CHALLENGES O[illegible]DELLING (BIM) IN
PROJECT IMPLEMENTATION

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ABSTRACT

Building Information Modelling (BIM) is a technology that is currently gaining momentum within the construction industry as interoperability issue is become more and more important in relative to the quality and productivity of the industry. BIM is defined as a modelling technology and associated set of processes to produce, communicate, and analyze building models throughout the entire project's lifecycle. Although there is bound of benefits that gained from the BIM application, the local construction industry still reluctant to deploy the technology in delivery its services. The objectives of the study is to identify the types of challenges and also investigate the effect of challenges to the outcome of BIM if BIM has being adopted in the local construction industry. The survey questionnaires were distributed in the construction field within Kuantan region. The method of data collection is by questionnaire and also interview. The main conclusion drawn from the study are that the high level of ICT usage among the construction professionals has make the industry more readily in emerging BIM and the identified barriers can confined into three main categories: people, technology and process. Furthermore, the research has identified the potential factors that driven the adoption of BIM and also the consequences of mandating BIM adoption in the local industry.

ABSTRAK

Building Information Modelling (BIM) adalah teknologi yang kini semakin meningkat dalam industri pembinaan disebabkan isu keantarakendalian menjadi semakin penting apabila berbanding dengan kualiti dan produktiviti industri. BIM ditakrifkan sebagai teknologi pemodelan dan set yang berkaitan proses untuk menghasilkan, berkomunikasi, menganalisis dan model bangunan sepanjang kitaran hayat keseluruhan projek. Walaupun terdapat pasti manfaat yang diperoleh daripada penggunaan BIM, industri pembinaan tempatan masih enggan menggunakan teknologi dalam penyampaian perkhidmatannya. Objektif kajian ini adalah untuk mengenal pasti jenis cabaran dan juga mengkaji kesan cabaran kepada hasil BIM sekiranya BIM diguna pakai dalam industri pembinaan tempatan. Soal selidik kajian telah diedarkan dalam bidang pembinaan di rantau Kuantan. Kaedah pengumpulan data adalah dengan menggunakan soal selidik dan juga temubual. Kesimpulan utama diambil daripada kajian ini adalah tahap yang tinggi penggunaan ICT di kalangan profesional pembinaan telah menjadikan industri yang lebih mudah dalam BIM baru muncul dan halangan yang dikenal pasti boleh terbatas kepada tiga kategori utama: orang, teknologi dan proses. Tambahan pula, kajian ini telah mengenal pasti faktor-faktor yang berpotensi yang didorong penggunaan BIM dan juga akibat mandat penggunaan BIM dalam industri tempatan.

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LIST OF ABBREVIATIONS

AEC	Architecture, Engineering, Construction
BIM	Building Information Modelling
CAD	Computer Aided Design
CADD	Computer Aided Drafting and Design
CAM	Computer Aided Manufacturing
CIDB	Construction Industry Development Board
CPM	Critical Path Method
ICT	Information and Communication Technology
IPD	Integrated Project Delivery
IT	Information Technology
MEP	Mechanical, Electrical, Plumbing
ROI	Return on Investment
2D	Two Dimensional: x,y
3D	Three Dimensional: x,y,z
4D	Four Dimensional

CHAPTER 1

INTRODUCTION

1.0 INTRODUCTION

Building Information Modelling (BIM) is an intelligent model-based process that provides insight for creating and managing building and infrastructure projects faster, more economically and with less environmental impact. It also represents the process of development and use of a computer generated model to simulate the planning, design, construction and operation of a facility (Azhar, Hein, & Sketo, 2011).

The Building Information Model is primarily a three dimensional digital representation of a building and its intrinsic characteristics. It is made of intelligent building components which includes data attributes and parametric rules for each object. For instance, a door of certain material and dimension is parametrically related and hosted by a wall. Furthermore, BIM provides consistent and coordinated views and representations of the digital model including reliable data for each view.

