Implementation of Building Information Modeling (BIM) in Sarawak Construction Industry: A Review

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Abstract. The construction industry believes that Building Information Modeling (BIM) is a platform to transform the construction industry to a higher level by enhancing productivity and efficiency. It is proven that with BIM process execution, productivity can be enhanced through the effective collaboration process, increased return of investment, and reliable information to support the decision-making process. Efficiency can be enhanced through an integrated design process, reliable and accurate cost estimates, reduced financial risk, and reduced potential dispute. Thus, clients are gradually enforcing the use of BIM in their projects, resulting in many construction companies investing in BIM technology to fulfill clients' needs. This paper presents a review of over recent research to identify the key elements of awareness, benefits, strategies and implementation of BIM. The result reveals that the top ten (10) ranking of BIM awareness, BIM benefits, BIM challenges and BIM strategies for the industry player to implement and adopt BIM in Sarawak construction industry.

1. Introduction

The complexity of the construction process has contributed to project failure and it has been difficult to manage by parties involved. One of the major problems that repeatedly occurs during the process is lack of coordination between different professional background among construction stakeholders and other relevant parties [1]. To overcome this complexity of construction, a major evolution in technology has been achieved to attain the process easily and efficiently. Construction stakeholders must know how to deal with a fast transition of technological, a high-integrated society, and construction issues that required solution from multidisciplinary. Because of that, Building Information Modeling (BIM) has been implemented efficiently and effectively in building projects through an integrated and computerized system [2]. Over the last 10 years, the construction software platform has changed from 2D modelling to 3D modelling. Since the introduction of computer-aided design (CAD) software a few decades ago, the concept of BIM has been discussed. At that time, however, the scope of design was a three-dimensional building model enriched with some additional graphic design [3]. Over the years, BIM has adapted the ideas explored in previous decades to overshadow them. But now, BIM tools are parametric with user-defined rules that automatically improved the level of production [4]. Numerous software were developed to offer specialized solutions that could capturing all the relevant project information [5]. The implementation of BIM began with Level 0 where the CAD is used to produce drawings, then printable documents are exchanged with other disciplines. Then, for Level 1 that started in the year 2000, 2D designs are combined with 3D models. Level 1 is where most construction stakeholders in the industry apply the current level. At the beginning of 2010, the BIM...
level was increased to Level 2 where there was an additional aspect, such as Time Management and Budget Calculation, and complete coordination and partial interoperability using different CAD models. Level 3 included full cooperation and full integration between stakeholders in a cloud-based environment. BIM is primarily used as a visualization tool and the manner in which it is applied is significantly associated with the characteristics of the project. BIM is considered to be interactive tools that allow efficient project management by enhancing the planning, design and other construction activities [1]. It has been shown that the introduction of BIM has improved the performance of mission more dramatically than those linked to the enhancement of productivity [6]. BIM in government projects requires a transformation of current working practices in order to achieve higher quality of buildings performing at lower the costs [7]. In fact, the systematic the coordination of construction industry players at the early stage of design, the wider the potential to optimizing the advantages of BIM [8-9].

2. Literature Review

2.1. Significance of Building Information Modeling (BIM) in the construction industry

BIM is a latest approach towards transforming stakeholder’s thinking about how technology can enhance the level of construction and safety control [10]. In the United Kingdom, 2016 was the target year for the BIM Level 2 adoption of all procured construction projects. The construction industry’s challenge is the standardisation in working with clients and supply chain. Therefore, in United Kingdom (UK) government construction industrial strategy 2016-2020, government construction board must recognise their most effective levers to support and advance in the construction process [7]. It was one strategy BIM developed to meet this mandate and enable greater supply chain integration and the use of optimised standard processes. In addition, misunderstanding and how BIM can be implemented within multidisciplinary may be part of the major issues with the introduction of BIM [11]. Nevertheless, BIM has become prevalent in the construction industry, especially in the United States and United Kingdom. But, the usage of BIM in the local industry is still at an infancy level. Table 1 provides a study of the importance of BIM in the construction sector.

