Study on Adoption of Building Information Modelling in Reducing Construction Waste in Malaysia

Gunalaan Vasudevan

Department of Construction Management, Faculty of Built Environment, Tunku Abdul Rahman University College Malaysia

Abstract. This paper is study of the adoption of Building Information Modelling (BIM) be adopted in finding a salient solution to the long-going predicament of management and minimisation of construction wastes in Malaysia. In doing so, the focus has been on the identification of ways BIM technologies could be introduced, the proclamation of its advantages in comparison to conventional methods and systems as well as the challenges the Malaysian construction industry and its players faced in pushing forward a formalised and standardised implementation of BIM in significantly reducing the amounts of construction wastes generated by the industry. The research, in answering the aim and objectives of the study was conducted by reviewing past, relevant literatures as well as through the distribution of questionnaire survey to industry players. The questionnaire was distributed to 135 industry players located in the Klang Valley and 91 out of 135 distributed questionnaires were returned and thus, perused in conducting the research analyses. Microsoft Excel and Statistical Package Social Science (SPSS) software were utilised in analysing and presenting the collected data. The analyses of data revealed that the adoption of BIM in Malaysia is relatively stagnant and happens at a low rate. Poor waste management and minimisation plans, poor awareness on the importance of such plans coupled with lack of demand from clients are regarded as the main reasons as to why this waste reduction has become a mare’s nest. In response to that, effective planning and scheduling of activities, effortless synchronisation of project design, site and materials together with detection of errors, discrepancies and clashes were chosen as the most important BIM-based benefits that could tackle this issue down once a proper implementation is set in place.

1. Introduction

The construction industry plays an imperative part in spearheading a nation’s growth. Aside from affecting the domestic environmental, social, political panorama as well as the employment, tourism and infrastructural developments, the Malaysian construction industry is mostly recognized for its importance and impact on the nation’s economy owing to its critical economic role and contributions to the total Gross Domestic Product (GDP). The figure below exemplifies this by showcasing the constant growth in the value of construction projects to the nation’s GDP enabling it to reach a new peak in 2018, bringing in RM 140.93 billion as opposed to RM 138.72 billion from the year 2017.

Therefore, it is undeniable that the national construction industry is a paramount driving force in Malaysia’s economic growth, therefore indicating a rapid flourishment of mega-sized project and investments in Malaysia. However, the growth of an industry generating such immense levels of revenue comes with a price. One of the biggest downsides to the expeditious evolution of the local construction industry has resulted in the continuous and swift build-up of an unsettling amount of construction waste [1]. Through researches conducted, it is proven that 5%-10% of the total construction materials used turn into construction wastes. These wastes not only bring about a myriad of negative effects to the local
environment but also, they significantly drag the efficiency and profits down. As these wastes are regarded as being highly contaminated and difficult to be segregated into their specific category of materials, it has been a challenge in disposal, recycling and reusing them. It is therefore imperative for the construction industry to come together and enlist probable solutions that could prove to have diminishing effects to this long-going predicament. The incorporation of Building Information Modelling (BIM), a relatively new, immensely popular and hyped up methodology that has been suggested to combat this issue of the mass generation of construction wastes, particularly during two vital stages namely the design and pre-construction stage.

2. Problem Statement
Malaysia, as a rapid developing nation with a ballooning construction industry, has fallen victim to a predicament that has affected most similar developing nations, which is the mass outflow of construction wastes. The expeditious advancements made by this sector couple with an all-time high demand of a list of development projects ranging from infrastructure to residential and commercial centres, has led to the production of large amounts of construction wastes which is made exponentially worse by the emplacement of flawed, inconsistent and insufficient practices in dealing with the ever-expanding rates of construction wastes [2][3].

As a potential solution in mitigating this problem, Malaysia has been looking at the introduction of BIM tools and technologies, as an industry norm, to all construction practices and stages. However, the proper and systematic assimilation of the BIM systems in Malaysia has not proven to be entirely possible yet, particularly in a scale that would be significant, enough where it could sufficiently be utilised in the reduction of construction wastes. This limitation, can be attributed to many factors such as the perceptions and acceptance of industry players to learn and adapt to this relatively new software, reluctance in replacing the conventional methods, which the industry players are all too complacent with, of waste managements that have been in-place for decades, coupled with an incomprehension of the myriad of benefits such an implementation could bring about to the local construction industry, as exemplified by many other developing nations that have jumped on the bandwagon of incorporation of BIM into their practices for years now.