This saves a lot of designer's time since each view is coordinated through the built-in intelligence of the model. According to the National BIM Standard, Building Information Model is "a digital representation of physical and functional characteristics of a facility and a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle; defined as existing from earliest conception to demolition".

Construction industry is moving rapidly toward modernization. Information Communication Technology (ICT) has played the significant roles in this transformation. The use of ICT permeates various industries and is seen as a major driver for improvement in performance and cost efficiency (CIDB, 2006).

However, the performance of ICT towards the industry is still under privileged. It might be due to the different types of software used by the participants of the industry, the amount of the redundant information and the manual transfer of information (Molnar, Andersson, & Ekholm, 2008).

To solve this problem, Building Information Modelling (BIM) has been introduces to the industry. BIM is suitable to support the simulation of a construction project in a virtual environment, with the advantage of taking place in silico through the use of a proper software package (Jardim-Goncalves, 2010). Although the adoption of BIM is expanding within the industry and it have been beneficial to several parties. Yet, there is still some space for improvements.

Even though the concept of BIM has been widely implemented, but people still failed to explore how a BIM can really talk to a construction project in a real time manner (W.S.Lu & Li, 2011).

1.1 PROBLEM STATEMENT

The productivity and economic benefits of BIM to AEC industry are widely acknowledges and increasingly well understood. Further, the technology to implement BIM is readily available and rapidly maturing. Yet, the adoption of BIM is much slower than anticipated (Fischer and Kunz, 2006).

The researchers and practitioners have to develop suitable solutions to overcome these challenges and other associated risks. There are two main reasons; technical and managerial that cause BIM adoption is much slower than anticipated (Azhar, Hein, & Sketo, 2011).

The major drawback of technical and managerial challenges needs to be identify, synthesize and discuss. It is expected that the use of BIM will continue to increase in the AEC industry.

Despite that, there are some barriers when dealing with the BIM. As Datuk Seri Prof Judin Abdul Karim said "It is not a problem of knowledge and information on the usage of ICT; it is always about the cost." Although there is awareness of using the ICT but the cost of investment prohibited companies from adopting the technology. Big companies can afford ICT investment while most of the small companies find its adoption unaffordable (Star, 2009).

Therefore, this research will identified the barriers when dealing with the widespread of BIM adoption which not only in the monetary term but also others related issues such as legal issues, data storage capacities, availability of real-time information and et cetera.

1.2 RESEARCH OBJECTIVE

The following is the research objectives that guide me throughout the study:

1.2.1 To identify the types of challenges from relevant literature review related to BIM.

1.2.2 To identify the types of challenges during the implementation of BIM.

1.2.3 To investigate the effect of challenges to the outcome of BIM.

1.3 SCOPE OF STUDY

This study focused on the participants of the construction industry generally consists of Consultants, Engineers and Contractors. The respondents will complete the questionnaire and give their opinions towards the challenges of Building Information Modelling (BIM) in project implementation and also project related issues. In addition, the study will only focus on the construction company that located within Kuantan area.

1.4 SIGNIFICANCE OF STUDY

Construction industry is a one of the main factors that leading a country's economy. It is undeniable that the usage of BIM in project implementation in construction industry brings benefits, but there are barriers that affect the implementation of BIM in construction industry. In order to make sure that BIM can be implemented, we have to find out the challenges that influence the BIM implementation. By doing this research, current challenges of BIM in project implementation can be recognized. Besides, this may also help the Engineering Design Consultants and Contractors so that the solutions to overcome these can be found. Lastly, tangible benefits of BIM can be enjoyed by the construction industry.

CHAPTER 2

LITERATURE REVIEW

2.0 INTRODUCTION

This chapter covers the basic information about Building Information Modelling (BIM) which includes the concept of BIM, the barriers to implementation such as legal issues, interoperability, major stakeholders' support, resistance to change, operator competencies are also discussed.

