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Research Article

BIM in Malaysian Construction Industry: Status, Advantages, Barriers and Strategies to Enhance the Implementation Level

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Abstract: Building Information Modeling (BIM) is a new approach of construction design. It does not only facilitate the digital representation for designs but also provides all the necessary information for any project before it is constructed. Despite this advantage, the adoption of BIM in Malaysian construction is very low. Motivated by this, current study has focused on assessing current status of BIM implementation in Malaysian construction industry. It has also investigated advantages and disadvantages together with barriers to implementations of BIM and proposing effective strategies for enhancing the BIM implementation in construction industry. Investigation was done through survey where 150 questionnaire forms were distributed and 95 completed forms received back were analyzed with Average Index (AI) and Relative Importance Index (RII) method. Findings of the study revealed that the rate of BIM implementation in construction industry is very low. Major advantages of BIM are improved scheduling, improved drawing coordinated, controlling time and cost and singe detailed model. Enhanced collaboration, requires coordinated drawing, interoperability are the major disadvantages and limitations of BIM. Major barriers to low level of BIM implementation are lack of competent staff to operate the software, unawareness of the technology and non availability of parametric library. Provision of trial software, training of construction staff and introducing of BIM in university curriculum are very effective strategies in enhancing the implementation of BIM.

Keywords: Advantages and disadvantages of BIM, barriers to implementation, building information modeling, Malaysian construction industry, strategies to implement BIM

INTRODUCTION

Building Information Modeling (BIM) is relatively new era in the construction industry and rarely used in local construction of Malaysia. It is a new emerging approach to design and construction which facilitates with a digital representation of the building process (Baba, 2010). BIM is the process and practice of virtual design and construction throughout its lifecycle (Hergunsel, 2011). It is not only software but also a 3D building design which organizes and visualizes all data of the building before the real construction is carried out. BIM has been proved a beneficial technique in construction industry which has enabled practitioners in reducing uncertainties and achieving successful completion of a project. BIM can be applied on every stage on construction process from planning until operation. Unfortunately in Malaysian construction industry, the implementation of BIM is very slow. This slow implementation is caused by the human itself and technical barrier, known as internal and external barrier. Internal barriers are caused by human itself and cost, usually to learn new tools and process of the software (Pena, 2011). While external issues are related to the lack of trust between the new software applications. Significant obstacles, although perhaps are not fully recognized by the industry yet, since most companies have no experience of the use of shared BIM (Kiviniemi *et al*., 2008). In order to successful implementation of BIM in construction, it is very important to understand barriers to implementation of BIM and develop strategies to control these barriers. Hence, this study aims to assess true picture of BIM applications in Malaysian construction industry. Also, the advantages experienced by the use of BIM and barriers to BIM implementation are identified. Finally, various strategies are determined to enhance the use of BIM.

LITERATURE REVIEW

Concept and application of BIM: Building Information Modeling (BIM) is a digital representation of the physical and functional characteristics of a

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Table 1: Differences between traditional 2D construction processes and BIM

Task	2D based process	BIM
Design	Linear, phase	Concurrent, iterative
Drawing	Paper 2D	Digital 3D object based tied to intelligent data
Site planning	Unclear detailed	Relief contours
Code review	Slow and detailed	Expedited automated
Design validation	Light table	Clash detection with audit trails
Field drawing	2D drawing	2D drawing and perspective
Scheduling	Stand alone activities	Activities link to models
Sequence planning	Limited scenarios evaluated	Extensive scenarios evaluated earlier in the process
Field coordination	Paper shop drawing	Overlaying digital models using collision detection software
Operating training	Use manual	Visual
Closeout document	Assemble near completion	Intelligent models for operation and maintenance instruction: Constantly update during construction

AGC Committee (2005)

facility. BIM is a shared knowledge resource for information about a facility, forming a reliable basis for decisions during its life-cycle; defined as existing from earliest conception to demolition (Smith, 2007). It is an intelligent model-based design process that adds value across the entire lifecycle of the project. It supports the users in exploring the planning, construction and management of a building virtually before it is built (Autodesk, 2011). BIM is intended to replace drawings as the main repository of design information and principal communication media (Mokhtar *et al*., 1998). Compared to 2D design, BIM provides a database containing all the building information to produce technical construction document suitable for the erection of building (Baba, 2010). Detailed comparison of 2D design and BIM process is presented Table 1.

