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BUILDING INFORMATION MODELING (BIM): A POTENTIAL FOR EFFECTIVE BUILDING INDUSTRY PRACTICE IN MALAYSIA

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Graphical abstract

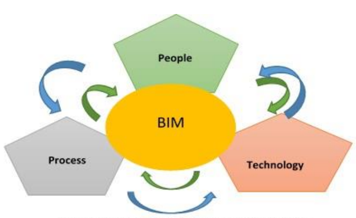

Figure 1 The interrelationship of the components of BIM

Abstract

It is an open fact that building information modelling (BIM) have been and is still expanding its usefulness across professional specialization in the building industry. Building Information Modelling (BIM) as a new way of doing things in the building industry and it is a system that is rapidly revolutionizing entire process therein. It is also apparent that most professionals in the building industry are aware and willing to embed the BIM culture but with absolute little to no knowledge about it workability. This is the major challenges, which is as a result of lack of BIM integration to education. This paper therefore seeks prominent works of researchers in BIM and the apparent benefits so far gained and still to be gained with BIM integration to higher education in Malaysia. Thus attempting to proffer an integration strategic that will facilitate an adequate smooth BIM adoption in the building industry, this will boost building project delivery and mitigate against shortcomings of the traditional delivery processes.

Keywords: Building Information modeling (BIM), building industry, revolutionizing, workability, bim integration, higher education.

1.0 INTRODUCTION

Building Information Modelling (BIM) has become the measure of yardstick and an international benchmark for efficiency in Architectural, Engineering, and Construction (AEC) and host of other building services. It is the platform that brings about collaboration and integration of environmental professionals and all other stakeholders. Ibrahim, affirm that every professional practice have particular task needed to achieving a successful BIM platform [1]. Thus, BIM can now be said to encompasses all phases of project development from investment conceptual stage through to architectural, civil/structural, Mechanical / electrical, cost evolvement and analysis, procurement, tendering and award, construction to completion and occupation, facility maintenance and operation, and finally the demolition of the building with a positive resultant returns on investment at the end of it live span. This is a very enormous and cumbersome tasks that can be rolled into a series of integrated tasks for easy project delivery with the use of BIM. Of course, it can be argued that these various task mentioned above have been initiated and executed successfully before the coming of BIM, but BIM is a better coordinated and integrated method whereby, time, money, decision making and precise predictions of project characters are of advantages, and besides, more potentials of BIM are still awaiting yet to be exploited [2]. In line with this argument this paper is a literature review of benefit deliverables that are characteristics of BIM when full adopted but also noted that the impediments standing against achieving this objectives is lack of BIM knowledge.

This is therefore the motivation and necessity for BIM integration into education for the new generation of AEC professionals. Thus, information technology era have no space for wait and see syndrome that have been historical characteristics of education sector. On this note, this paper serve as a wakeup call to the higher education institution to earnestly embrace the integration of BIM into higher education in Malaysia.

2.0 BACKGROUND OF THE STUDY

Building information modeling is a technology that revolve round three base components, without any one it BIM is not complete, these components are: - people, process and digital technology. The interrelationship of these elements make up a system called building information modeling. From the figure 1 below, the BIM cycle cannot be completed without any of these items. This is a very important reason that doing BIM cannot be practice in solos for any professional discipline of the building industry.[3]

