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# Sustainable Construction Method: Key Issues of BIM Implementation in Malaysia

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**ABSTRACT**

Building Information Modelling (BIM) is not a new approach to ensure a sustainable construction as it has been used extensively by western countries. As for Malaysia, the adoption of BIM was quite apparent in big organisations. Meanwhile for small and medium sized organisations, the adoption of such software was slowly adopted. It can be seen that some of the organisations have put an effort to familiarise with the software in order to meet the client's requirements especially the government sector. Despite BIM being aggressively promoted through the Construction Industry Transformation Programme (CITP) 2016-2020, there has been no significant improvement in BIM implementations in the industry. Looking into this scenario, the main purpose of the research is to identify the key issues faced by construction organisations in implementing BIM. Using a quantitative base-approach, 351 sets of questionnaires were distributed to the industrial player namely architect, engineer and quantity surveyor. However, only 222 sets of questionnaires were collected successfully. The findings have been discussed systematically. It was found that most of the respondents agreed that the construction industry in Malaysia was not ready yet for BIM adoption though initiatives being made by various parties. The best way to resolve the inefficiency of BIM implementation among construction organisations also has been proposed to assist this industry to move forward.

***Keywords:***
Sustainable construction method; BIM adoption; Readiness; Industrial Player

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|---|---|---|---|

## 1. Introduction

The conventional construction method used nowadays operating with little regard for environmental impacts. The industry should change this method to a new method that makes environmental concerns as main objectives [1]. BIM is a building design and documentation methodology. Udhayakumar and Karthikeyan [12] mentioned that "the concept of BIM facilities beyond 3D parametric virtual representation in to 4D Parametric in Scheduling; 5D parametric in Costing; 6D parametric in sustainability and 7D parametric in facilities management." It provides

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more than just a 3D rendering or transferring electronic versions of paper documents [2]. During the design stage, BIM allows the contractors to detect potential clashes through the 3D model. Besides, it allows project stakeholders to view the proposed construction project in a 3D view. According to AIA [2], after BIM is implemented; design intent is maintained, the quality control becomes easier, communication between project teams is clearer, higher analytic tools are more accessible, and risk to the stakeholder is reduced. Furthermore, BIM can reduce 20 to 30% of construction and provide cost savings throughout the project's life cycle.

## 2. Literature Review

Although there are a lot of advantages in adopting BIM, some companies still unable to adopt BIM because some barriers which can classify into 3 categories which are process, social and technical obstacles [16].

### *2.1 Process*

There are two types of processes which will be discussed which are new business processes and risk management. There are two types of risk under risk management which are contractual risk and technical risk.

#### *2.1.1 New business processes*

As a promoter of innovation, the implementation of BIM will help to improve business processes and strategies, examine the impact processes and reorganize [5]. However, some firms refuse to implement BIM to their business due to uncertainty, time and cost. They need to spend more money as investment to subscribe to BIM software [17]. In some time, their existing computer is out of date and cannot run the software smoothly, they need to upgrade their computer's hardware or system in order to make these software work correctly. In addition, organizations need to consider that they need to send employees to train to assist the implementation of BIM. In the view of employees, they are afraid of these technologies because they believe that BIM can replace their position and cause them to lose their work. However, organizations believe that BIM technology will help them to reshape their business process and reassign staff, which will impact the productivity of work due to the transition process from fragmented to collaborative [17]. Moreover, the roles and responsibilities of stakeholders at different stages need to be redefined in order to make implementation of BIM successfully [9].