BIM offers various useful applications in achieving success of the projects as elaborated in following sections.

Design assistance and constructability: BIM is used in analyzing and testing ‘means and methods’ to ensure that the designs are buildable and constructible for convening targeted schedule and cost. It is very helpful in exposing errors and omissions in design documentation (Campbell, 2007).

Scheduling and sequencing: BIM is 4D process which means 3D plus time. It has ability to link the individual 3D parts by assembling with the project delivery timeline, including scheduling of resources and quantities and modular prefabrication to assist tracking and project phasing. In addition to collaboration, 4D simulation function is used as communication tools to reveal potential bottlenecks. Both planners and contractors can use BIM on site for verification, guidance and tracking of construction activities (Muzvimwe, 2011).

Cost estimating: BIM also supports 5D which means 4D plus “cost”. It integrates design with estimating, scheduling and costing which facilities the generation of Bills of Quantities, derivation of productivity rates and labor costs (Muzvimwe, 2011). With this information, it is easy to understand the cost implication of the projects with real time.

System coordination: BIM allows design changes by creating section, elevations of a building or any component and integrating with remaining work. All the equipment, fixture, pipes, duct and other building component are updated and checked through “clash” tools to discover and resolve conflict before system are installed in the real construction.

Layout and fieldwork: BIM is very helpful in assisting with layouts of component and system in the field through supporting fully coordinated design. It includes ‘lift’ drawing, such as 2D extraction and view in plan, details and dimension; and integrates with quality and safety information. Besides that, auto surveying facility translates XYZ coordinates to north, east and elevation points, which is directly transferable to surveyor’s equipments.

Clash detection: BIM enables the identification of ‘clash’, which means that different elements are occupied in the same space. It happens when more than one construction components are spotted at same points in the drawings. For example, if the structural designer places beam in the path of air-conditioning units located by MEP engineer, clash detection highlights that situation as clash through the use of ‘clash detection’.

Advantages of BIM: BIM has been proved as a very beneficial approach in reducing uncertainties and also improving the efficiency of construction process. One of the most frequently observed benefits is increased utility and speed. BIM is very useful in increasing the speed and utility of activities by enhancing the quality of schedule and cost information throughout project lifecycle (Fallon and Palmer, 2007). BIM is also very helpful in improving the interaction between the architects, engineers, designers and contractors, Contractor provides all the required information regarding site which is needed in BIM. Consequently,

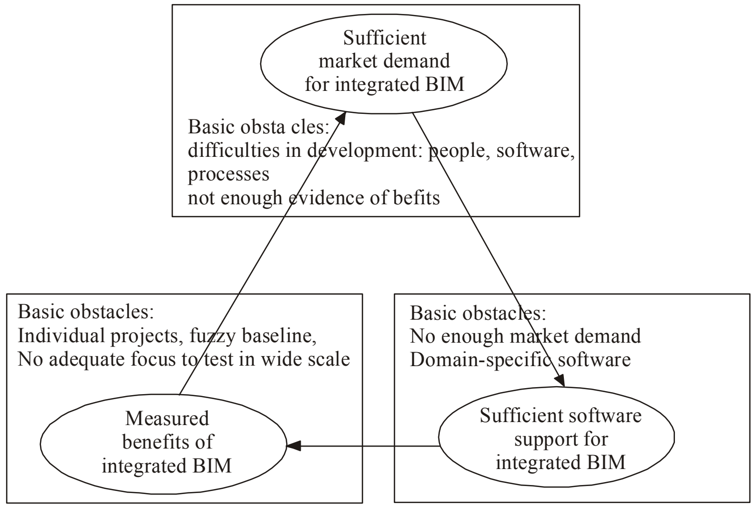

Fig. 1: Obstacles in BIM implementation, Baba (2010)

designer can proceed with design work in faster way and send feedback to contractor relatively in shorter time as compared to traditional approaches. This reduces the required total working duration. Further, by integrating BIM with current developments of mobile technology, it can help in identification of any errors or mistakes in design or working process. This will reduce faults and reworking efforts and shortening the time requirements. For example: CRC for Construction Innovation (2007) highlighted that the use of BIM can reduce the project time by 7%. Besides that, BIM is very useful in benchmarking. It assists in finding improved and innovative solution. These processes are performed at multiple stages which assists all disciplines across. The data base embedded with these models play important role in uniting dissimilar sectors. With the use of same model, designers and contractors are able to solve engineering problems quickly and articulate their knowledge regarding the issues faced during executions in faster and clear way. Thus, BIM is considered as a tool for solving the construction disputes occurring during design and construction phase. Beside this, BIM increases collaboration and partnership between the parties as the use of 3D design in BIM supports the participants for several design iteration in order to provide feedback for improvement of the design (Taylor and Levitt, 2007).