2.1 BUILDING INFORMATION MODELLING

Earlier, CAD systems were used to produce drawings and three-dimensional images. Now the focus has shifted to the data itself. BIM has following components: those with behavioral data, those that build (with intelligent digital representations), those with consistent and non-redundant data, and those with coordinated data. All of these enable the architects to catch and avoid the costly mistakes and in a way, virtually try the building before incurring the huge expense of building it in real-time (McGraw-Hill Construction, 2008).

BIM helps construct a virtual yet accurate model of the building in the digital world before raising it in the physical world. This building model supports construction, fabrication and procurement activities and, thus, can be used for feasibility studies, conceptual design, more accurate estimating, relative detailing, easier coordination, etc. by the architectural firm; and also for construction planning, logistics, operation, etc. by the other members of the team (Larson and Golden, 2008). Another use the architect can employ BIM for is to study the building's performance, such as solar studies, energy usage, green building analysis, construction costs, sequencing of construction, etc.

BIM allows easier coordination of different software and project personnel, which leads to improved productivity, communication and quality control (McGraw-Hill Construction, 2008). It transforms how buildings are built, how they look and how they function – adding intelligence to the buildings. The powerful 3D model helps visualize, present and create architectural documents. It helps save time and reduces errors as design changes are automatically coordinated throughout the entire model. Not only are the building elements represented as 3D objects, but it also accommodates associated information about each element.

The concurrent information is kept up-to-date and digitally accessible, giving clear overall vision and ability to make better decisions faster. Using BIM technology, all phases of design, scope, documentation, cost information and scheduling can be better coordinated, leading to better reliable quality and allowing for higher profitability for the project team. Changes can be made without laborious, low-value coordination and manual rechecking. Hence, the architectural industry in US ends up saving time and money, making fewer errors, getting greater productivity, higher quality of work and repeat business opportunities (AIA Knowledge Resources Staff, 2008).

Architectural, mechanical and structural elements are most likely to be modeled in BIM. In the US, architects are the heaviest users of BIM, with 43% using it on more than 60% of their projects, and it is observed that BIM has a very positive impact on architects' businesses (McGraw-Hill Construction, 2008). In India, the client enters into agreement with an architect defining their scope of work, responsibilities, functions, fees and mode of payment. Once the architect has completed the design, he prepares working drawings, specifications and schedule of quantities sufficient to prepare estimate of cost and bid documents. He also invites, receives, analyzes tenders and advises client on appointment of contractors (Council of Architecture of India). Hence, in determining whether

BIM should be used on a project, architects are considered the primary drivers of BIM use among all build team members, making them the top decision makers. As a matter of fact, BIM was initially developed with a focus on the design world.

BIM reduces risk of errors' occurrence in the design process (Rundell, 2007). Human errors are caught and corrected during the design process itself due to the extended coordination and communication across the entire project team. BIM improves design decision making, prediction of performance, cost estimation and construction planning with automatic document coordination and clearer project communication.

Quantity takeoff, scheduling and estimating are the top most popular tools used in conjunction with the integrated modeling data (Tulke, Nour and Beucke, 2008). BIM enables quantities of materials to be tracked throughout the project, hence, allowing quantity takeoffs and cost estimates to be more accurate and reliable than those prepared using conventional methods. Less field staff can do the work of a typical larger staff if contractors employ BIM on the construction site too.

2.2 NATURE OF CONSTRUCTION INDUSTRY

The construction industry has lagged behind other industries in accepting the benefits of adopting Information Communication Technology (ICT). In 1990s, while interoperability productivity benefits were being realized in other industries and the building construction industry went largely unaffected. Much of this was due to the fragmented nature of the industry where relationship between designers, contractors and subcontractors often inhibited communications and teamwork. The problem was compounded further by the fact that many design and construction firms were small and did not have resources required to take full advantage of new information transfer technologies (Gabriel & W.Jun).

