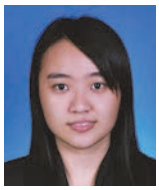
Primljen / Received: 12.1.2014.
Ispravljen / Corrected: 15.5.2014.
Prihvaćen / Accepted: 25.5.2014.
Dostupno online / Available online: 10.9.2014.

Building Information Modelling application: focus-group discussion

Authors:

Hafez Salleh, PhD. CE
University of Malaya
Faculty of Built Environment
hafez@um.edu.my



Wong Phui Fung, BSc. CE
University of Malaya
Faculty of Built Environment
phuifung@gmail.com

Original scientific paper

Hafez Salleh, Wong Phui Fung

Building Information Modelling application: focus-group discussion

Although the potential of building information modelling to achieve sustainability has been widely acknowledged by the scientific community, the level of implementation is nevertheless quite low. Most of the existing research focuses on the study of the barriers and strategies of BIM application through a quantitative approach. This study ascertains critical barriers and appropriate strategies for the application of BIM through qualitative approach via focus group discussions. The findings reveal that the cost of implementation is not indicated as a critical barrier, and that the lack of expertise, training, and awareness, is more critical in that respect.

Key words:
building information modelling (BIM), sustainability, construction industry, barriers, strategies, focus group

Izvorni znanstveni rad

Hafez Salleh, Wong Phui Fung

Primjena *Building Information Modelinga*: analiza na osnovi interesnih skupina

Iako znanstvena zajednica u osnovnim crtama prihvaća mogući doprinos Building Information Modelinga (BIM) radi postizanja održivog razvoja, stupanj provedbe još uvijek je vrlo mali. Većina istraživanja danas se usredotočuje na analizu prepreka i strategija za primjenu BIM-a i pritom se koristi kvantitativni pristup. U ovom radu određuju se ključne prepreke i odgovarajuće strategije za primjenu BIM-a, ali se pritom koristi kvalitativni pristup na osnovi ispitivanja interesnih skupina. Rezultati pokazuju da troškovi provedbe nisu ključna prepreka, te da su u tom smislu značajnije prepreke nedostatak znanja, osposobljenosti i svijesti o potrebi uvođenja BIM-a.

Ključne riječi:
Building Information Modeling (BIM), održivost, građevinarstvo, prepreke, strategije, interesna skupina

Wissenschaftlicher Originalbeitrag

Hafez Salleh, Wong Phui Fung

Anwendung der Gebäudedatenmodellierung: Fokusgruppendiskussion

Obwohl die Wissenschaftsgemeinde prinzipiell mögliche Beiträge der Gebäudedatenmodellierung (engl.: Building Information Modeling - BIM) zur nachhaltigen Entwicklung anerkennt, ist der Umsetzungsgrad noch sehr gering. Untersuchungen befassen sich derzeit hauptsächlich mit auf quantitativen Ansätzen beruhenden Analysen der Hindernisse und Strategien zur Anwendung der Gebäudedatenmodellierung. In dieser Arbeit werden die wichtigsten Hindernisse und entsprechenden Strategien qualitativ, durch Fokusgruppendiskussionen, analysiert. Die Resultate zeigen, dass die Durchführungskosten kein wesentliches Hindernis darstellen und das entscheidende Schwierigkeiten auf ein Mangel an Kenntnissen, Schulung und Bewusstsein des Bedarfs der Einführung von BIM zurückzuführen sind.

Schlüsselwörter:
Gebäudedatenmodellierung, Nachhaltigkeit, Bauwesen, Hindernisse, Strategien, Fokusgruppen

1. Introduction

The impact of the buildings and infrastructure on our environment has attained global attention. In the United States, buildings consume near to 40 % of all the annual energy used, and this country contributes with 40 % to the global carbon dioxide emissions [1]. In the UK, buildings account for close to 50 % of carbon dioxide emissions [2]. It has been revealed that the building construction industry contributes to green house gas emissions and energy consumption. The environmental impact brought by the construction of buildings has attracted many professionals in the industry to consider sustainable design for their building design projects. Nguyen et al. [3] point out that sustainable design has emerged in the construction industry to enable designing, constructing and operating facilities in such a manner to minimize environmental impacts. Sustainable design is defined as the design that "meets the needs of the present without compromising the ability of future generations to meet their own needs" [4]. It seeks to minimize the negative impacts on the environment through sustainable building design and construction.