Another benefit of BIM is visualization which helps the practitioners throughout the project lifecycle especially in design phase, visualization helps in reducing the chances of misinterpretation from any participant involved in the project (Salazar *et al*., 2006). BIM is also capable to evolve 3D model with time and produce 4D simulation. 4D model is very beneficial in improving the understanding of the process flow which will assist practitioners to identify the related issues. Further, visualizing the project in early stage will provide a clear vision of design to determine all possible uncertainties so that the design can be improved at earlier stage to save time, cost and quality. BIM facilitates project team for developing virtual environment which is useful in reducing complexities and optimizing the resources.

BIM is also very useful in fault finding in any project as all the projects are modeled and monitored through single database. It helps in decreasing the problems of coordination in drawings and conflict errors. Main advantage of using single integrated data environment is that incorporation of information from several authorities produces a better picture regarding the project (CRC for Construction Innovation, 2005). Besides this, BIM also facilitates visualization, simulation and optimization. It can detect internal conflicts which help in determining the proper solution (Ashcraft, 2008).

Barriers to BIM in construction industry: Like any other new technology, personal attitudes towards BIM adoption are shaped by various factors. These include the risks involved in using unproven means and methods; difficulty in implementing; financial risks involved; and the perception of other workers attitudes towards new technologies (Paulson and Fondahl, 1980; Tatum, 1989 cited by Baba, 2010). Bernstein and Pittman (2004) highlighted that major barriers to adoptions of BIM are transactional business process evolution, computability of digital design information and meaningful data interoperability. Baba (2010) highlighted various critical barriers to implementation of BIM in construction industry as presented various obstacles as shown in Fig. 1.

Following sections elaborate major barriers faced in construction industry for implementing BIM technology.

Cost: For BIM adoption in construction industry, a large initial investment is required for updating software, hardware and the training of staff. Morrison (2010) from McGraw Hill (2009) report on business value for BIM presenting survey results of the USA contractors also highlighted that the return on investment is between 10-25%. Besides this, implementation of new technologies is costly in terms of changing in work flow and work process. Often most service providers are not willing to make such investment unless they perceive long term benefits to their own organization and/or if the owner subsidizes the training costs (Baba, 2010).

Training: Lack of training is one of the major obstacles in achieving satisfactory level of BIM implementation. It has also affected on decision making for BIM adoption as reported by (McGraw-Hill, 2009). To overcome this barrier, currently various training programs and workshops are being arranged worldwide (Bentley, 2013). Yuan and Domian conducted a survey among the practitioners of USA and UK construction industry and found that 40 and 20% of respondents from USA and UK respectively reported that their organizations require putting time and human resource for training.

Client demand: Many stake holders are scared of change. Clients think that if contract conditions are changed for incorporating 3D or BIM models, it will affect on receiving competitive bids. This will be limiting their potential pool of bidders and ultimately increasing the price of the project (Baba, 2010). This may be because of the reason that the clients are not aware of new technology and its benefits. Hence, they are scared of BIM. In fact, without client demand, there is hard to implement BIM to the construction industry.

Ownership: It is very critical to resolve the issue of ownership for BIM data and taking necessary actions for protecting it (Azhar, 2008). Morrison (2010) highlighted that ownership problem is more important if the data input for model comprises of proprietary design elements. Main goal of ownership is to avoid reserves which may discourage the participants from adoption (Thompson, 2001). Generally, the ownership for the designs is hold by the clients. However, the parties involved in the team have privilege for certain level of information in the model. Hence, the issue of ownership cannot be resolved by a single rule but varies for each project depending on the personnel involved and the extent they are involved in providing information as cited by (Azhar, 2008).

Culture issues/resistance to change: BIM implementation has forced technology change and process change within the organizations (Arayici *et al*., 2009). People are the main drive for success to achieve goal of BIM implementation, knowing that BIM is still new in Architecture, Engineering and Construction (AEC) industry. Problem occurs when people refuse to move towards for better changes, for them using BIM means an expert is needed to apply the software in their company. This trend can be changed by enforcement from the clients and focusing on changing the traditional approaches for contractor's selection. This selection must be done based on lifecycle cost assessment rather than low bid cost criteria (Smith and Tardiff, 2009; Morrison, 2010).