#### *2.1.2 Risk management*

i. Contractual risk

There is insufficient for contractual agreements in terms of the protection of copyright and determination of ownership of the date of BIM [3]. For example, the client wishes to own it because they are paying for the design, but the design team will also want to protect their copyrights. Furthermore, if there is no contractual establishment support, design teams and contractors will not take the responsibility for monitoring the data entry and inaccuracies of the BIM model. It is important to negotiate for indemnities for BIM users and offer limited warranties and disclaimers of liability for the design team where risks and cost implementation must be identified before

implementing BIM [21].

ii. Technical risk

Responsibility for interoperability between different software becomes an issue as the dimension of cost and schedule are added into the BIM model [9]. Usually, the contractors take the responsibility to compile the data and create a project schedule and cost breakdown for the project. If the main contractor and subcontractor use the same software, then there is no problem in integration [3]. If the data are incomplete or delivered in different programs, one person needs to re-enter the new data to update the model [3]. To solve this problem and avoid disputes, the project members must share the risks and award of using BIM. Besides that, it needs to be addressed precisely in the contract [3]. Thus, in order to assist and resolve these legal issues, some foreign professional bodies such as American Institute of Architect (ALA) have developed guidelines.

### *2.2 People*

One of the issues in implementing BIM is related to the people who are involved in the project. The people-related issues are lack of knowledge and training and lack of client demand.

#### *2.2.1 Lack of knowledge and training*

Human interaction plays an important role in the adoption of BIM. One of the barriers facing the current market in implementing BIM is that organizations refuse to accept new technology because they lack knowledge and training on BIM. This will cause the difficulties in improving management systems and lack of self-confidence [21]. The most important thing of BIM evolution is training and education [14]. Some companies have provided workshops and training for their staff to encourage BIM adoption, but the outcomes of these educations do not meet the expectations of the industry [10]. This is because most of the BIM education and training focus on the use of software rather than application of BIM practices. This gap will lead to the worst of further BIM implementation due to a shortage of internal BIM experts over the next 20 years [15].

#### *2.2.2 Lack of client demand*

Architects are not willing to use BIM due to lack of demand from clients [19]. Besides, there is also a lack of case studies that show the benefits after using BIM. Organizations that use BIM may have no intention of sharing their knowledge due to the nature of the human's personality, they tend to be selfish and want to be monopolists [8].

### *2.3 People Technology*

#### *2.3.1 Interoperability issues*

The ability of a system or software to use and exchange of information is called interoperability. BIM is not just a tool, it provides a platform for team members to exchange information [16]. In the construction industry, different organizations usually use various tools or software that do not interface well with each other. This will cause exchange information within different organizations become difficult due to interoperability issues. Moreover, many national initiatives have been introduced to resolve these problems. However, new challenges will still arise due to different BIM policies. Overall, the government should enforce the use of BIM on public sector projects so that the

other organizations follow the same policies when adopting BIM [20].

*2.3.2 Lack of standards and guidelines*

According to the BIM survey conducted by Building Cost Information Service (BCIS) of Royal Institution of Chartered Surveyors (RICS), 58% of the Quantity Surveyor and 53% of Building Surveyors select that the absence of BIM standards is one of the primary barriers of BIM adoption [4]. For example, most of the United Arab Emirates (UAE) buildings such as Burj Khalifa and Burj Arab are large, high risks and complex projects but they cannot successfully receive BIM due to the lack of BIM standards [11].

Since there is no national standardized BIM standard, more organizations tend to establish their own guidelines and standards which are inconsistent. Thus, the government must establish a standardized and consistent guidelines and standards. Besides, the government should encourage the collaboration between public and private sectors to accelerate the implementation of BIM in the construction industry [18].

*2.3.3 Different views on BIM*

According to previous research by Gu *et al.,* [7] showed that BIM has different definitions for different sizes of firms and different professions. For example, large organizations are more involved in larger projects, so they prefer tools that are flexible while smaller organizations will be in the opposite way. Besides, the architect may view BIM as an extension of CAD while the contractor and project manager will view BIM as an advanced document management system. The reason is because this current BIM's application is not mature enough [7].

*2.3.4 Poor match with the user's needs*

According to a quantitative survey conducted by [19], most participants thought the BIM tools were useless to them, while the rest found BIM difficult to use because it did not seem to have enough BIM libraries and objects where users had to customize their own objects. However, users require to spend more time and money attending BIM training to be able to customize BIM objects.