Better monitoring of building performance in initial stages, supported with a significant amount of accurate information, is required to achieve sustainable design [5]. It is noteworthy that decisions regarding sustainability of design have to be made at early design stages [1, 6]. However, traditional building design methods, such as the conventional CAD practices, do not contain sufficient amount of information at the beginning stage to support early decision-making as needed for various sustainability analyses aimed at achieving a sustainable design. The application of the Building Information Modeling (BIM) allows decisions to be made at the early stages of design based on the rich information contained in a single coordinated model. Krygiel and Nies [7] point out that the BIM application can properly define several aspects of a sustainable design such as the building orientation, building massing, day lighting analysis, energy modeling, water harvesting, sustainable materials, and the site and logistics management. Various sustainability analyses, assessments, evaluations and calculations can be performed to improve air quality, thermal comfort and, ultimately, the overall energy usage, by linking the building model to energy-analysis tools. This cannot be done using traditional 2D tools [8, 9] as traditional methods require a great deal of human intervention, which makes the analyses time-consuming and more costly. By incorporating the BIM technology into a sustainable design, the traditional design practices can be changed and a greener building can be produced, with an improved performance due to design analysis and optimization [6, 8, 9] in the early stages of design work.

Various literature sources provide ample evidence that the application of BIM can improve building performance to achieve sustainable design [6, 8, 10, 11, 12]. Although the use of BIM can help in achieving sustainable designs, its adoption has been relatively limited in construction industry. Fischer and Kunz [13] state that the BIM adoption has been much slower than anticipated. Gu et al. [14] emphasize that the industry has been slow to adopt BIM in practice despite the rapid growth of its capabilities and the availability of BIM supporting technologies. Both authors have provided an insight to the slow implementation of BIM in construction industry. The present implementation of BIM is still burdened with many challenges that remain to be overcome. Construction industry operators have been slow to accept changes resulting from BIM due to certain barriers. The identification of the factors that characterise the biggest barriers to the implementation of BIM could accelerate the adoption of BIM, and help identify appropriate strategies. A limited number of empirical studies have been made on the barriers and strategies of BIM application through focus group discussions. Most of these studies employ quantitative questionnaire surveys. The aim of this study is to identify the barriers affecting the application of BIM in construction industry, and also to define strategies aimed at overcoming the barriers through focus group discussions in workshop, in order to present a more comprehensive picture of this issue.

2. Past research and limitations

BIM implementation is steadily gaining popularity in construction industry. This is evidenced by the growing number of research and studies made on the barriers and strategies of BIM application, as published in recent years in various countries. In Hong Kong, Tse at al. [15] conducted a survey in order to identify barriers that hinder practical implementation of BIM. Based on this survey, the major reasons for not adopting BIM are the lack of demand from the clients and other project team members, and also the notion that the current practice is satisfactory. Based on the survey results, the authors conclude that the adoption rate is still very low in Hong Kong, and that the CAD software is still preferred by industry professionals. After having identified the barriers, the authors present several strategies to address these obstacles in the Hong Kong's construction industry. Both and Kindsvater [16] made a questionnaire survey in Germany to investigate the barriers and constraints to BIM application. Before actual distribution of questionnaires, the authors grouped these barriers into four categories: technological issues such as software and hardware, general issues such as financial resources, normative issues such as standardization, and education issues. At the end of the survey, strategies which focus on the four identified categories were suggested in order to facilitate the adoption. Gerrard et al. [17] examined the barriers and strategies of BIM application in Australia by questionnaire survey and follow-up telephone interviews

with selected survey respondents. The survey revealed that the barriers were primarily the lack of BIM expertise, lack of awareness, resistance to change, interoperability, and legal issues. In order to increase the application of BIM, the authors suggested several strategies such as the stiumulation of the client's demand by showing BIM adoption results on trial research projects, in order to enhance understanding and boost confidence.

