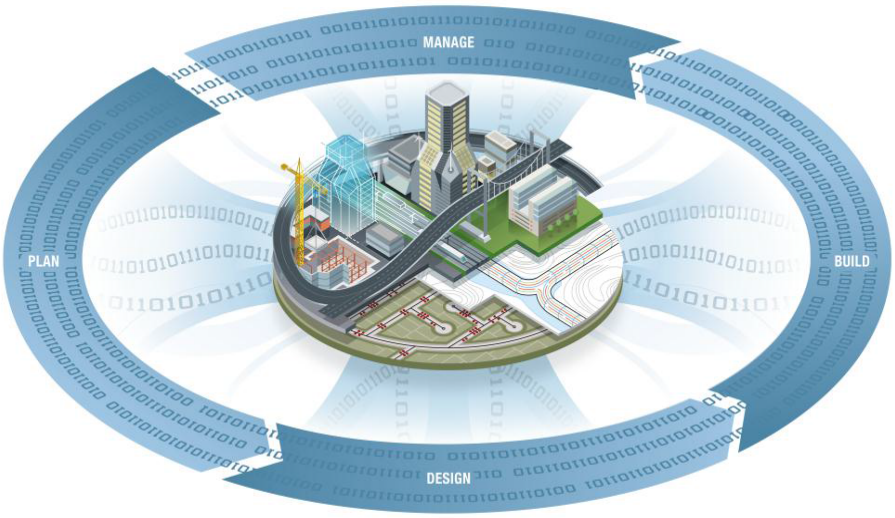


Figure 1. With BIM the cross-functional project teams share intelligent models to better plan, design, build, and manage building and infrastructure projects.

2. Computer Aided vs Building Information Modeling

The main different between CAD and Building Information Modeling (BIM) is that the older CAD system produce 2D drawing with plotted system and the building plan is created separately. For example, the architecture plan, engineering plan, plumbing plan, door and window plan, etc. Nevertheless, CAD system is improved to 3D modeling and complex surfacing tools were added but it only shows the geometrical modeling 3D with digital volumes and surfaces. In BIM, the intelligent model is created in the form of an interactive tool and support different views of data contained within the drawing set with 2D and 3D. The information that shows in BIM include the properties of the material like width, height, bearing or non-load bearing, cost, quantities, and even the suppliers. The BIM platform shows all the information into one system that all parties in the project team can review. In addition, there is no linkage between the data created by CAD [2]. The transformation occurring in the worldwide economy has presented architects, engineers, surveyors and contractors with a window of prospect to retool their businesses and implement new tools and workflows that will support them deliver higher-quality building and infrastructure projects at a lower cost and, thereby, help them differentiate themselves in the marketplace and stay competitive in challenging times. Figure 2 shows the integrated systems in BIM environment.