*2.4 Problem Statement*

The construction industry currently faces significant challenges in meeting clients' needs due to the unmet requirements which are time, cost, quality, safety and environmental characteristics. Egan [6] reported that the main causes of customer dissatisfaction are time delays and cost overruns. Seeley [13] mentioned that the higher the construction cost, the more difficult it is to meet the customer's requirements, because the cost is directly related to the complexity of the project. Thus, a higher proportion of dissatisfied and critical clients in the construction industry compare to other industries [13]. In general, the public believes that any construction project will inevitably encounter delays, cost overruns, accidents, poor product quality and pollution. Thus, both Egan [6] and Latham (1993) have suggested that the construction industry must learn from the automation and manufacturing industry to improve performance. Thus, Building Information Modelling (BIM) acts as computer aided tools to stimulate the automation process. Looking at the potential benefits of BIM, this paper aims to identify the key issues that may arise within Malaysian context before a suitable improvement is made.

## 3. Research Methodology

In order to collect the necessary data, the quantitative approach was used in this research. There are two approaches will be conducted. The approaches used are Literature Review and Questionnaire. Questionnaire was chosen instead of interviews with industry professionals because of ability of questionnaire to examine knowledge and implementation effectiveness among industry players on BIM.

### *3.1 Data Collection*

In order to collect the necessary data, the quantitative approach was used in this research. About 351 sets of questionnaires were prepared and sent to construction industry professionals to gather their views on issues and challenges of implementation BIM. Respondents in this research consists of professions from the construction industry which includes developers, architects, contractors, engineers and others associated with the use of BIM. Methods for distributing and collecting questionnaires include Emails and Google forms (invitation links will be made available in social media)

### *3.2 Techniques of Data Analysis*

The questionnaire to be analysed by using SPSS to generate Descriptive and Frequency Statistics, Mean Methods Standard Deviation (SD) and Ranking. The issue related to implementing BIM can be determined by descriptive statistics. The results obtained from descriptive statistics higher or lowest can be the level of agreement or disagreement to those issues. In this survey, the presentation table comparison was influenced by numbers of respondents.

There are total of 19,198 registered construction company in Malaysia, Malaysia BIM Report 2016 [23] the adoption of BIM by profession is 42% for architect, 21%, 13%, 12% and 2% for civil structural engineer, contractor, quantity surveyor and developer respectively. Thus, the total population for the company adopted BIM is 4239. With reference to Table for Determining Sample Size from Given Population by KREJCIE and MORGAN (1970), look for 4000 number of populations, about 351 sets of questionnaires were distributed.

The method used for ranking is Garrett Ranking Technique to find out the most significant factor which influences the respondent. The respondents have been asked to assign the rank for all factors and the outcomes of such ranking have been converted into score value with the help of the following formula:

Percent position = "100 (Rij – 0.5)" /"Nj"

where,
Rij = Rank given for the ith variable by jth respondents
Nj = Number of variables ranked by jth respondents

With the help of Garrett's Table, the percent position estimated is converted into scores. Then for each factor, the scores of each individual are added and then the total value of scores and mean values of score is calculated. The factors having the highest mean value is considered to be the most important factor.

### *3.3 Data Analysis*

The response rate is considerably high as there are a total 222 sets out of 351 sets were returned, with a percentage of the return rate of 63.24%. Although questionnaire is a useful way of data collection, the limitation of this method is also obvious. It is highly dependent on the willingness and cooperation of the respondent in completing it. Besides that, time is also one of the key factors to consider when developing questionnaires. In this questionnaire survey designs in six sections consist of multiple-choice questions and Likert-scale questions.

## 4. Results and Discussion

There are 14 questions in this section. All of these 14 questions are divided into 5 parts which are cost and finance, skill and knowledge, readiness, negative perception and government issues.

### *4.1 The Issues in Implementation of BIM*
#### *4.1.1 Cost and finance*

Table 2 shows that most of the respondents agree BIM will save money in the long run with 81 strongly agree and 94 agree. Whereas from Table 1 stated 91 disagree and 79 strongly disagree which means most of the respondents disagree that the BIM will increase the cost of the project. The results show that most of the respondents know that the use of BIM will not increase the cost of the project and it will save a lot of money in the long run.