Interoperability: In application of BIM, one of the most common obstacles is lack of interoperability. It is highlighted by 80% of respondents participating is BIM smart market survey conducted by McGraw Hill Construction (2009). Majorly, this problem of interoperability has arisen because of the reason that a single software tool is developed for accomplishing the requirement of different fields (Thompson and Miner, 2006). Besides this, a large number of aggravated market shares also hinder the creation of interoperable software as claimed by software companies (Fortner, 2008). Morrison (2010) cited that lack of software interoperability also represented that potential project team members utilizing different program of BIM may not wish to work together.

METHODOLOGY

Data collection and analysis: This study adopted questionnaire survey, the most common tool used in gathering the relevant supportive information. Questionnaires are used to extract, as much as possible, the relevant data and information from predetermined respondents. Questionnaire survey usually gathers a large amount of data in a short period of time and relatively makes the process of preparation, distribution and tabulation of answers easier. The responses can also be given easily and quickly. In ensuring that the developed questionnaire gathers appropriate required information, guidelines of Frary (1996) were adopted to achieve an effective questionnaire. These guidelines are:

- Provide clear instructions (for respondents, interviewers and processors)
- Avoid open-ended question
- Be sure to commit the study goals to writing
- Clearly and concisely define what is to be collected and recorded
- Maintain respondents' cooperation and involvement

Table 2: Characteristics of the respondents

Characteristic	Frequency	(%)	Cumulative (%)
Type of organization			
Client	15	16	16
Consultant	55	58	74
Contractor	25	26	100
Category of organization			
Private	29	30.5	30.5
Government	65	68.4	98.9
Joint venture	1	1.1	100
Qualification level			
Degree	56	58.9	58.9
Diploma	31	32.6	91.5
Others	8	8.5	100
Working position			
Engineers	70	73.7	73.7
Managers	2	2.1	75.8
Directors	7	7.4	83.2
Quantity surveyors	11	11.5	94.7
Others	5	5.3	100
Working experience			
1-10 years	11	11.6	11.6
11-20 years	76	80	91.6
21-30 years	3	3.2	94.8
Above 31 years	5	5.2	100

- Enable respondents to complete it accurately and within a reasonable time
- Use a language that is understood by the respondents
- Avoid bias in question wording
- Make the job of the respondent and/or interviewer easy
- Appear uncluttered on the form
- Be in a suitable form for keeping as a hard copy record

Based on above guidelines, close ended questionnaire was developed and sent via by hand, post and email to the 150 selected organizations from clients, consultants and contractors. In response of that, 95 completed forms of questionnaire were received. Among the responses 55 questionnaire were received from consultant organizations, 25 questionnaires from contractors and 15 sets from client organizations. From respondent's organizations, 65 are registered as private organization while 29 organizations are government organizations. Majority with 56 representatives from these organizations completing the feedback have completed engineering education while 31 respondents have achieved diploma certificate. The respondents have various years of working experience. Majority of respondent i.e., 76 of 95 have experience of 11 to 20 years and 11 respondents have experience of 1-10 years. Summary of the respondents' characteristics is presented in Table 2.

Data from questionnaires forms received by these respondents was analyzed and presented as in the form of flowchart and tables, in order to understand them better. Descriptive statistics with frequency analysis and Average Index (AI) analysis were used to analyze the questionnaires. Frequency analysis used a tabular form to represent frequency of the responses received for individual questions asked in the questionnaire. The results were further summarized by using an average in order to assess the advantages and disadvantages of using BIM and also the popular software using among practitioner in construction industry. A five-point liker scale of 1 to 5 was adopted in order to assess the degree of significance for each of the causes, in which:

Table 3: Evaluation ranges

Average index	Rating scale
1.00<average index (I) <1.50	Not significant
1.50≤average index (I) <2.50	Slightly significant
2.50≤average index (I) <3.50	Moderately significant
3.50≤average index (I) <4.50	Very significant
4.50≤average index (I) <5.00	Extremely significant

1 = Not Significant
2 = Slightly Significant
3 = Moderately Significant
4 = Very Significant
5 = Extremely Significant

The average index analysis for each variable was calculated by using the classification of the rating scale:

$$\text{Average index} = \frac{\sum \text{ai.xi}}{\sum \text{xi}}$$

$$\text{AI} = \frac{\sum(1\times1 + 2\times2 + 3\times3 + 4\times4 + 5\times5)}{\sum(x_1 + x_2 + x_3 + x_4 + x_4)}$$

where,
x_1 = No of respondents for "Not Significant"
x_2 = No of respondents for "Slightly Significant"
x_3 = No of respondents for "Moderately Significant"
x_4 = No of respondents for "Very Significant"
x_5 = No of respondents for "Extremely Significant"

The evaluation ranges to asses significant level as adapted by Memon *et al*. (2011) was used in this study as shown in Table 3.