2.2. Building Information Modeling (BIM) in the Malaysian Construction Industry

In Malaysia, industry players need to have an environment and specific vision for them to enjoyed the benefits of BIM [16]. Encouragement from the local authorities and close coordination among industrial practitioners are one of the criteria to success. The queries appear as to whether all construction stakeholders in Malaysia are well aware of this and how much the grasp BIM in the Malaysia construction industry. Besides that, in Malaysia, the development of BIM is still in its infancy level, but it has get serious attention from different disciplines. In Sarawak, the most prominent challenges to the implementation of BIM are related to the high initial costs, lack of knowledge and training [17]. As a result, the government has made a number of efforts to encourage BIM development such as BIM Roadmap. BIM has also become a state agenda through Construction Industry Transformation Plan (CITTP) 2016-2020 with initiatives and mandates aimed at increasing productivity and efficiency in Malaysian construction industry to a higher level [4]. However, a numbers of challenges in implementing BIM remain, including costs, industry capacity, information requirements, lack of knowledge, lack of client demand and low BIM maturity level [18]. Construction players should be alert of the positive results of BIM in guide them strengthen the construction process. It is known that BIM is still new in the Malaysian construction industry. BIM is seen as high cost technology, but it has been shown to give a better clarification on the issues happened in construction.

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| Authors             | Field of study                                    | Issue                                                                 | Key findings                                                                 | Research gaps                                                                 |
|---------------------|--------------------------------------------------|----------------------------------------------------------------------|--------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| Lu et al. [12]      | BIM for Green Buildings                          | As the utility of BIM has been recognized in the construction industry, there is an urgent need to review the update of the study on the relation between BIM and green buildings is urgently needed. | Give significant guidelines for the construction practitioners to improve the relation between BIM and green building in construction development. | Not touch on the awareness of BIM but focusing on how to establish the guideline for building practitioners to implement BIM towards green building development. |
| Ghaffarianhoseini et al. [13] | Benefits, Understanding, risk and challenges of BIM implementation | The low level of BIM adoption tends to be related to the threats and barriers that potentially impede its usefulness. | Lack of demand, cost and ability were the main reasons of not implementing BIM. The difficulties of BIM and lack of BIM expert is a major concern. | Shows recommendation on why future use of BIM could be established. But, no comparison towards conventional methods. Not touch on the case studies that have implemented BIM. |
| Tan et al. [14]     | Barriers in BIM adoption in China’s construction industry | The advantages of BIM remain abstract without overcoming any important obstacles in an appropriate manner. | Revealing significant difficulties to implement BIM in China and designing an effective three-level strategy to promote potential BIM implementation | Limited to 12 barriers from previous studies. Though the barriers have been discussed, there is scarcity of discussion on the advantages and strategy to implement BIM among construction stakeholder. |
| Singh et al. [15]   | BIM and Stakeholder Management in UK Construction Industry | The BIM approach is transform the conventional approach of the construction industry, where there were many construction projects have not accomplished their goals because of inadequate management system among stakeholders. | BIM has an enormous potential for construction stakeholders where trust, technology, communication, people, collaboration, and stakeholder engagement are key to managing stakeholders in BIM projects. | Limited to the purpose of BIM in relation to construction stakeholders. |

**Table 1.** Review on importance of BIM in construction sector.
3. Research Methodologies
This paper is focused on the findings of a much broader study involving a fair, logical point of view on the approach to the analysis and method of collecting data. The approaches of positivism have been applied in this research which consist of literature review, questionnaire survey, interviews and in depth comparative analysis. Through this approach, researchers to study on the awareness, benefits, challenges and strategies in implementing BIM in Sarawak construction industry. The researcher might explore more on the top ten (10) of BIM awareness, BIM benefits, BIM challenges and BIM strategies for the industry player to implement and adopt BIM in Sarawak construction industry. This allows the researcher the ability to interrelate with the stakeholders, thus understanding the organization’s issue; the essence stakeholder’s relationship during the decision-making process to implement BIM approach. Thus, by integrating positivism approach, a strong desire to increase the level of BIM implementation in Sarawak by providing the top ten (10) factors of awareness, benefits, challenges and strategies.

The research methodology employed in this study was to review the literature on BIM awareness, BIM benefits, BIM challenges and BIM strategies for the industry player to implement and adopt BIM. The choice of literature ranged five (5) years latest publication which since 2015 to 2019. The review was referring to the articles published from various recognized journal such as Journal of Engineering Design and Technology, Journal of Renewable and Sustainable Energy Reviews, Journal of Cleaner Production, Journal of Automation in Construction, Journal of Applies Mechanics and Materials, Journal Engineering Construction & Architectural Management, International Journal of Marketing Studies, and Journal of Organisation, Technology and Management in Construction. The analysis should concentrate on the factors that cause low level of acceptance towards BIM in construction industry. The peer-reviewed literature should be the author’s primary source of knowledge in presenting the top ten (10) key awareness, benefits, challenges and strategies for strengthening the implementation of BIM.