A survey forms were circulated to industry professionals during the Construct IT workshop in the UK by Arayici et al. [18] to examine the industry's readiness for the BIM implementation. The results showed that the barriers were the insufficient familiarity of companies with the usage of BIM, and the reluctance to initiate new workflows and train staff. Strategies aimed at eliminating these barriers were highlighted by various authors. Thus, McCartney and Kiroff [19] conducted interviews by using a questionnaire to explore factors affecting the BIM implementation in the Auckland's architecture, engineering and construction industries. They found out that the implementation cost and staff training were not the main issues that inhibit the BIM adoption, although these issues were listed most often in relevant literature. They established that the main obstacle preventing the BIM adoption is the change in the design and construction process. The BIM adoption requires a shift in the design and engineering work towards the front end of a project. This results in the change of fee structure to take into account the change that occurs in the process. For this reason, they recommended change in procurement method from the traditional to the integrated and collaborative, such as the design and build. Ku and Taiebat [20] also carried out a similar survey and found out that the learning curve, lack of skilled personnel, and the cost or lack of company investment, were perceived to contribute to barriers to the BIM application in the US. The authors pointed out that it is imperative to bridge the gap between the academic community and practice by including the BIM in the educational system, and teaching it to construction students. In Singapore, the Building and Construction Authority (BCA) has implemented a BIM roadmap with the goal of getting industry to use BIM widely by 2015 [21]. The Roadmap contains the challenges of BIM adoption, and relevant strategies aimed at facilitating its effective adoption.

Tables 1 and 2 summarize and tabulate previous research about the BIM application barriers and strategies in various countries. This is a worldwide overview of the barriers and strategies of BIM application across different countries. It is indispensable to interact with other countries to comprehend industry trends, investigate factors that have the biggest impact on BIM implementation, and analyze strategies implemented in different countries. Identifying the barriers and strategies given in literature would facilitate and accelerate adoption of BIM in construction industry. It also helps us to understand the BIM practices in different contexts. By comparing various findings about barriers and strategies in multiple countries, two important findings can be singled out. First, the majority of the findings show that the cost of implementation and the lack of training are the top barriers affecting the BIM application. The cost is always a concern as mentioned by several authors [22-25]. However, McCartney and Kiroff [19] argue that this is no longer a major barrier. There appears to be some ambiguity surrounding critical barriers to BIM implementation. The findings from the previous research may not reflect the current scenario as the BIM technology is growing progressively. It is necessary to identify current barriers to the BIM adoption, so that appropriate strategies can be proposed to relevant parties. Second, the majority of the authors [15-20] have conducted quantitative surveys to identify the barriers and strategies of BIM application in their respective countries. It can be noted that the quantitative data collection is a widely popular data collection method. However, quantitative surveys are limited by response rate. In addition, the researcher can never be certain if the respondent is indeed the person who actually responded to the questionnaire. There is also the risk that the respondents who answer the questionnaires may not be the appropriate respondents for the research. In this case, there is a risk that respondents are not knowledgeable about the BIM. Moreover, the respondents may not fully understand the issue, which is in such cases subject to the respondents' interpretation.

Therefore, the purpose of this study is to further investigate the abovementioned two findings by carrying out focus group discussions in the scope of a BIM workshop. Liamputtong [26] argues that the focus group method is a useful approach to explore the differences in the findings as to whether the cost of implementation is a major barrier of BIM application. Focus groups can be used to explore the differences and contradictions from different group members so as to shed more light on the issues [27, 28]. Focus group discussions also allow researchers to follow up on the comments, and to interactively cross-check with the participants in the workshop [26]. Therefore, focus group discussions are viewed as an appropriate method to achieve the purpose of this study. The focus group method is explained in greater detail in Section 3.

3. Research methodology

This study is divided into two phases: extensive literature review and focus group discussions in the scope of a BIM workshop. The study first focuses on literature data about barriers and strategies in construction industry all over the world. A number of barriers and strategies have been identified through review of worldwide literature on the BIM implementation, as presented in Table 1 and Table 2. Although the research on barriers and strategies related to BIM adoption is extensive, many of the studies employ

Table 1. Tabulation of barriers impeding BIM implementation in multiple countries

Countries / Barriers for BIM application	Hong Kong	Germany	Australia	New Zealand	UK	US	Singapore	Malaysia (Focus-group result)
Lack of training	✓		✓	✓	✓	✓	✓	✓
Lack of expertise/ technical support	✓		✓			✓	✓	✓
Cost of implementation	✓	✓		✓		✓		
Lack of vendor support	✓							✓
Lack of requirement/ demand from clients	✓			✓			✓	
Hardware upgrading		✓						
Interoperability issues		✓	✓			✓		
Standardisation		✓				✓		
Lack of education in universities		✓						
People and cultural issues			✓		✓			✓
Lack of empirical data supporting BIM adoption				✓				
BIM does not offer enough benefit compared to CAD / current practices are better	✓				✓		✓	✓
Legal aspects			✓			✓		