**Table 1**
The use of BIM will increase in cost

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Strongly Agree | 4 | 1.8 | 1.8 | 1.8 |
| | Agree | 26 | 11.7 | 11.7 | 13.5 |
| | Moderately Agree | 22 | 9.9 | 9.9 | 23.4 |
| | Disagree | 91 | 41.0 | 41.0 | 64.4 |
| | Strongly Disagree | 79 | 35.6 | 35.6 | 100.0 |
| | Total | 222 | 100.0 | 100.0 | |

**Table 2**
The use of BIM will save money in the long run

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Strongly Agree | 81 | 36.5 | 36.5 | 36.5 |
| | Agree | 94 | 42.3 | 42.3 | 78.8 |
| | Moderately Agree | 43 | 19.4 | 19.4 | 98.2 |
| | Disagree | 4 | 1.8 | 1.8 | 100.0 |
| | Total | 222 | 100.0 | 100.0 | |

### *4.1.2 Skill and knowledge*

From Table 3, we can see most respondents' companies send their staff to BIM training as most of the respondents ranked it as "Strongly Agree" which is around 36.50% of respondents. The results show that more companies are willing to send their staff for training, workshop or talk about BIM.

**Table 3**
Does your company send staff to BIM training

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Strongly Agree | 81 | 36.5 | 36.5 | 36.5 |
| | Agree | 58 | 26.1 | 26.1 | 62.6 |
| | Moderately Agree | 11 | 5.0 | 5.0 | 67.6 |
| | Disagree | 39 | 17.6 | 17.6 | 85.1 |
| | Strongly Disagree | 33 | 14.9 | 14.9 | 100.0 |
| | Total | 222 | 100.0 | 100.0 | |

Table 4 illustrates that 32% of respondents disagree that BIM training is taking too much time. Only 5% of respondents strongly agree with this statement. This means that BIM training typically does not take up much of the participant's time.

**Table 4**
Do you think BIM training takes too much time

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Strongly Agree | 11 | 5.0 | 5.0 | 5.0 |
| | Agree | 63 | 28.4 | 28.4 | 33.3 |
| | Moderately Agree | 39 | 17.6 | 17.6 | 50.9 |
| | Disagree | 71 | 32.0 | 32.0 | 82.9 |
| | Strongly Disagree | 38 | 17.1 | 17.1 | 100.0 |
| | Total | 222 | 100.0 | 100.0 | |

Table 5 shows that almost half (48.60%) of the respondents disagree and strongly disagree the BIM training is expensive. There are 49 respondents just fine with the training fees. The rest which is 29.3% of respondents agree and strongly agree the BIM training is expensive. From the results, it can be seen that the fee for BIM training is affordable for most respondents.

**Table 5**
Do you think BIM training is expensive

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Strongly Agree | 16 | 7.2 | 7.2 | 7.2 |
| | Agree | 49 | 22.1 | 22.1 | 29.3 |
| | Moderately Agree | 49 | 22.1 | 22.1 | 51.4 |
| | Disagree | 76 | 34.2 | 34.2 | 85.6 |
| | Strongly Disagree | 32 | 14.4 | 14.4 | 100.0 |
| | Total | 222 | 100.0 | 100.0 | |

Table 6 illustrates almost all the respondents which is 92.80% representing 206 number of respondents agree the BIM training is useful. Only 16 respondents (7.20%) rate "Moderately Agree". None of the respondents ranked this issue as "Disagree" and "Strongly Disagree". This means that almost all respondents who attended or did not attend the training also agreed that BIM training is useful. This shows the importance of knowledge and skill.

**Table 6**
Do you think BIM training is useful

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Strongly Agree | 149 | 67.1 | 67.1 | 67.1 |
| | Agree | 57 | 25.7 | 25.7 | 92.8 |
| | Moderately Agree | 16 | 7.2 | 7.2 | 100.0 |
| | Total | 222 | 100.0 | 100.0 | |

### *4.1.3 Readiness*

Table 7 shows that the majority of respondents strongly agree and agree that the current market is not prepared for BIM. There are a total 161 people rated "Strongly Agree" and "Agree" for this question. This contributes up to 72.50% to the answer of this question. This shows that the current market lacks awareness of BIM adoption.