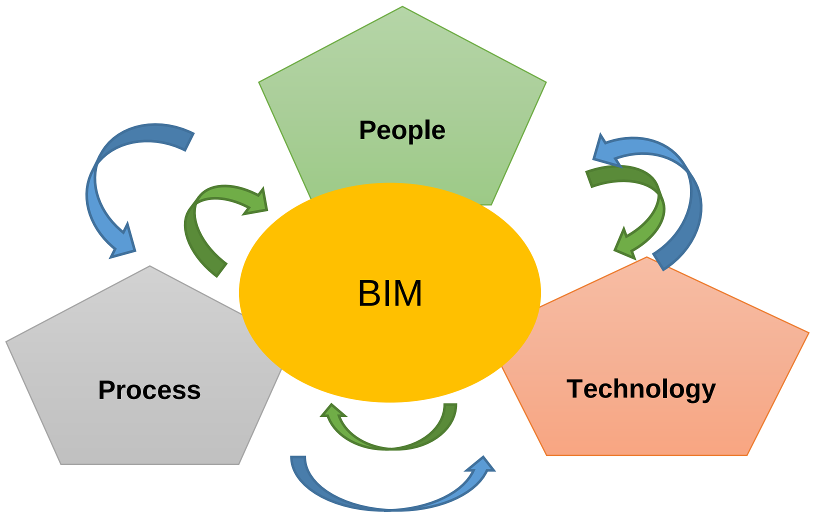

Figure 1 The interrelationship of the components of BIM

In many countries of the world, it is largely believed that construction industry is one of the most challenging industries in this age. But construction industry still remains with a low reliable rate of profitability, little investment in research, education and development. Also part of the problem is a crisis in training of beginners for replacement of aging people and lack of inject or non-availability of computer native hands, worst still the investor's tendency of selecting the lowest price are among the issues raised by the 1998 Construction Task Force Report as cited in [4]. Conversely, building information modeling can be said to be a methodology to manage the building design and project data in digital format throughout a building lifecycle [5] and it is considered as a paradigm shift within the industry. Series of study have also reveal that BIM is having the potential to significantly change and improve performance and documentation in the AEC industry, and this will invariably reduce inefficiencies, enhancing productivity, and increasing collaboration and communication [6], with the intention that BIM will achieve decreased project costs, increased productivity and quality, and reduced project delivery time [7]. Despite the success factor perceived of the BIM and the envisage potential, the embracement and the adoption of these opportunities has remain low [8].

In Australia, it was identified that various problems facing AEC industry can be put out by the implementation of BIM as industry operational language, this give raise to the development of 'National BIM Initiative Blueprint' which was developed by BuildingSmart, part of it aim was meant to promote the education and adoption of BIM at higher education level. Also the blueprint is to facilitate Australia government's adoption of full collaborative BIM for all government building projects procurement coming year 2016. This is touring same line of BIM development in UK, US and other governments world over [9]. Besides, Gu and London [10] revealed that limited understanding of industry needs and technical requirements pose a major factor hindering the advancement and adoption of BIM related technologies within the Australian AEC industry. Aksamija and Ali [11] recent study identified "inadequate training and education" as major hindrance to the adoption BIM in the Australian AEC industry which is consistent with that being faced globally. These are challenges that BIM as an emerging technological process is facing in Australia and this largely due to inadequate education foundation BIM.

2.1 BIM Awareness in Malaysia

In any capital development, human resources is believed to be important if not the most important factor and the quality of this variable depends on the level of awareness of the society. This can only be ascertained by the quality of education and training. [12]. Furtherance to that, Foray and Freeman, (1992) believed that an overall level of education and in particular technical education is essential for the design and productive use of new technologies [13]. The ability to adopt and practice new ICT technology largely depends on the capacity of the whole society to be educated and to be able to assimilate and process complex information. The only avenue for this to be achieved is by starting with the education system, from the bottom up, that is, from the primary education through to the university[13]. From the works of Enegbuma and Ali [14], Malaysia government is aware of the importance of BIM as an emerging technology that is revolutionizing the entire building industry, it is at this instance that the government established Jabatan Kerja Raya (JKR) and the Construction Industry Development Board (CIDB) came up with Construction Industry Master Plan (CIMP) 2006-2015, in its Seven Strategic Thrusts, the number fourth and fifth of these thrusts will strive to develop human resources and also to encourage innovative research and development and also to encourage the use of modern technology for building project delivery. Besides these, CIDB have been organizing awareness talk among building industry team players. As a step further, JKR is now have a BIM unit that is responsible for the implementation building projects using BIM. [15], suggested that BIM should be made more important in the training of architects and other professionals, and he warn that failure to embrace this trend at our education institution may connotes a fundamental setback. This training is deficient in collaborative construction in line with BIM ideology [16-17].