Relative Importance Index (RII) method of calculation was used for ranking the barriers to implementation of BIM in construction industry and strategies in enhancing the implementation of BIM. RII was computed with following formula:

$$\text{RII} = \frac{\sum W_i X_i}{\sum X_i}$$

where,
i = Response category index = 1, 2, 3, 4 and 5
W_i = The weight assigned to ith response = 1, 2, 3, 4, 5, respectively
X_i = Frequency of the i^{th} response given as percentage of the total responses for each factors

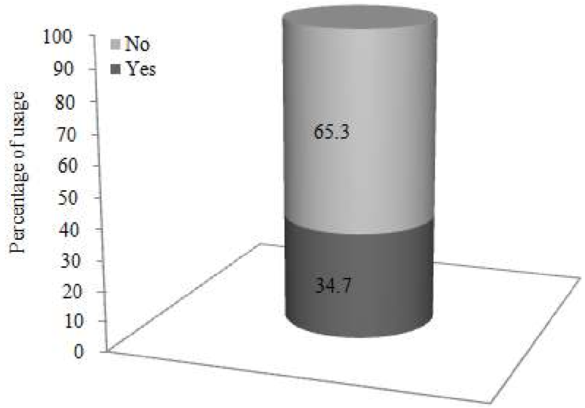

Fig. 2: Implementation of BIM in construction industry

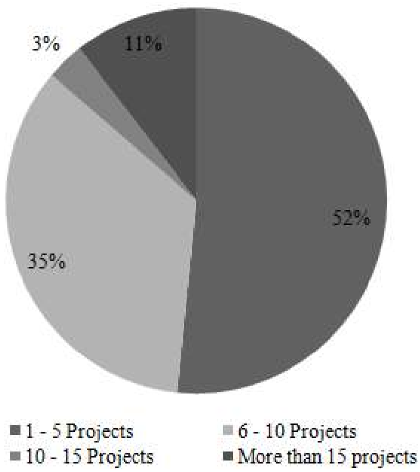

Fig. 3: Number of BIM projects handled by respondents

Table 4: BIM implementation in various stages of project

Phase of project	Frequency	(%)	Cumulative (%)
Conceptualization	20	21.1	21.1
Design	46	48.4	69.5
Execution	4	4.2	73.7
All phase	25	26.3	100.0

RESULTS AND DISCUSSION

Level of BIM implementation: The respondents were asked whether they or their organizations are practically implementing BIM in the projects or not. Majority of the respondents with 59 of 95 (65.3%) mentioned that their organizations are not well aware of BIM and they are not directly involved in BIM implementation. Only 35.5% of respondents confirmed that they have experienced for implementing BIM as shown in Fig. 2.

Based on results from Fig. 2 it can be concluded that the implementation rate of BIM in Malaysia is very low. The respondents implementing BIM have adopted it at various stages of projects as summarized in Table 4.

Table 4 demonstrates that highest ratio of the respondents with 48.8% have experience BIM in only design phase of the project. While the least ratio of respondents with 4.2% have applied BIM during execution stage i.e., actual construction phase. Only 26% of the respondents mentioned that they have implemented BIM throughout the project in all phases. These respondents have implemented BIM in several projects. The respondents have applied BIM in several numbers of projects as summarized in Fig. 3.

Figure 3 demonstrates that majority with 52% of respondents have applied BIM up to 5 projects while 35% of respondents have implemented BIM in 6 to 10 projects. This indicates that BIM implementation is not very common but is occasionally applied by the organizations. This may be due to unawareness of potential benefits of the BIM implementation in construction project.

Advantages and disadvantages of BIM implementation: BIM practices have been very beneficial in achieving project success. Respondents were asked to rank most important benefits they have experience by applying BIM in the construction projects. The benefits were assessed through ranking based on AI values as presented in Table 5.