**Table 7**
Market less readiness

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Strongly Agree | 69 | 31.1 | 31.1 | 31.1 |
| | Agree | 92 | 41.4 | 41.4 | 72.5 |
| | Moderately Agree | 33 | 14.9 | 14.9 | 87.4 |
| | Disagree | 13 | 5.9 | 5.9 | 93.2 |
| | Strongly Disagree | 15 | 6.8 | 6.8 | 100.0 |
| | Total | 222 | 100.0 | 100.0 | |

Table 8 shows that more than half of the respondents, which is 55.40% represented 123 number of people "Agree" they still need a long time for learning curve. Only 4 number of respondents' rate "Strongly Disagree" about this statement. This means that the current market still has a long way to go to learn about BIM.

**Table 8**
Still need a longer time for learning curve

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Strongly Agree | 41 | 18.5 | 18.5 | 18.5 |
| | Agree | 123 | 55.4 | 55.4 | 73.9 |
| | Moderately Agree | 44 | 19.8 | 19.8 | 93.7 |
| | Disagree | 10 | 4.5 | 4.5 | 98.2 |
| | Strongly Disagree | 4 | 1.8 | 1.8 | 100.0 |
| | Total | 222 | 100.0 | 100.0 | |

Table 9 shows the majority agree that the people in this industry more prefer to use conventional method than modern method which is BIM. In this question, 33.80% and 42.30% of respondents expressed "Strongly Agree" and "Agree" respectively. The least people (2.70%) rate "Strongly Disagree" toward this statement. It can be concluded that most of the organizations are still using traditional methods instead of sustainable construction methods.

**Table 9**
More preference of using conventional type of construction method

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Strongly Agree | 75 | 33.8 | 33.8 | 33.8 |
| | Agree | 94 | 42.3 | 42.3 | 76.1 |
| | Moderately Agree | 24 | 10.8 | 10.8 | 86.9 |
| | Disagree | 23 | 10.4 | 10.4 | 97.3 |
| | Strongly Disagree | 6 | 2.7 | 2.7 | 100.0 |
| | Total | 222 | 100.0 | 100.0 | |

### *4.1.4 Negative perception*

Table 10 illustrated that 13.50% of respondents “Strongly Agree” BIM is difficult to use. Besides, 31.10% which is 69 people “Agree” this statement. Moreover, 54 and 38 persons answered “Disagree” and “Strongly Disagree” respectively. Besides that, only 14.00% of respondents feel “Moderately Agree”.

**Table 10**
BIM is difficult to use

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Strongly Agree | 30 | 13.5 | 13.5 | 13.5 |
| | Agree | 69 | 31.1 | 31.1 | 44.6 |
| | Moderately Agree | 31 | 14.0 | 14.0 | 58.6 |
| | Disagree | 54 | 24.3 | 24.3 | 82.9 |
| | Strongly Disagree | 38 | 17.1 | 17.1 | 100.0 |
| | Total | 222 | 100.0 | 100.0 | |

Table 11 illustrated the answer of the respondent in answering this question. Most people, which is 41.9% of respondents, choose “Agree” for this question. The percentage of people choosing “Strongly Agree”, Moderately Agree” and “Disagree” is quite balanced which is 18.00%, 19.40% and 17.6% respectively. The least people which is only 7 people “Strong Disagree” the BIM need a long time to learn.

**Table 11**
BIM takes a long time to learn

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Strongly Agree | 40 | 18.0 | 18.0 | 18.0 |
| | Agree | 93 | 41.9 | 41.9 | 59.9 |
| | Moderately Agree | 43 | 19.4 | 19.4 | 79.3 |
| | Disagree | 39 | 17.6 | 17.6 | 96.8 |
| | Strongly Disagree | 7 | 3.2 | 3.2 | 100.0 |
| | Total | 222 | 100.0 | 100.0 | |

Table 12 shows the number of people who chose "Agree", "Moderately Agree" and "Disagree" as the answers was close to each other, at 64, 56 and 58, respectively. Only 19 respondents “Strongly Agree” that the BIM will increase the cost for a project.