Table 2. Tabulation of strategies for enhancing BIM implementation in multiple countries

Countries / Strategies for enhancing BIM application	Hong Kong	Germany	Australia	New Zealand	UK	US	Singapore	Malaysia (Focus-group result)
Provide training	✓	✓	✓	✓	✓			✓
Required by client / Government support	✓		✓	✓		✓	✓	
Increase awareness and understanding of BIM	✓		✓	✓	✓	✓	✓	✓
Develop BIM guidelines	✓						✓	✓
Improve data exchange standards		✓	✓					
Provide education at university level		✓				✓	✓	✓
Reduce cost/ provide incentives			✓	✓			✓	
Change in procurement method				✓		✓		

the quantitative method. The qualitative data collection method is used in a limited number of studies only. Thus, to gain a more profound understanding about the BIM adoption barriers and strategies, the present study employs a qualitative approach in the second phase by conducting focus group discussions in a workshop. Focus groups are arranged for discussions on a specific topic. The aim is to gain an understanding of a specific issue through interpretations made by a select "focused" group of people, from their perspectives [26]. Participants in the workshop are therefore selected by choosing the ones that have some basic knowledge of the BIM technology, as suggested by Burrows and Kendall [29]. Thus, this approach constitutes a richer and a more detailed method for exploring diverse viewpoints of the participants having some BIM knowledge, allowing the researcher to reach fuller understanding of this topic. As the aim of the study is to identify current barriers that cause slow adoption of BIM, and to define appropriate solutions, it is believed that focus group discussions are the most suitable method for achieving this purpose. The focus group discussion has been chosen due to its nature which encourages rich discussion on specific topics among group participants aimed at identifying barriers and exploring solutions, which is considered to be better than the solutions reached from an individual's perspective only. Compared to questionnaire surveys conducted by other researchers in multiple countries, focus groups elicit a multiplicity of views and perspectives within a group, and gain a detailed and larger amount of information in a shorter period of time. The ability to gain access to such a diverse form of communication would have not been feasible if any other data collection method, such as the questionnaire surveys, one-to-one interviews, or case studies, were used [26].

In this particular case, participants were divided into seven groups with an average of seven participants per group. Each group consisted of participants from different backgrounds in order to encourage better interaction and richer discussion on a focused topic among participants from different professions. It gauged perceptions from a broad range of perspectives that are representative of opinions from various professional backgrounds. By doing this, barriers that are currently affecting the uptake of BIM were identified, and appropriate solutions were proposed by participants. A moderator was appointed for each group to act as the note-taker and to facilitate interaction between the participants. Before discussion, the moderator introduced the topic and provided clear explanations about the purpose of the discussion. Throughout the discussion, the moderator's role was to facilitate and guide the discussion to obtain accurate information. The barriers and strategies that had been gathered through literature were used as a template in the focus groups to ensure consistency of discussion. Each group discussed in detail every barrier and strategy listed in the template. The list of barriers and strategies guided the participants to form their own opinions. The discussion also allowed participants to express their view and perspectives for other barriers and strategies that were not listed in the templates. Extensive notes were taken by moderators during the focus group discussions. Focus group sessions lasted for approximately one hour. At the end of the discussion, the data were analyzed using the Krueger [30] and Ritchie & Spencer [31] framework analysis, and according to procedures described by Rabiee [32].

The framework analysis is defined as an analytical process that involves the following five key stages: familiarization; thematic framework identification; indexing; charting; mapping and interpretation [31]. As it provides a clear series of steps, this analytical method is recommended by Krueger [30] for the first-time researchers who have to manage large and complex qualitative data. The analysis began with data collection from moderators immediately after the focus group discussions. This stage was followed by familiarization with the data, by reading several times the notes taken during the discussion. The purpose of this was to grasp a general sense of the ideas and to formulate major themes. The next stage was to identify a thematic framework by writing short phrases, ideas or concepts arising from the texts in the margin of the text to develop categories [32]. The indexing and charting was conducted to filter and reduce the data by comparing and contrasting, cutting and pasting similar quotes together. The final stage of analysis, the data mapping and interpretation, was aimed at establishing the relationship and links between the data as a whole to obtain a complete overview for each barrier and strategy. At the end of the data analysis, the results were discussed with moderators to confirm their validity, and to ensure that no items were left out. The findings are reported in the next section of the study.