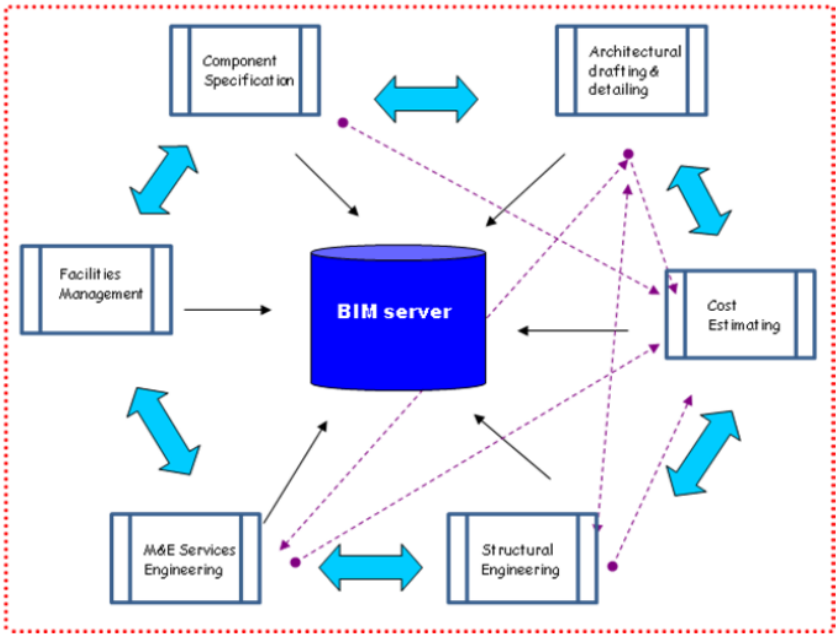


Figure 2. Integrated systems in BIM environment

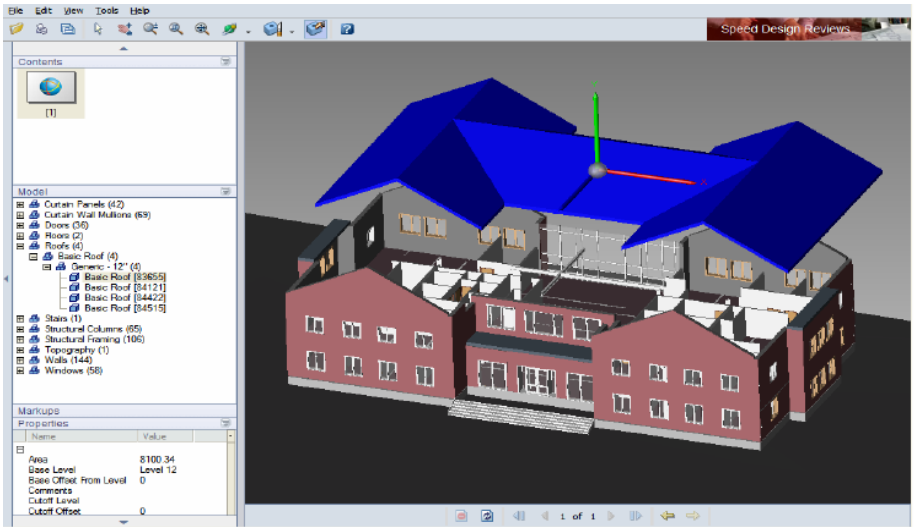
3. Benefits of Building Information Modeling

Building Information Modeling (BIM) system is involved from the design phase until the post construction phase and it shows different benefits and advantages in every different stage.

3.1. During Pre-Construction Stage

i) Visualization

A detailed part of the plan can also be performed in BIM as 3D modeling with the right information in the correct format, so that it can be seen in the context of the whole project. The BIM model is essentially a single computer file to create therefore the possibility to use the BIM as a central sharing system for much of the project information is promising. Figure 3 shows project visualization using BIM and Figure 4 shows BIM that capitalizes on the information in the model to enable additional capabilities, such as sustainable design and analysis.



ii) Generate Accurate and Consistent 2D Drawing

Accurate and consistent 2D drawing can be extracted for the specific view or detail of the project. This will help in reducing time and number of error in the plan. For the current CAD drawing if any information changes to one of the plans the other plan needs to change by manually. However, in BIM system the fully consistent drawings can be generated automatically as soon as the design modifications are entered [3].

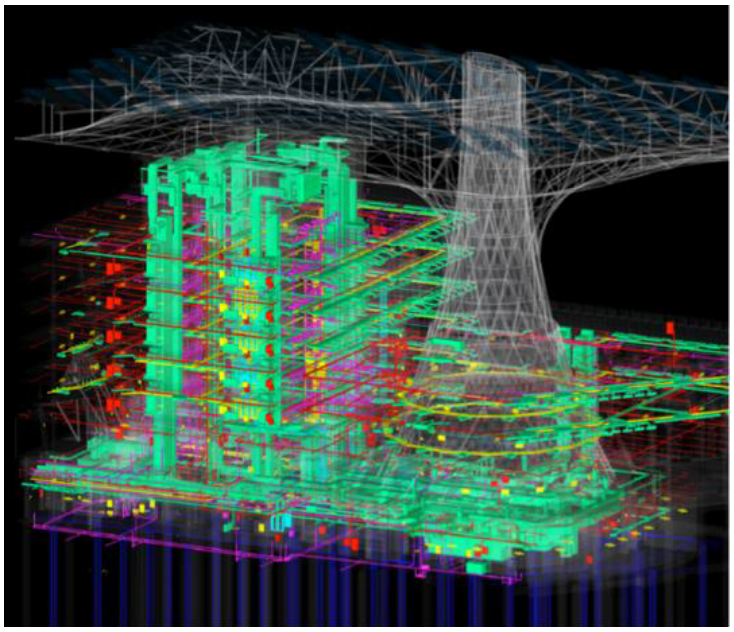


Figure 4. BIM capitalizes on the information in the model to enable additional capabilities, such as sustainable design and analysis.