**Table 12**
BIM will increase cost for a project

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Strongly Agree | 19 | 8.6 | 8.6 | 8.6 |
| | Agree | 64 | 28.8 | 28.8 | 37.4 |
| | Moderately Agree | 56 | 25.2 | 25.2 | 62.6 |
| | Disagree | 58 | 26.1 | 26.1 | 88.7 |
| | Strongly Disagree | 25 | 11.3 | 11.3 | 100.0 |
| | Total | 222 | 100.0 | 100.0 | |

### *4.1.5 Government issues*

Table 13 shows 59 number and 57 number of the respondents "Moderately Agree" and "Disagree" the government did not promote implementation of BIM. About 37% of the people "Strongly Agree" and "Agree" with this statement.

**Table 13**
Government did not promote implementation of BIM

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Strongly Agree | 36 | 16.2 | 16.2 | 16.2 |
| | Agree | 46 | 20.7 | 20.7 | 36.9 |
| | Moderately Agree | 59 | 26.6 | 26.6 | 63.5 |
| | Disagree | 57 | 25.7 | 25.7 | 89.2 |
| | Strongly Disagree | 24 | 10.8 | 10.8 | 100.0 |
| | Total | 222 | 100.0 | 100.0 | |

From Table 14, it can be observed that the number of respondents who "Agree" and "Moderately Agree" the government did not provide incentive in implementing BIM is the same which is 57. However, there are 47 and 42 respondents "Disagree" and "Strongly Disagree" respectively toward this question. Malaysia government has made efforts to promote the implementation of BIM by giving incentives to those who adopted the method.

**Table 14**
Government did not provide incentive

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Strongly Agree | 19 | 8.6 | 8.6 | 8.6 |
| | Agree | 57 | 25.7 | 25.7 | 34.2 |
| | Moderately Agree | 57 | 25.7 | 25.7 | 59.9 |
| | Disagree | 47 | 21.2 | 21.2 | 81.1 |
| | Strongly Disagree | 42 | 18.9 | 18.9 | 100.0 |
| | Total | 222 | 100.0 | 100.0 | |

Table 15 shows the total Garret score of the issues in implementation of BIM. The market's readiness is ranked as the top issue while the government issues become the least important issue in implementing BIM.

**Table 15**
Total Garrett Score for issues of implementation of BIM

| | 1 | 2 | 3 | 4 | 5 | Total Score |
|---|---|---|---|---|---|---|
| C1 | 318 | 3600 | 1625 | 1900 | 988 | 11300 |
| C2 | 4819 | 3405 | 1438 | 1860 | 644 | 12165 |
| C3 | 4625 | 6180 | 1683 | 613 | 208 | 13310 |
| C4 | 2225 | 4520 | 2167 | 2013 | 583 | 11508 |
| C5 | 2063 | 3090 | 2900 | 20280 | 825 | 10958 |

C1=Cost and finance
C2=Skill and knowledge
C3=Readiness
C4=Negative perception
C5=Government issues

Table 16 shows the ranking of the issues in implementation of BIM. The market's readiness is ranked as the top issue while the government issues become the least important issue in implementing BIM. Overall, the current market is not ready to start adopting BIM although the government has put in many efforts to promote BIM.

**Table 16**
Average Garrett Score for issues of implementation of BIM

| | Total | Average Score | Rank |
|---|---|---|---|
| C1 | 11300/222 | 50.90 | 4 |
| C2 | 12165/222 | 54.80 | 2 |
| C3 | 13310/222 | 59.95 | 1 |
| C4 | 11508/222 | 51.84 | 3 |
| C5 | 10958/222 | 49.36 | 5 |

C1=Cost and finance
C2=Skill and knowledge
C3=Readiness
C4=Negative perception
C5=Government issues

Table 17 illustrated the mean score and SD in different issues of implementation BIM. The government issue was ranked the top issue and the least important issue is skill and knowledge. It can be concluded that, the government plays crucial roles in implementation of BIM.