The fragmented nature of the industry who involved a wide range of parties from the blue collar labour: carpenters, bricklayers until the white collar workers: Engineer, Architects, Quantity surveyors and et cetera with play with different roles and duties in order to faster the development of construction industry which include: Designer (Architect and Engineer), Consultants (Quantity Surveyor), Construction team (Contractor) and et cetera. To cope with the improvement of the Information Communication Technology (ICT), the professions have been developed their own construction-related software for the ease of their works. However, they only utilized it within their own department or within their profession's group. The interoperability within one groups and another still is an issue within the industry.

2.3 ROLES OF CONSTRUCTION PROFESSIONALS

Building construction requires many workers and many trades. From the perspective of realizing a project, a professional project team is needed to make sure that project will be constructed successfully. The construction professionals include the architect, engineer and quantity surveyor. They are the most responsible person in a project especially when technical works are concerned. Thus, the expertise of each construction professionals must be carefully exercise as they are answerable to any sinfulness occurred during the construction (Hussin & Omran, 2009).

2.3.1 Client

The client's role is to provide leadership and a mandate for change. Whether or not the client becomes directly involved in technical issues is a matter of choice, but what is important is and the client is seen by the rest of the design and construction team to be committed and sufficiently knowledgeable to be committed and sufficiently knowledgeable to be decisive and set clear requirements.

2.3.2 Architect

In general, architect is a person who is involved in the planning, designing and oversight of a building's construction. In the broadcast sense, an architect is a person who translates the user's needs into the builder's requirements. The knowledge about the building and operational codes is necessary so that he or she is not apt to omit any necessary requirements, or produce improper, conflicting, ambiguous, or confusing requirements. Furthermore, architect must understand the various methods available to the builder for building the client's structure, so that he or she can negotiate with the client to produce a best possible compromise of the results desired within explicit cost and time boundaries. Then architect also responsible with being familiar with the construction work and reporting the general progress and quality of the work, as completed to the owner (Hussin & Omran, 2009).

2.3.3 Engineer

The scope of work of engineers involves planning and execution of the designs from transportation, site development, and hydraulic environmental, structural and geotechnical engineers. The main part of engineers' job description is analyzing report which includes the analysis of maps, drawings, blueprints, aerial photography, topographical information, calculation of the building loads and analyzes the grade requirements and et cetera. Engineers also have to make sure that there are no impediments in the way of where the structure will be built and if there are any they must move them. Finally, the engineers have to provide construction information, including repairs and cost changes to the managers (Hussin & Omran, 2009).

2.3.4 Contractor/ Builder

A contractor sources materials and manages the construction process. This involves both direct material purchase and indirect purchasing through trade contractors. Therefore, the contractor is the party responsible for agreeing with the design team how they will meet the client's requirement for recycled content and et cetera. The contractor's task is then to source and incorporate specific products that satisfy or exceed the client's requirement into the works as specified. On completion, the contractor should be able to provide the client with documentary evidence that the target level of the project had been achieved.

2.3.5 Quantity Surveyor

Quantity Surveyor is the person who manages and control costs within construction projects and may involve the use of management procedures and technical tools to achieve this goal. The method employed cover a range of activities such as: cost planning, value engineering, feasibility studies, cost benefits analysis, lifecycle costing, valuation and cost estimation. A quantity surveyor can also be known as construction economists, cost engineers or construction managers. Quantity Surveyors control costs and prices of work, labor, materials and plant required, an understanding of the implications of design decision at an early stage to ensure that good value is obtained for the money to be expended. Quantity surveyors will also preparing tender document in accordance with a published standard method of measurement as agreed to by the quantity surveyor profession and representatives of the construction industry (Hussin & Omran, 2009).