4. Research findings and discussions

4.1. Workshop participant profile

Workshops participants were representatives from various sectors including construction consultants (architects, engineers, and quantity surveyors), construction contractors, academicians and delegates from government agencies. A total of 47 participants attended the workshop. Most participants, i.e. 30 % of all participants, were construction consultants such as architects, engineers and quantity surveyors. They are followed by academicians (26 %) who are actively involved in promoting the BIM application both in the construction industry and in the educational system. 23 % of participants were construction contractors, 17 % came from Government agencies, and 4 % from professional associations. It should be noted that more than 50 % of participants came from construction sector, and were familiar with the BIM application. It can be concluded that

the majority of participants were from various fields of construction industry. Moreover, the participants were from different professional areas, which encouraged a wider range of responses. Therefore, the responses gained during the discussion are reliable, and provide information of high value for this study.

4.2. Barriers to BIM implementation

Barriers that impede the BIM implementation were discussed by industry professionals in the scope of the BIM workshop. Most participants in the workshop consider that the lack of expertise is a major and critical barrier to BIM implementation. There is a strong lack of BIM experts in the construction industry, especially those who would be able to handle and operate BIM technology and workflow. The application of BIM is not a straightforward implementation process that would merely be limited to the purchase and installation of the new BIM software into the working environment. It requires changes in organization workflow, practices, skills, roles, information technology (IT) infrastructure, and other aspects. Unfortunately, there is a limited number of trained experts that can provide consultancy in terms of computer hardware and software, and also be suitable for the organization of workflow and for setting appropriate requirements. Moreover, the implementation assistance, technical support, and user training, are also inadequately provided by the BIM implementation experts. Without proper assistance and consultation from the BIM experts, the effective BIM implementation would be impaired, and the organizational performance would be affected. A number of participants pointed out that the vendors may have a better understanding of their BIM products, but are not equally familiar with the construction management practices. They also raised complaints that the vendors do not provide adequate support in BIM implementation, especially once the BIM tool has been purchased. It is suggested that the relevant technical support by the vendors should not be limited to the implementation only, but should be extended to include an appropriate after sales service and support. An adequate and continuous technical support is highly correlated with the user satisfaction and confidence. Participants emphasize that provision of BIM experts that have expertise on BIM software, organizational practices, and workflow, is an important factor that can contribute to the effective BIM implementation. Hence, BIM experts are required to provide proper consultancy on the following three aspects: people, process and technology.

According to workshop participants, the next barrier that inhibits the BIM adoption is the lack of awareness. In this respect, some of the participants consider that the industry players are aware of BIM but lack the necessary understanding. The lack of concrete understanding across the construction industry affects the ability of industry players to embrace the BIM. Workshop participants mentioned that the majority of industry professionals mistakenly consider that the application of BIM calls for a very costly investment, which would be difficult to recuperate. This is due to the lack of a true perception about the return on investment (ROI) for BIM implementation. In addition, some industry professionals are under the misconception that their expertise and professionals would be replaced by the BIM. Misconceptions about the BIM hinder industry professional from embracing it. It was revealed that industry players have misunderstood the BIM concept and potential benefits the BIM would bring to their organization and the construction industry as a whole. As a result, the industry fails to embrace the true potentials of BIM. Workshop participants also raised concerns on the lack of training as a barrier to the BIM application. Most of the workshop participants agreed that the BIM adoption generates a steep learning curve. In fact, an appropriate time and cost is needed to enable familiarisation with the new workflow, which can be totally different from traditional methods. Most of the industry professionals are reluctant to implement the BIM simply because they are already familiar and comfortable with the existing working practices. Lack of proper skills to handle the BIM technology and extract information from the model has also inhibited the interest of industry professionals towards BIM adoption. On the other hand, the majority of workshop participants also consider that the cost of implementation is not a critical issue that would discourage BIM adoption. This finding is in contradiction with the data provided by previous authors who argue, based on quantitative surveys, that the cost factor is a major barrier to BIM adoption. Results presented in this study show that presently the cost of implementation is not the main barrier inhibiting the BIM application. In fact, high cost of implementation was the major barrier when BIM was first introduced to the construction industry as there was a big concern about the total cost of migrating to the BIM technology, mainly due to high initial investment in the hardware, software, and training. However, industry professionals have gradually started to show interest in the BIM implementation. The problem that worried them is not cost but rather the lack of reference for seeking consultation. The results from the workshop focus group discussions offer a more profound understanding of actual barriers, when compared to previous findings. The results help us to avoid the risk of spending resources on rectification of irrelevant barriers. This provides a clear direction to government agencies, professional associations, top management officials, and relevant stakeholders, to identify and formulate relevant strategies. By considering the critical barriers identified in this study, relevant parties will not only be able to formulate suitable strategies for speedier adoption, but would also be able to meet the industry professionals' needs and requirements. Eventually, this will lead to formulation of strategies enhancing effective adoption of BIM. The barriers

impeding BIM implementation in Malaysia, identified during focus group discussions, are shown in Table 1.