iii) Cost estimate during the design stages

At the design stage, BIM technology can extract an accurate taking off or bill of quantities. In the early stage of a design, cost estimates are based on the unit cost per square foot. Cost implication with a given design before the detailed required need for construction bid can be done with BIM. Finally, the final stage of design an estimated are based on the quantities for all the object and a more accurate final cost estimate can be done.

3.2. During Construction Stage

i) Construction Planning

Construction planning with 4D BIM requires linking a construction plan to the 3D objects in a design so that the construction progress can be estimated and show what should the site and building look like at every different stage of the construction progress. Besides this, the temporary construction objects such as shoring, scaffolding, and other major equipment can be linked to schedule activities and reflected in the construction plan. In addition, by using a holistic design approach, BIM helps designers investigate how an entire building comes together, and it helps reduce the amount of design changes during construction as been shown in Figure 5.

Figure 5. BIM helps designers investigate how an entire building comes together, and it helps reduce the amount of design changes during construction.

ii) Clash Detection

BIM design with virtual 3D can eliminate the design error caused by inconsistent 2D drawings. In BIM system design from all discipline can be compared in a single design system, multi-system are easily checked both systematically and visually [4]. Therefore, conflicts and design failure are identified before they are constructed. This will speed the construction process and reduce the cost and provide a smoother process for the project team. The BIM process helps team members to coordinate with each other early in the project to determine how they will build the model (Figure 6).

iii) Better Waste Management

BIM provides an accurate model design and the materials resources required for each segment of the work, it provides the improvement in the planning and schedules of contractor and sub-contractor. Therefore, it will help the sub-contractor to ensure the equipment, material, and people can arrive just in time. This will reduce the cost of construction material waste and allow for better collaboration at the site.

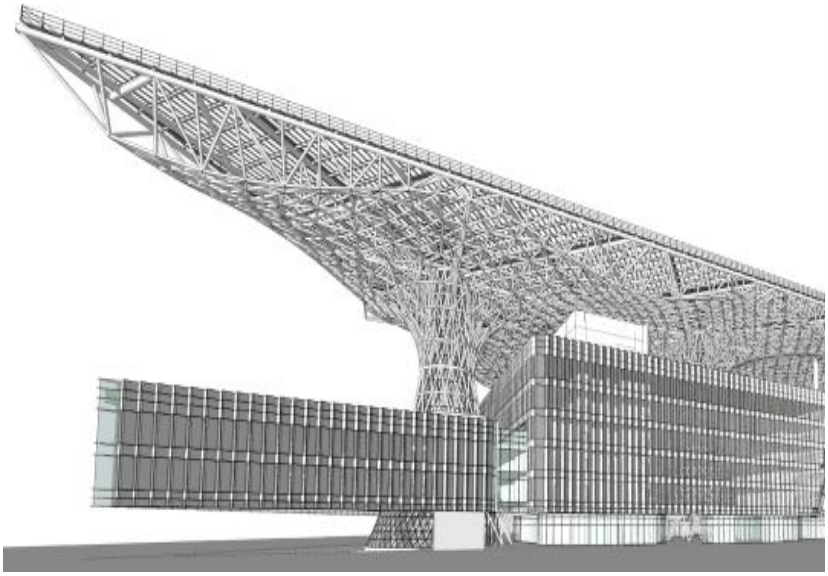


Figure 6. The BIM process helps team members to coordinate with each other early in the project to determine how they will build the model.

3.3 During Post Construction Stage

i) Facilities and operations management

3D model able to view a certain aspect of management and able to provide a latest information about the building as all the changes will be updated in BIM system automatically. It also benefits in operation control and maintenance for the building. The component in BIM can show maintenance-related information such as maintenance scheduling information, replacement parts ordering information, etc.

4. Adoption of BIM

The adoption of BIM has been divided into 4 categories which are organizational culture, people, technology and recognition from the government.