2.4 THE CONCEPT OF BIM

Building Information Modeling (BIM) represents the process of development and use of a computer generated model to simulate the planning, design, construction and operation of a facility. A BIM is a data-rich, object-oriented, intelligent and parametric digital representation of the facility, from which views and data appropriate to various users' needs can be extracted and analyze to generate information that can be used to make decisions and to improve the process of delivering the facility (AGC, 2005).

While, Wong et al. said that BIM has the attributes of both an approach and a process/action. It is an approach as it provides an alternative to the traditional paper based approach of project design and management. It is also a process/action as it creates a product called Building Information Model, whose performance can be measured.

BIM is actually the intersection of two critical ideas: (Autodesk, 2003)

- Keeping critical design information in digital form makes it easier to update and share and more valuable to the firms creating and using it.
- Creating real-time, consistent relationships between digital design data – with innovative parametric building modeling technology – can save significant amounts of time and money and increase project productivity and quality.

BIM is now rapidly gaining acceptance as the preferred method of communicating the design profession's intent to the owner and project builders (Bruce A. Burt, 2009). In addition, BIM now is also being increasingly used as an emerging technology to assist in conceiving, designing, construction and operating the buildings in many countries (Wong et al., 2009).

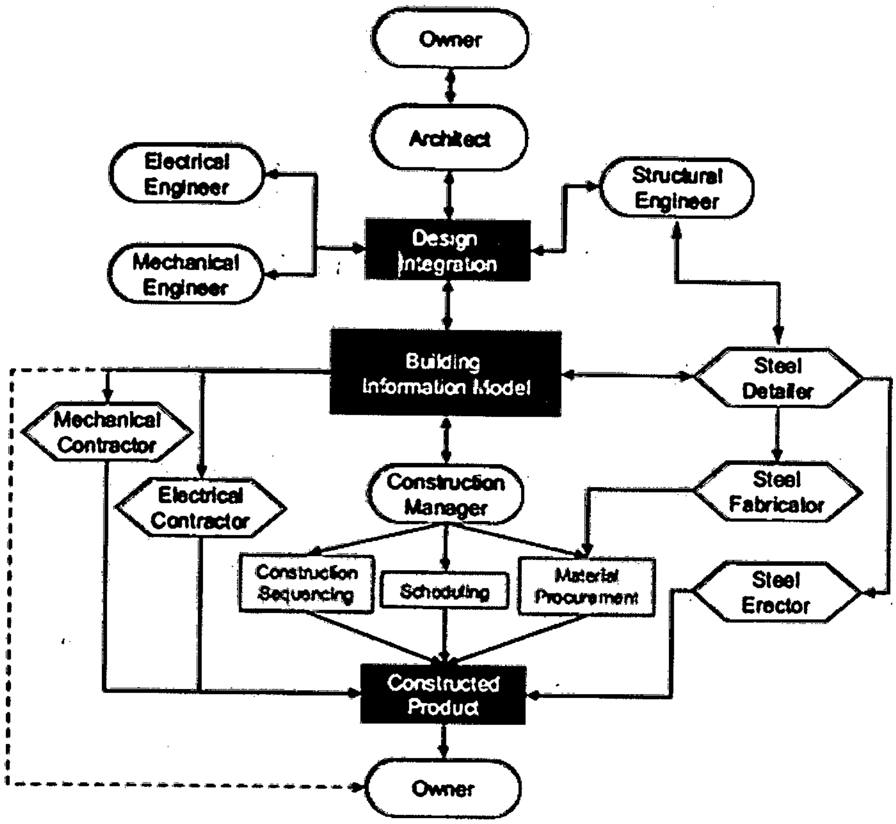

Figure 2.1: The concept of BIM

Source: Bruce A. Burt, 2009

2.4.1 Function of BIM

According to editor of BIM journal (2012), BIM has a broad range of application, right cross the design, construction and operation process. These BIM function can be roughly grouped into five categories:

- Design
- Analysis
- Construction
- Operation
- Data Management

Design applications relate to the pre-planning and planning phase of a project. This section includes initial data collection (laser surveying, existing conditions modeling and site analysis), spatial programming and design authoring. It encompasses includes design review and coordination.