4.3. BIM implementation strategies

As highlighted by workshop participants, there is currently a pressing need to improve awareness and understanding of BIM. The concepts, potentials, benefits and capabilities of BIM have to be promoted and explained properly to increase awareness of parties concerned. For instance, the BIM implementation requires an up-front investment. However, an effective implementation does enable organizations to achieve their long-term productivity goals and maximize return on investment, compared to traditional working methods. It is crucial to highlight the benefits which outweigh by far the up-front investment needed for BIM application. The majority of workshop participants maintain that seminars, conferences and workshops on BIM implementation should be conducted regularly to disseminate knowledge about BIM throughout the industry. By doing this, the level of understanding and acceptance would be increased.

Moreover, industry stakeholders have to be informed about the skills needed, the changes that have to take place, and about the way to deal with such changes to enable BIM application. According to workshop participants, the provision of proper training sessions for staff is important to cope with slow adoption of BIM. The implementation of BIM does not only involve purchase and installation of new software. It also causes significant changes in working processes and practices, from improvement of individual skills to a greater need for collaboration. The construction industry stakeholders have been slow to accept the BIM because many of them are unsure about how to respond to the changes resulting from BIM adoption. Construction stakeholders who are not familiar with BIM tend to default back to traditional working methods. Without a proper approach to dealing with these changes, the implementation is bound to be ineffective. Therefore, proper training is essential to ensure that the construction operators can use the BIM software, and understand the new workflow requirements. The workshop participants suggest that training schemes should be provided and targeted at different groups such as new employees, senior managers, and directors.

As the adoption of BIM incurs a change in the working processes, the roles of the staff will also change in the sense that the staff will be required to acquire a set of new skills. Therefore, this adoption will definitely cause a passing feeling of anxiety in the organization. The resistance of staff to the change, and the anxiety of being replaced by the BIM, has to be alleviated and properly explained. The industry operators should change the mistaken notion that BIM is a replacement to professional expertise. In fact, the BIM is a tool to enhance the job performance and to take away tedious tasks but not the main role of the company's professionals. By increasing the understanding through seminars and training programs, the staff would use BIM more comfortably and confidently. This would lead to an increased adoption of BIM. Workshop participants confirm that having training and awareness programs is critical to the BIM application. It will have a positive influence on the behaviour of industry stakeholders. One of workshop participants pointed out that a high rate of staff turnover may be expected once they have acquired new skills during the BIM training. As the construction industry is lacking experts in BIM application, the staff possessing this valuable expertise will become a valuable asset to the competitors in construction practice. It is difficult to retain staff with the BIM knowledge due to scarcity of BIM experts. Hence, he suggested that the BIM teaching within higher education communities is vital for overcoming this problem. In addition, the majority of participants also agreed that higher-education institutions should start teaching BIM courses within the syllabus for undergraduate students. By introducing BIM into the curriculum, undergraduates will attain sufficient BIM knowledge and skills before entering the construction industry. This will lessen the burden imposed on organizations to provide additional training for fresh graduates.

Although the cost of implementation is not the major obstacle preventing the BIM adoption, participants hope the government will provide more incentives and monetary support to industry professionals in order to lessen the burden, especially to small and medium enterprises (SMEs). SMEs are being dominated in the industry by larger stakeholders, and they need support from government to adopt the BIM in their organizations. The implementation of BIM calls for adequate funding. In this case, the Construction Industry Development Board (CIDB) Malaysia has recently launched a program named the BIM Portal and Information Exchange Platform for Affordable BIM, which is aimed at helping and lessening the burden borne mostly by SMEs with regard to BIM adoption. The portal developed by CIDB allows industry professionals to purchase the necessary BIM software, training program, and consultancy service, at an affordable price. The BIM portal developed by CIDB was launched at the end of 2013. BIM implementation strategies in Malaysia, which resulted from focus group discussions, are shown in Table 2.