Table 5 shows that 'Improved Scheduling' is the most important benefit achieved by BIM practices. It is agreed by client and consultant group of respondent's respondents while contractor respondents place this advantage at second rank. 'Improved Drawing Coordinated' is placed at second rank and agreed by consultant respondents. On the contrary, client group of respondents ranked this advantage as most important by placing it at first rank while contractors placed this factor at third rank. Improved work quality is also 2nd ranked benefit of BIM while contractors ranked this factor as the most important benefits and ranked it at 1st rank. While consultants and contractors ranked this factor as 3rd major advantage of BIM. Third rank in experiencing the important benefits achieved by BIM implementation is shared by two factors which are 'Single Detailed Model' and 'Control Time and Cost'. Together with these advantages, the respondents also highlighted that there are some disadvantages of BIM implementation as summarized in Table 6.

Table 6 shows that client respondents believe that top ranked disadvantage is that BIM 'requires coordinated drawing' and 'add work to designer' as the designer will have to spend more time creating the initial drawing (model). Client ranked Interoperability as 2nd ranked disadvantage while need of enhanced collaboration is ranked at 3rd place. From consultant's perceptive, most significant disadvantage of BIM implementation is that it requires coordinated drawing. This is followed by the factor add work to designer while need of enhanced collaboration is placed at 3rd rank and interoperability is the last ranked disadvantage of BIM. On the contrary, contractors ranked 'enhanced collaboration' as top ranked disadvantage of BIM and

Table 5: Advantages of BIM implementation

	Overall		Consultant		Contractor		Client	
Advantages of BIM	AI	Rank	AI	Rank	AI	Rank	AI	Rank
Improved scheduling	3.98	1	3.85	1	4.44	2	3.60	1
Improved drawing coordinates	3.94	2	3.78	2	4.42	3	3.60	1
Improved work quality	3.94	2	3.76	3	4.56	1	3.40	3
Single detailed model	3.85	3	3.75	4	4.08	5	3.60	1
Control time and cost	3.85	3	3.73	5	4.32	4	3.53	2
Reduces human resource	3.83	4	3.58	8	4.56	1	3.33	4
Increase drawing speed	3.75	5	3.65	7	3.96	6	3.53	2
Improved productivity	3.66	6	3.78	2	3.64	8	3.27	5
Creative and innovative solution	3.64	7	3.55	9	3.92	7	3.53	2
Avoiding error tools	3.60	8	3.69	6	3.56	9	3.33	4

Table 6: Disadvantages of BIM implementation based on respondent groups

	Client		Consultant		Contractor	
Disadvantages of BIM	AI	Rank	AI	Rank	AI	Rank
Requires coordinated drawing	3.60	1	3.87	1	4.36	2
Add work to designer	3.60	1	3.67	2	4.20	4
Interoperability	3.53	2	3.47	4	4.28	3
Enhanced collaboration	3.47	3	3.60	3	4.60	1

Table 7: Disadvantages of BIM

Disadvantages of BIM	AI	Rank
Enhanced collaboration	3.60	1
Requires coordinated drawing	3.45	2
Interoperability	3.35	3
Add work to designer	3.33	4

requires coordinated drawing as 2nd ranked disadvantage. Third rand disadvantage of BIM as perceived by contractors is interoperability and add work to designed as the least important disadvantage. Overall, the ranking of the disadvantages of BIM implementation are summarized in Table 7.

From Table 7, it is perceived that the respondents believe that 'enhanced collaboration' is the most critical disadvantage of BIM implementation. Requires coordinated drawing is placed at 2nd rank followed by interoperability at 3rd place. The least important disadvantage of BIM implementation is 'add work to designer'.

Barriers and strategies to BIM implementation: For assessing the barriers to implementation of BIM, the scale was used as 1 for strongly disagree, 2 for disagree, 3 for moderately agree, 4 for agree and 5 for strongly agree. While, for assessing the strategies, scale was used as 1 for not effective, 2 for slightly effective, 3 for moderately effective, 4 for very effective and 5 for extremely effective. Results for RII and ranking for the barriers to implement BIM in construction is presented in Table 8.