Analysis refers to secondary applications, often undertaken by a party who may not have authored the model themselves. Analysis activities include structural analysis, energy analysis, "green building" certification, lighting analysis, mechanical analysis, as well as other specialty disciplines. This category also includes model auditing, that is validating model integrity and verifying the model against design parameters and building code requirements.

Construction functions refer to the deployment of BIM for construction management. This includes construction planning as well as applications for construction sequencing (4D) and quantity take-off and estimation (5D). This section also examines shop drawing production and integration with Computer Aided Manufacturing (CAM). A significant part of this section addresses "BIM to Field" activities such as establishing construction set-out points and recording as-built data and construction status.

Operation refers to BIM functions that support facility management. This includes record modeling, model maintenance and integrating the model with Facilities Management software for asset or spatial management, equipment tracking and maintenance scheduling. This section also examines how a model can be reactivated for future facility expansion.

Data Management examines best practices for BIM data structure and exchange, and how multi-model data may be regulated. This section includes an introduction to collaborative platforms and electronic project delivery systems, as well as key sessions on model collaboration, change management and issue reporting & tracking. This section also includes functions relating to interoperability and exchange formats (such as IFC), managing metadata and linking multiple databases (model & text file).

2.4.2 Benefits of BIM

Due to the nature of BIM software, there are several wide ranging benefits to be gained by deploying BIM. Basically, the advantages of BIM technology are a means either to reduce cost, materials usage or indirectly through efficiency gains throughout the three major phases in the building lifecycle: design, construction and management (Autodesk, 2003). While when look into the individual elements, the main benefits that drive the deployment are: (Davidson, 2008)

- Accuracy and consistency of data
- Design visualization
- Ease of quantity takeoff
- Multi-user collaboration
- Energy efficiency and sustainability

2.4.2.1 Design Phase

During the course of a building project, an architect must balance the project scope, schedule and cost. By using BIM, all of the critical information such as design and geometry information is immediately available, so that project-related decisions can be made more quickly and effectively. Furthermore, BIM allows a project team to make changes to the project at any time during the design or documentation process without laborious, low-value re-coordination and manual checking work. In addition, all of the building design and documentation work can be done concurrently instead of serially, because design thinking is captured at the point of creation and embedded in the documentation as the work proceeds. Lastly, the automatic coordination of changes offered by BIM would eliminate coordination mistakes, improves the overall quality of the work and helps companies win more repeat business (Autodesk, 2003).

2.4.2.2 Construction Phase

During the construction phase, BIM makes available concurrent information on building quality, schedule and cost. The builder can accelerate the quantification of the building for estimating and value-engineering purposes and for production of updated estimates and construction planning. The consequences of proposed or procured products can be studied and understood easily and the builder can quickly prepare plans showing site use or renovation phasing for the owner, thereby communicating and minimizing the impact of construction operations on the owner's operations and personnel. The result is that, less time and money are spent on process and administration issues but goes into the building (Autodesk, 2003).

2.4.2.3 Management Phase

In the management phase of the building lifecycle, BIM makes available concurrent information on the use or performance of the building, its occupants and contents, the life of the building over time and the financial aspects of the building. Moreover, the provided digital record of renovations accelerates the adaption of standard building prototypes to site conditions for businesses of similar buildings in different locations. Furthermore, BIM also provide the physical information about the building such as finishes, furniture and equipment or financially important data about leasable areas and rental income or departmental cost allocations are all more easily managed and available. Generally, it can conclude that the consistent access to these types of information improves both revenue and cost management in the operation of the building (Autodesk, 2003).

2.5 IMPLEMENTATION OF BIM

Building Information Modelling (BIM) is becoming more and more important to manage complex communication and information sharing processes in collaborative building projects (Sebatian and Léon, 2010). BIM is now