Both the academia and the professional community attested to fact that education is critical for quickening the learning and recruitment of BIM professional for the industry. This is because they both acknowledge that there exist gap between the industry expectations and higher education turned out graduates. This explain why most often companies recruit fresh graduate for jobs opening dedicated to BIM [18]. At international arena the Malaysia Deputy Prime Minister (DPM) Tan Sri Muhyiddein Yassin retraced the unrelenting effort on producing skilled and qualified work force, he explained that there is need for education system that not only served the community at large but will also projected what is to be expected in the future. Further to this, the outcome of the interview survey that conducted by researcher includes; two architects, two quantity surveyors, and one engineer all in private practice, another set of responders are; one architect, and two quantity surveyors from academics sector of AEC and finally one senior management staff each from CIDB and JKR; indicated that all agreed to the fact that, there is need for BIM to be integrated to education and they also collectively argued in favor of man-power development needs for the upcoming BIM market in Malaysia in a very near future.

2.2 Study Significant and Values

Building Information Modelling (BIM) has become the international benchmark for efficiency in Architectural, Engineering, and Construction (AEC) and host of other building services. Also recent studies have revealed that construction industry is vital to the economic growth of most developed countries [19]. Malaysia is a rapidly growing economy in Asia which cannot afford to folder it arms to the modern technology that is positively aids building project delivery. Studies also shown that the maximum utilization of BIM benefits cannot be fully earnest because of lack of adequate manpower in the sector. The education sector especially the higher education is still lacking behind in balancing the imbalance of the industrial needs in terms of manpower to the current turn-out [20]. Taking clue from happiness in UK, US, Australia, and host of others, where BIM education is growing, integration of BIM into higher education under collaborative setting among all the building industry disciplines will enable maximum BIM benefits to be achieved at all levels. Considering experience from other countries believed to have integrated BIM to education and a study of local situation in Malaysia universities, a suitable approach to BIM integration to education would be developed. Discussed below are some of the characteristics of BIM that have made the most preferred building delivery process for this age.

2.3 BIM Project Management

BIM in its characteristics, creates building models that is consistently been used for coordination, computation of information about a building project during design, construction and building operation and management. it is a repository of building information that covers not only geometry, spatial relationships and geographic information and quantities, but also properties of building components quantities and shared properties of materials can be extracted; it also can be used as source of information for analysis of the building solutions as well as to store the results of analysis; in addition, it can be used to represent the entire lifecycle (LC) of buildings including the processes of construction and facility operation [21]

2.4 Sustainable BIM

Various studies have indicated that construction industry and its activities have and are still significant effecting the environment and that sustainability performance of any construction project through its life cycle phases are indispensable in attaining the goal of sustainable development [22]. In the same vein globally, the cost of energy and environmental impact of construction actives have pose serious concerns to the building industry, this have demanded for sustainable building facilities with minimal environmental impact and energy cost. To carry out the most effective decisions regarding sustainability in a building facility, decisions are better made in the early design and preconstruction stages [23]. This is only practicable with BIM technology which allows for multi-disciplinary information to be superimposed within one model, and this creates an opportunity for sustainability measures and performance analysis to be performed throughout the design process [24]. Taking clue from definition given by [20], [25] that the Sustainable construction brings about the required performance with the least unfavorable environmental impact, while encouraging economic, social and cultural improvement at a local, regional and global level. In another definition by the World Commission on Environment and Development, that sustainable development is meeting the basic needs of the public and satisfying their aspirations for a better life without compromising the ability of future generations, here the emphasis of this definition is placed on the balance among social development, economic development, and environmental sustainability which is tailing same line as above [21] .

To this ends, an efficient information-technological solutions are needed and this can only be supported by complete design information of a building consists of several domain specific design BIMs, such as architectural, structural, HVAC and electrical, with building construction process and overall building environmental management operations. Therefore, in this context, Building Information Modeling (BIM) is a platform for performing complex building performance analyses to ensure an optimized sustainable building design [26, 27] and to carry out some of the basic sustainable building task such as; Service life design; Environmental assessment; Energy consumption estimate; Maintenance manual; Optimization on building refurbishment and sustainable building rating. The benefits that the building industry stands to benefits from the use of building information modeling for environmental sustainability are still unfolding.