4. Findings and Discussion
Due to lack of BIM acceptance among construction players, it has been identified that there is an urgent need to increased knowledge and awareness of BIM in the industry [19]. However, the awareness among construction players in Malaysia is still way behind compared to Singapore and Hong Kong. Table 2 shows the top ten (10) of keys of awareness and benefits of BIM in construction industry.

Table 2. Top 10 ranking of awareness and benefits of BIM.

| Awareness of BIM       | Authors                      | Benefits of BIM                | Authors                      |
|------------------------|------------------------------|--------------------------------|------------------------------|
| Internet               | [20][21][22][23]             | Improve Maintenance Process   | [24][25][26]                |
| Friend & Colleagues    | [27]                         | Improve Value Engineering      | [11]                         |
| Seminar                | [28][27][29][30]             | Improve Productivity           | [31][32]                    |
| BIM-ArchiCAD           | [33][22][34]                 | Facilitate Design, Construction, and Maintenance of Projects | [35] |
| BIM-AutoDesk Revit     | [21][20]                     | Reduce Material Waste          | [36][37][38]                |
| BIM-Bentley            | [23][39]                     | Better Production Quality      | [40]                         |
| BIM Glodon CubiCost   | [41]                         | Performing Through Sustainability Analyses in Design Stage | [5][42] |
| BIM-AutoDesk Naviswork | [43][21]                     | Provide Accurate Quantities for Building Materials and Components | [44][45] |
| BIM-AutoDesk BIM 360 Glue | [46][47]                | On-Site Verification and Tracking | [48]                     |
| BIM-Tekla Structure    | [49][23]                     | Early Design Error Identification | [23]                      |
In the construction industry, not everything goes well according to plan. There are always challenges. However, new challenges bring along opportunities for innovation and improvements. Table 3 shows the top ten (10) ranking of challenges and strategies to increase the level of BIM adoption in construction industry.

Table 3. Top 10 ranking of challenges and strategies of BIM adoption

| Challenges of BIM Adoption | Research | Strategies of BIM Adoption | Research |
|----------------------------|----------|----------------------------|----------|
| High Cost of BIM Implementation | [50][51][52] | Subsidizing the price of BIM software | [9][53] |
| Low Awareness of BIM causing fear and uncertainty | [54][55] | Undertaking BIM training and seminar | [53][1][56][57] |
| Difficulties in the employment of skilled BIM manpower | [58] | Improve internet and power supply infrastructure | [59][60] |
| Lack of National BIM Guidelines and Standard | [44][9][2] | Enhance the cooperation between BIM experts, academia and researchers to educate and expose BIM to the young generations | [53] |
| High Cost of Maintenance and Technical Support Issues | [61] | State compliance to incorporate BIM in construction projects | [28] |
| Lack of Government Involvement | [62] | Early understanding of BIM implementation by top management in the organisation | [54][34] |
| Steep Learning Curve and Time-Consuming for BIM Complexity | [2][32] | Encouragement from top managerial in the organization to implement BIM | [1] |
| Lack of Support and Commitment to Top Management | [29][27][43][2] | The government should provide national BIM standard and guidelines | [63] |
| Integration, Storage and Compatibility Issues | [20][23] | Strategic approach framework is needed to help builders to adopt BIM | [64] |
| Unconvinced of BIM Benefits and Competitive Advantages | [65] | Employ competent staff to operate BIM software | [29][66] |

5. Conclusions
BIM is a useful digital approach for anyone who involves in the construction industry. There is no question that over the years, the idea of collaborative work has become increasingly more popular. That is why all construction stakeholders must be aware of the different BIM maturity levels. Since then, BIM has been used as construction management tools by the industry player to enhance coordination, exchanging information as well as effectiveness of the documentation in construction projects. This study offered some new insights into some of the explanations for low levels of awareness, poor acceptance and negative perceptions of the BIM in the Sarawak Construction Industry.

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