3. Literature Review

3.1 Integration of BIM Tools & Technologies in Waste Reduction
Although the introduction of BIM to the local construction industry, which was initiated by The Malaysian Public Work and Department (PWD), was done in 2007, the adoption of BIM, in a considerably small scale which was for the construction of the National Cancer Institute, only happened in 2010 [4]. In accordance with the national construction agenda of embracing new technologies laid out by CIDB, various conferences took place in discussing the best methods that should be in-place for the adoption of BIM technologies on a much-larger, wholesome scale. The CIDB also organized an assortment of programmes to motivate and improve the rate of which BIM industry players utilise technologies, regardless of if they represent the government sector or private sectors. To further strengthen this agenda, CIDB in 2014, developed and published a BIM Roadmap, which branches out into seven pillars as it can be seen in Table 2.1 to facilitate a wide-ranging adoption of BIM by industry players in Malaysia.

3.2 Methods of Integration of BIM Tools & Technologies
One of the most vital reasons for the incorporation of BIM into the current construction industry practices is due to the extremely unsustainable nature of the industry especially in terms of management of wastes and unusable construction materials. The utilisation of BIM tools and technologies allows for the detection of major sources that generate large amounts of wastes as well as the abolishment of unnecessary construction activities that bring about no significant addition to the value of the project. BIM tools and technologies also enables all parties to a construction project to develop a comprehensive
understanding and visualization of all the materials, activity procedures, machinery operations as well as issues arising from and between building elements [5]. This information modelling system allows for the evaluation of reduction of wastes by presenting various options for high-rise buildings besides enabling an in-depth analysis of potential generation of construction wastes alongside the implications of any and all decisions made to the overall construction project with the provision of the ‘Virtual Prototyping On’ tool. Below are some of the many solutions that could be implemented by the utilisation of BIM tools and technologies in significantly and effectively reducing construction wastes.

3.3 Benefits of BIM Tools & Technologies in Waste Reduction
BIM, regarded as a relatively new technology due its limited use, can be defined as the exploitation of Information Technology (IT) to develop a combination of advanced process and technology, that offer a collaborative platform to all associated parties of any given construction project it is utilised upon. Conventionally, it is time-consuming to manually verify the accuracy and checking of discrepancies, of approved 2-Dimensional (2D) designs and drawings, particularly for complex designs. BIM, due to its reliance to 3-Dimensional (3D) technologies, produced using computer-aided-design (CAD) software, which permit information to be traded in digital formats amongst all associated parties of a construction projects aside from the existence of a reliable pool of information and effective clash detection features, executed by overlying 2D designs in visualizing locations of the project components in a 3D space, that significantly minimizes errors that are typically committed by humans. BIM facilitates the quantification of cost and project materials by a quantity surveyor, in a much shorter period of time, whereby in some instances, a reduction of up to 80% can be observed, especially when compared to conventional taking-off methods. In addition to that, enhancements in terms of project productivity and reductions in terms of project cost and duration are some of the primary benefits of BIM which have been demonstrated in many projects [6][7]. More importantly, BIM tools are equipped with advanced features that are able to detect and reduce waste-related costs and materials in construction projects.

4. Result and Discussion
4.1 Causes of Construction Wastes

In perusing the data presented in Figure 1, it is evident that concrete wastes, steel wastes and formwork wastes are the three main types of construction wastes that are often generated throughout the construction and completion of a project. Concrete wastes lead the pack with 36.30%, followed by formwork and steel wastes with 25.30% and 24.20% respectively. The lead by concrete wastes can be accredited to the nature of it as well as the many ways by which concrete or concrete elements can be damaged or turn faulty. Mishandling of precast concrete members during transportation, mixing up an inaccurate or inadequate concrete mix, errors made during concreting and demolition of concreted structures due to errors are some of the few ways concrete wastes are typically generated in a construction project. Timber or formwork wastes, on the other hand, owe their considerably large percentage of wastes generated to their low durability characteristic, exposures to nature such as rain,
as well as lack of supervision and management plans on maximising the reusability of the formwork. Steel wastes are mostly attributed to the defaults effectuated when cutting steel bars resulting in excessive residual bars in unusable sizes and dimensions. Brick wastes, though only gathering a result of 8.80% are often said to transpire during their storing, transporting and handling throughout various construction stages.