**Table 17**
The mean score and SD in different issues

| | N | Mean | Std. Deviation |
|---|---|---|---|
| Readiness | 222 | 2.2072 | .85212 |
| Negative perception | 222 | 2.7432 | .89670 |
| Skill and knowledge | 222 | 2.7815 | .53984 |
| Cost and finance | 222 | 2.8176 | .64472 |
| Government issues | 222 | 3.3829 | .93440 |
| Valid N (listwise) | 222 | | |

### *4.2 How to Enhance Implementation Of BIM?*

Table 18 shows the total Garrett Score for each way to enhance implementation of BIM in the industry. According to Table 19, F2 which is 'education and training' was ranked the top ways to enhance BIM implementation with average Garrett Score 67.70. Respondents believe that by having good knowledge in BIM could improve the implementation of BIM. Education could potentially cultivate a group of specialists in BIM that genuinely discover the benefits of BIM and apply in the industry. With proper knowledge of BIM, stakeholders can eliminate the negative perceptions towards BIM. The way that has least impact is F3 which is 'incentives from government' with the average Garrett Score 50.29 as shown in Table 19**.** This shows that the Malaysia government should put more effort in building a relationship with other stakeholders in the construction industry to implement new technology and innovation effectively and efficiently.

**Table 18**
Total Garrett Score for ways to enhance implementation of BIM

| | 1 | 2 | 3 | 4 | 5 | Total Score |
|---|---|---|---|---|---|---|
| F1 | 2475 | 3480 | 3500 | 1560 | 400 | 11775 |
| F2 | 10650 | 3420 | 500 | 360 | 100 | 15030 |
| F3 | 1275 | 3840 | 3550 | 2000 | 500 | 11165 |
| F4 | 8400 | 5820 | 350 | 240 | 0 | 14810 |
| F5 | 6375 | 4380 | 1150 | 1120 | 325 | 13350 |

F1=Restrict labour import
F2=Education and training
F3=Incentive from government
F4=Enhance standardization on regulation and components
F5=Increase IBS product range and manufacturer / supplier

**Table 19**
Average Garrett Score for ways to enhance implementation of BIM

| | Total | Average Score | Rank |
|---|---|---|---|
| F1 | 11775/222 | 53.04 | 4 |
| F2 | 15030/222 | 67.70 | 1 |
| F3 | 11165/222 | 50.29 | 5 |
| F4 | 14810/222 | 66.71 | 2 |
| F5 | 13350/222 | 60.14 | 3 |

F1=Restrict labour import
F2=Education and training
F3=Incentive from government
F4=Enhance standardization on regulation and components
F5=Increase IBS product range and manufacturer / supplier

Table 20 shows the ranking of the practical ways to enhance the implementation of BIM. The 'Increase BIM product range and manufacturer/supplier' is ranked as the top way while the 'enhance standardization on regulation and components' become the least important way in implementing BIM.

**Table 20**
Practical ways to enhance the implementation of BIM

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Education and training | 222 | 1.0 | 5.0 | 1.541 | .8953 |
| Enhance standardization on regulation and components | 222 | 1.0 | 4.0 | 1.581 | .6861 |
| Increase BIM product range and manufacturer / supplier | 222 | 1.0 | 5.0 | 2.149 | 1.2258 |
| Restrict labour import | 222 | 1.0 | 5.0 | 2.734 | 1.1323 |
| Incentive from government | 222 | 1.0 | 5.0 | 2.964 | 1.0882 |
| Valid N (listwise) | 222 | | | | |