Table 8 shows that 'Lack of competent staff to operate the software' is most significant barrier in implementation of BIM in construction industry. It is agreed by contractor group of respondents. While client ranked this factor as second most significant barrier and consultant place this factor at third rank. Based on overall ranking 'Unawareness of technology' is second most significant barrier in implementation of BIM in construction industry. It is agreed by contractor group of respondents. While client ranked it at the sixth position and consultant placed this factor as the most significant barrier in implementation of BIM in construction industry. Third most significant barrier in implementing BIM in construction industry is 'Non availability of parametric library'. It is agreed by client group of respondents. While consultant ranked this factor at sixth position and contractor placed this factor as fourth position. Fourth place on the overall ranking for the BIM barrier is "expensive software". The client ranked it at first position as it is the major barrier in implementation of BIM application in the industry. While consultant ranked it at second position and the contractor respondents ranked it at seventh position, which is second last position means that the software price is not the major problem to implement in the construction industry. For overcoming these barriers and enhancing the implementation of BIM, this study also proposed strategies as tabulated in Table 9.

Table 9 shows the ranking for strategies are divided into four groups of respondents which are client, consultant and contractor and overall. Based on the findings, 'Provision of trial software' is most effective strategy to enhance the implementation of BIM application in construction industry. It is agreed by client and contractor group of respondents. While consultant ranked this factor as third most effective strategies. Based on overall ranking, the second most effective strategy to enhance the implementation of BIM is 'Training of construction staff'. It is agreed by consultant and contractor group of respondents, while client ranked this factor as third most effective strategies to implementing BIM in construction industry. Introduction of BIM in University Curriculum has been ranked at the third position and is agreed by contractor group of respondents. While client and consultant groups ranked this strategy at fourth place.

Table 8: Barrier in implement of BIM application

	Overall		Client		Consultant		Contractor	
Barriers to implementing BIM	RII	Rank	RII	Rank	RII	Rank	RII	Rank
Lack of competent staff to operate the software	0.82	1	0.76	2	0.80	3	0.89	1
Unawareness of the technology	0.80	2	0.69	6	0.85	1	0.85	2
Non availability of parametric library	0.80	3	0.75	3	0.79	6	0.82	4
Expensive software	0.78	4	0.83	1	0.80	2	0.78	7
Not ready to distort normal operational structure	0.77	5	0.73	4	0.79	4	0.79	6
Take longer time to develop model	0.76	6	0.68	7	0.77	7	0.82	5
Difficult to learn	0.75	7	0.65	8	0.79	5	0.84	3
No enforcement from client	0.74	8	0.72	5	0.75	8	0.73	8

Table 9: Strategies to enhance the implement of BIM

	Overall		Client		Consultant		Contractor	
Strategies to enhance the implementing BIM	RII	Rank	RII	Rank	RII	Rank	RII	Rank
Provision of trial software	0.85	1	0.81	1	0.77	3	0.94	1
Training of construction staff	0.84	2	0.80	3	0.79	2	0.90	2
Introduction of BIM in university curriculum	0.82	3	0.80	4	0.73	4	0.90	3
Subsiding the price of BIM software	0.81	4	0.81	2	0.72	5	0.89	4
Provision of legislation on BIM usage	0.78	5	0.71	6	0.69	6	0.87	5
Mobilizing client on the importance of BIM	0.78	6	0.75	5	0.80	1	0.85	6

Subsidizing the price of BIM software is fourth ranked effective strategy and is agreed by the contractor group of respondents. While client ranked it as second most effective strategy and consultant group of respondents have ranked this strategy at fifth position in enhancing BIM applications in construction industry.

CONCLUSION

This study investigated implementation of BIM in construction industry of Peninsular Malaysia. From the finding of the study it can be concluded that:

- Rate of BIM implementation in construction industry is very low which needs attentions and serious effort in achieving the thriving construction projects.
- BIM implementation benefits in construction industry through developing and providing improved scheduling, improved drawing coordinated, controlling time and cost and singe detailed model.
- BIM has certain limitations such as requires enhanced collaboration, requires coordinated drawing, interoperability. These limitations need to be overcome for effective and enhanced implementation of BIM.
- Major barriers to implementing BIM are lack of competent staff to operate the software, unawareness of the technology and non availability of parametric library.
- Provision of trial software, training of construction staff and introducing of BIM in university curriculum are very effective strategies in enhancing the implementation of BIM.
- Further, for seeking enhanced use of BIM in construction industry, a detailed investigation should be carried out through case studies in assessing benefits and limitations. Consequently a framework must be developed for the application of BIM.
- For improving the level of implementing BIM in Malaysian industry, a flexible training program of BIM for all practitioners must be created.

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