4.2 Poor Waste Management in Malaysia

As showcased above in Figure 2, poor waste management and minimization plans has been selected as the main cause, with a 22.34% lead, that has allowed for an uncontrollable growth of amount of construction wastes by the respondents of this survey. Trailing closely behind is poor awareness on waste management and minimization, followed lack of attention from clients and mistakes made by Quantity Surveyors in computing quantities required. This allows for a contemplation on the fact that there is not one particular reason or party that should take responsibility for this predicament of vast amounts of construction wastes generated by the industry. As it can be seen, 12.09% of the respondents selected poor involvement and intervention from government as the fifth biggest factor to this issue. Factors such as improper material storage and handling, excessive materials due to ordering errors and poor quality of materials are the causes that have garnered the least amount of percentages. These factors have repetitive in nature whereby the are generally inescapable in most construction projects.

4.3 Awareness on BIM Initiatives on Waste Reduction

According to data illustrated in Table 1, the number of respondents that are aware of the BIM initiatives to reduce construction wastes is significantly larger than those that are not, whereby the former category amassing a percentage of 92.3 and the later with a percentage of only 7.7%. These figures reflect that many of the local construction firms are, for the most part, aware of the abilities of BIM tools and technologies in cutting construction wastes short. However, this awareness does not translate well into the acquisition, utilisation and implementation of BIM into construction projects and all of its phases as it has been exemplified in the studies discerned above.

4.4 Methods of BIM Training
Figure 3. Methods by which BIM training was conducted

In reference to Table Figure 3, the most preferred method by which BIM training is conducted is when it is carried out of work hours (49.50%), followed by learning by collaborating with a professional BIM team on an on-going project (24.20%), then a dedicated time-slot for formal training during working hours (17.60%) and lastly, combination of formal training and self-learning through web & online tutorials (8.80%). It shows that, respondents to the survey prefer a training method that is uninterrupted by workload and one that is completely focused and hands-on that permits a better grasp on the knowledge on BIM imparted. Both methods of complete formal training are far ahead of the combination method with only 8 out of 91 responses is due to the fact that formal training entails the opportunity to utilise the software whilst discovering its features instead of just listening to a lecture or tutorial on the software. The needs of a firm or the needs of the top management of said firms would typically determine the level and type of training the staff to the firm would partake in.

5. Conclusion

To conclude, it is undeniable that a nation that is advancing a pace that is as rapid as Malaysia is, will be bound to drag some negative externalities along its way to modernization and globalization. The negative externalities primarily originate from the biggest contributors to this spur of economic growth, which is the local construction industry. It therefore becomes imperative for the nation, its governing party and all relevant and associated bodies, organizations and individuals, to get a complete grasp, ranging from their sources, types to causes, on these externalities, which in this case, are the vast production of construction wastes. Although there has been a plethora of methods, campaigns and plans effectuated that address this crisis head-on, the lack of a standardized, clear, simple and all-encompassing method of waste management and reduction sticks out like a sore thumb. This is because landfills designated for construction wastes are completely filled up, presence of disposed construction wastes along the proximity of the majority of construction sites as well as most importantly, an increasing production of construction waste, from year-to-year highlighted in statistics and percentages. In salvaging this issue and as a stepping stone moving forward, it becomes vital for the country, including the government and all related parties of the industry, to rally up a proactive and full-fledged movement that foresees to implement BIM tools and technologies, not as a temporary and small-scaled application but, as the norm of all construction industry practices affecting all stages of any construction project from now onwards.

6. Recommendation for Action

The utilisation of BIM tools and technologies in Malaysia in comparison to our neighbouring countries is still at a considerably low rate, attributed to the various inhibitory factors limiting its implemented as it has been established in this study. Following are some recommendations that could accelerate the rate at which BIM software are adopted in Malaysia:
• Intensifying the efforts made by government in urging construction players to expedite the transition from implementation of conventional software and methods to modern and relevant BIM-based software by demonstrating the benefits and features of the software.
• Increasing subsidies and incentives provided by the government in purchasing and enrolling for training for such software, to motivate construction players to make the shift of implementing BIM-based software
• Inviting firms’ members and industry players that have been able to successfully adapt and adopt BIM implementation to share their stories, suggestions and opinions at BIM conferences or seminars.
• Firms that own this BIM software should build their reputation and win the trust of industry players by providing excellent after-sales service and feedback to any issues or concerns faced by their customers as well as ensuring all their information pertaining to BIM products are constantly up-to-date.

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