### *4.3 Conclusion for BIM Issues and The Way to Solve It*

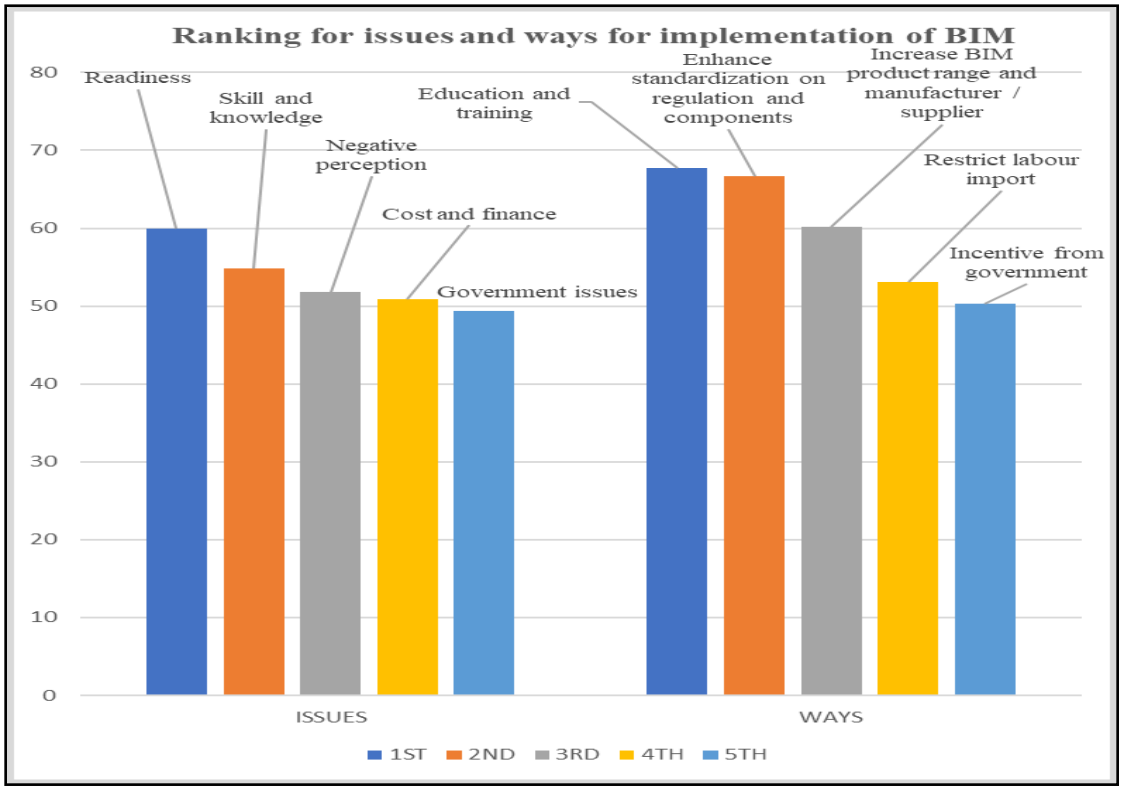


**Fig. 1.** Ranking for issues and ways for implementation of BIM

According to Figure 1, the issue 'skill and knowledge' was ranked as the second significant issue for implementation of BIM. However, 'education and training' has become the most important way to solve the issue in the implementation of BIM. These statements show that the market player realizes that the skill and knowledge of BIM is important while promoting BIM.

On the other hand, the issues related to government were ranked as least significant issues for implementation of BIM. Moreover, the 'incentive from government' has become the least efficient way to solve the issues arising from implementation of BIM. It can be said that the government has put more effort in implementing BIM so the respondents feel that the other issues were more significant than government issues.

## 5. Conclusion

In conclusion, the main purpose for this paper is to identify the issues for implementation of BIM by industry key players in Malaysian construction industry. From the results and discussions above, it can be concluded that the key issue relating to BIM is about the readiness level among industrial players which remains slow and still requires more time for this new transition (from previous software to BIM). Based on data analysis also, it can be summarised that the best way to solve this issue is through education and training. Increased knowledge of BIM by industry participants will allow them to understand the benefits of sustainable construction methods and start to use it. Besides, this will also help them to solve the problem that occurs during implementing these sustainable construction methods.

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