2.5 BIM Collaboration Platform

Building information modeling adoption and understanding varies from country to country, discipline to discipline and from client to client, this in turn affect the level of adoption and usage among various building project teams. This have pose challenges to building information modeling adoption in AEC industry [28]. Although, building information modeling is a collaboration work process, but [29] noted that, despite the abundance and complexity of information in the construction industry, the non-corresponding management of the information is increasingly resulting to fragmentation among the industry practitioners, it is also note that the construction industry has always been very slow in adopting strategies, methodologies and techniques. In another study, [30] noted that the construction industry is vital to the economies of most developed countries, but studies shows that despite this importance the productivity has declined over the past 30 years and that the industry is extremely inefficient compared with others. The construction industry has also been described as extremely fragmented and lacking integration. To this ends, in order to improve this situation it is necessary to enhance the communication among the different disciplines through BIM technology that is contributing to greater construction industry efficiencies and boost collaboration among project delivery teams, reduce collisions and remove rework [29, 31].

3.0 METHODOLOGY

From array of available literatures, the research made use of review of literatures and empirical pilot survey conducted by the researcher among practicing and academia in the building industry. Thus, the paper is primarily descriptive and provide an empirical assessment of the benefits that building information modeling (BIM) adoption offers and the challenges that limits its wider adoption among both the practicing and academic professionals in the industry. Knowledge and awareness is very key to the adoption of any new technology and when this is secure then maximum benefits can then be achieved with progressive growth and development in such innovation. But without the above, the adoption and growth will be constrained and limited. This is the case with BIM in Malaysia and other growing economy.

4.0 THE NEEDS FOR BIM EDUCATION AND TRAINING

[5] noted that with rapid BIM proliferation within Design, Construction and Operation (DCO) industry there is need to equip current and future professionals with the necessary knowledge and skills to engage in collaborative workflows and integrated project deliverables and for this, there is need for a Competency Knowledge-Base (CKB) for BIM learning to be taught at higher education institutions. This is a process that leads to identification, classification, and aggregation of instruction materials for BIM competency delivery in education. In other words, BIM as a tools is mainly a repository of shared digital building information models and the management of the corporate knowledge information will increase the

productivity and efficiency which will further provides organizations with competitive advantage [18]. In the management of this corporate knowledge information education must be fully involved in the identification, classification and sorting of items for adequate BIM education delivery in higher institutions. Various studies have shown that both the academia and the professional community attested to fact that education is critical for quickening the learning and recruitment of BIM professional for the industry. This is because they both acknowledge that there exist gap between the industry expectations and university turned out graduates. This explain why most often companies recruit fresh graduate for jobs opening dedicated to BIM [14]

4.1 Effects of BIM on Project Delivery Time

Of importance is the effects of BIM implementation on project delivery time [27]. Based on the survey conducted by [7] which examined a number of case studies that employed BIM, found that BIM can influence time management with a 7% reduction in time for project completion. [32] also share the same opinion that BIM helps to delivery projects on time.

4.2 Effects of BIM on Project Delivery Cost

[33] reports that a 2007 study by the Stanford University Centre for Integrated Facilities Engineering (CIFE), based on 32 major projects that employed BIM, found cost benefits including a reduction of unbudgeted change by 40%, accuracy of cost estimation brought to within 3%, time taken to produce a cost estimate reduced by 80%, and clash detections resulting in savings of as much as 10% of the contract value. Another cost effective evidence was a study from a 2009 US study, with two thirds of over 1,000 BIM users attested to positive return on investment (ROI) [34]. [32] carried out similar survey, where qualitative data was collected to assess practitioners' perceptions about BIM impacts on building project delivery through some Key Performance Indicators (KPI) of: quality control (rework), on-time completion, cost, safety (lost man-hours) and others. The resulting from this survey, it was gathered that in the KPI ranking as: Quality, with 87.7%, Cost, with 83.7%, Schedule, with 82.8%, Productivity, with 74.9% and Safety, with only 53.7% of despondences attested that BIM improves these KPI elements.

4.3 BIM As A Learning Tool

[35] retreated that due to the characteristic inherent in the BIM, it is a better option as a learning tool. Some of the BIM characteristics that qualifies it are: reduce accessibility time to data information, easy visual correlation with real world elements through a 3D model, cost estimation methods which facilities approximate-accurate quantification at the early design stage and many more. With the tradition delivery process of using 2D critical path method (CPM), visualization skills limits the students' ability to comprehend the construction sequence [36]. But with the 3D model, this is addressed by using four dimensional (4D) modeling [37, 38], which give a better understanding of construction sequence.