4.1. Organizational Culture

The implementation of BIM is still progressing slow due to the low-level knowledge about BIM. This is because there is no standard for BIM implementation guideline at the national level, every construction company develops their own guideline. Therefore, government should set up a team of committee to control and produce the national BIM implementation guideline. In addition, the majority of the construction players still doubt the effectiveness of BIM because of the limited data has proven the effectiveness of BIM [5].

Thus, the awareness of BIM and the knowledge about BIM in Malaysia construction industry is low. Besides that, the construction players are afraid of the unknown and the resistance to change appears in working condition.

4.2. People

In order to ensure success in the implementation of BIM in the organization, the organization should equip with BIM knowledge and training. Education is one of the methods to train people with skill and knowledge. Creating a new post related to the BIM system and giving a clear job scope is one of the strategy to the implementation of BIM. To speed up the process of learning new technology, new employees with minimum experience for 3D software should be employed to train and practice new technology in an organization. Besides that, motivation and support from a company play an important role for the staff to embrace and use BIM technology [6]. Figure 7 visualizes typical amalgamation platform between BIM software and other process applications

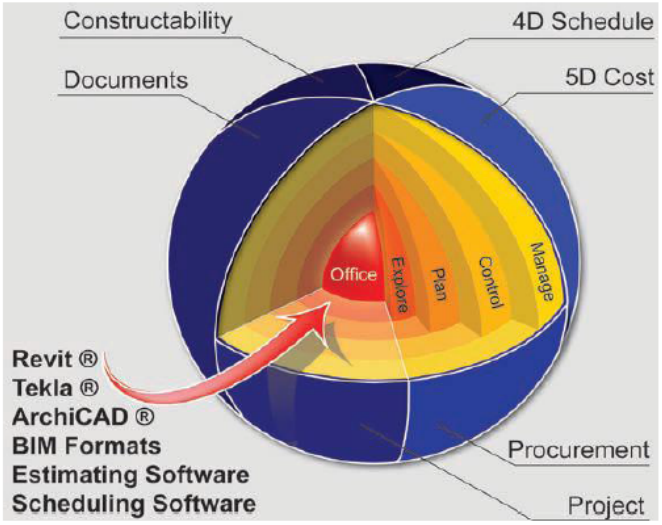


Figure 7. Distinctive incorporation platform between BIM software and other process applications

4.3. Technology

In order to successful implementation of BIM successful in organizations the software, hardware and infrastructure of organizations need to be upgraded so that it can support the BIM system. Besides that, the complexity of BIM software is one of the barriers to BIM implementation. The operational cost will be increased to upgrading current software, hardware, and infrastructure to adopt the BIM

technologies. The selection of BIM authoring software is one of the most challenging tasks for BIM unit to meet the BIM objectives.

Majority of the BIM users chooses to use Autodesk family as their BIM software platform. It would involve all parties from a project team to submit their models in the agreeing format and these BIM models should consists of architect model, structural model, and MEP model and will be stored at the construction company server for coordinating meeting purpose [7].

4.4. Recognition from the government

The government plays an important role to promote the implementation of BIM in the construction industry. First of all, the government has to establish BIM committee member to support the adoption of BIM. The National BIM standard and guideline should provide by the government to the players in the construction industry [8]. On the other hand, the government should encourage the industry players to practice the BIM system for smaller scale projects, through this will provide a lot of information to them and will gain the experience in BIM system.

5. Conclusion

The transformative power of BIM is worth the effort. It is already a boon for many in the industry who are realizing increased efficiency, productivity, and quality. Adapting to the advantages BIM offers requires investment in staff, processes, and technology. Approaching these changes with a positive approach will speed the transition and allow firms to quickly realize the productivity and quality gains possible with BIM. BIM could become more explicit in the nearest future, it is expedient to explore them in relation to the enablers of unusual paradigm shifts in construction conventions, especially as per possible changes in professionals□ roles and responsibilities. The need for effective information management in construction is increasingly becoming important. While the industry still grapples with the limitations of manual and conventional CAD applications, BIM brings more competent changes that can overcome these defies. This study has identified and presented gains inherent in BIM over manual and conventional CAD applications.

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