4.4 BIM Through The Phases Of Project Delivery

Basically three phase of project delivery are identified these are; design phase which comprise comprehensive drawings and document from all the disciplines as relates to the project; the construction phase which sum-up all that entails the physical construction of the project till hand-over of the facility and the operation phase comprise of all activities that kept the facility in use from the point of take over for use throughout till demolition. The Table 1 graphically explain BIM functions under each building delivery phase.

Table 1 BIM qualities and usage across project delivery phases

Project Delivery Phases	BIM Qualities	Use of BIM
Design Phase	Virtualization	- Earlier and more accurate visualizations of a design. - The 3D model generated which can be used to visualize the design at any stage of the process with the expectation that it will be dimensionally consistent in every view. - It also facilitate the generation of accurate and consistent 2D Drawings at any stage of the design, this enables easy production of design drawings [39], [40]
	Earlier Collaboration Of Multiple Design Disciplines	- Earlier collaboration of multiple design disciplines. This allows simultaneous work by multiple design disciplines, shorten design time, reduces errors and omission and it also unveiled design problems and possible improvement opportunities [39], [41]
	Cost Extraction At The Design Stage	BIM enables accurate extraction of bill of quantities and spaces that can be used for cost estimation at early design stage [39], [27]
	Clash Detector	It is very useful in the design stage, single model with conglomeration of the interwoven components e.g. Pipes, electrical, beam structure can be united to detect any clashes. [42, 43].
	Clash Resolution	Practical, as with this case study BIM software will notify you of these clashes and adjustments can be made so that the error that have arisen will not become a problem during actual construction [42, 43]
Construction Phase	Work Schedules	It also enables automated material takeoffs, cost estimation and construction schedules. [26]
	Construction Management	BIM also can be used as source of information for analysis of the building solutions as well as to store the results of analysis; in addition, it can be used to represent the entire lifecycle (LC) of buildings including the processes of construction and facility operation [21]
	Construction Delivery Time	BIM can influence time management with a 7% reduction in time for project completion. Issa and Suermann [32] also share the same opinion that BIM helps to delivery projects on time.
	Cost	Another cost effective evidence was a study from a 2009 US study, with two thirds of over 1,000 BIM users attested to positive return on investment (ROI) [34].
Operation Phase	Project Management	Easy evaluation of design, construction and management of project before the actual project implementation. Ellis [44].
	Positive Return On Investment	BIM enable the investors to monitor the profitability of their investments before actually embarking on such projects. [34]
	Sustainable Design	BIM facilitates complex processes of sustainable design such as daylighting and solar access, it also enables automated material takeoffs, cost estimation and construction schedules, all these from a single integrated building model. [26]
	Data Management	BIM is an excellent tool for data management, that facilities easy and fast access to the information in a single centralized database through the 3D model [45].
	BIM As A Learning Tool	Meadati and Irizarry [35] retreated that due to the characteristic inherent in the BIM, it is a better option as a learning tool. Some of the BIM characteristics that qualifies it are: reduce accessibility time to data information and easy visual correlation with real world

5.0 CONCLUSION

BIM is very likely to be the AEC industry standard and it teaching and training of this technology it at university education is inevitable [46]. However the growth of BIM globally is without limits and more breakthrough of it usage are still unfolding. Therefore for maximum benefit to be achieved, an unrelenting effort on producing skilled and qualified work force to the AEC industry in Malaysia remain the immediate need of the education system that will serve the present industrial needs and also projected what is to be expected in the future. In order to adequately adopt BIM to building industry in Malaysia the following approaches may be adopted:

- Extension of awareness campaign to the educators and institution of higher learning.
- Collaborative education and training among AEC industry and academic disciplines.
- Integration of works of project team members and necessary point of integration

The implementation of these above will open up knowledge and awareness and it will forestall rapid growth and adoption in the building industry in Malaysia. And this will further enhance maximum achievement of benefits awaiting to be achieved.

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