Workshop participants also maintain that the government's enforcement is not a good initial strategy to enhance the BIM adoption in construction industry. The majority of participants point out that the government actually needs to make the BIM adoption mandatory but that such a step should not be the first step in the process. They explain that forcing industry professionals without educating them properly will lead to negative impacts. The government should consider the willingness of industry stakeholders to accept the changes, while managing the training and

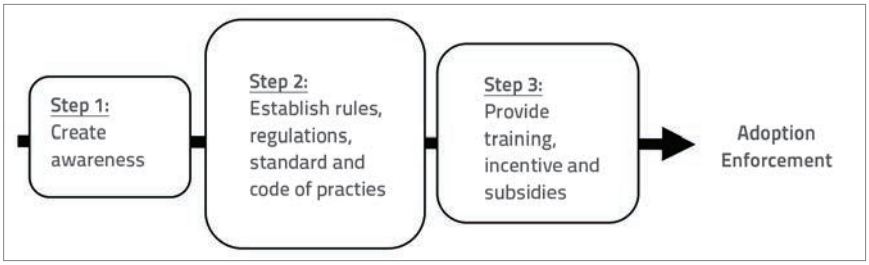


Figure 1. Steps in enhancing BIM adoption

awareness programs. The application of BIM is not an easy process and it takes time for industry professionals to get comfortable with this new technology. Steps for enhancing BIM adoption were identified after the analysis of workshop results, as shown in Figure 1. It is suggested that these three fundamental aspects must be taken into account for BIM implementation, before the BIM use is enforced by the government. Firstly, proper awareness should be instilled in the construction industry to gain better understanding and confidence. This initial step is crucial and it requires a great degree of commitment from government, professional institutions and associations to raise awareness about BIM application and its benefits. Secondly, the government, professional associations and relevant parties should establish and formulate appropriate standards, rules, and regulations for BIM implementation. By having guidelines and framework as a reference, the process will be standardised and disputes will be avoided. Thirdly, training should be provided for industry professionals, and incentives and subsidies should be given for upgrading hardware and purchasing the IT infrastructure such as the BIM software. As the industry players' understanding of the potential and capabilities of BIM increases, a rapid growth in BIM application may reasonably be expected. It is believed that the proposed three steps can enhance an efficient adoption of BIM and that, in this respect, it would first be necessary to gain confidence and understanding among industry professionals, before the government makes the BIM use mandatory.

5. Conclusion

The sustainability of design practices has been gaining attention in construction industry. The BIM helps to achieve sustainability in design work by keeping relevant information in a single coordinated model which allows the conduct of various sustainability assessments at the early stages. However, the level of BIM implementation in construction industry is still considered low. In an attempt to understand the reasons for the poor adoption of BIM, some researchers have investigated the obstacles in their own countries, as well as solutions to eliminate key barriers through quantitative research methodology involving questionnaire-based surveys. Findings from previous questionnaire surveys show that the cost of implementation has a profound effect on the BIM adoption. It should be noted that the questionnaire-based surveys have their limitations which can be overcome by using a qualitative approach such as the focus group discussion. Moreover, the BIM implementation is considered to be a novelty unknown to many industry professionals. The focus group discussion encourages interaction and rich discussion among participants that have some knowledge on a specific topic. Therefore, this study employed the focus group discussion in workshop in order to identify barriers to the BIM implementation and propose appropriate strategies. This study also provides a literature review from multiple countries, which was used to form a list of barriers and strategies for BIM implementation. The list of barriers and strategies was adopted as basis for focus group discussions to ensure consistency of discussion.

According to quantitative results, the cost of implementation is a critical barrier and major concern with regard to BIM application. However, the results of focus group discussions conducted in workshop reveal that the cost of implementation is not a major barrier that inhibits BIM application. This differs from previous findings based on questionnaire surveys. The findings made in the scope of focus group discussions show that the following barriers contribute to low adoption of BIM: lack of expertise, training, and poor awareness. The lack of expertise is affecting the widespread use of BIM more than the cost of implementation. BIM experts need to provide consultation services not only about the BIM knowledge but also about a suitable workflow, in order to enable successful adoption of BIM. These qualitative findings reveal that BIM experts should be required to provide consultancy services on the following three aspects; people, process and technology, as this would enhance BIM adoption effectively. Previous authors (Fisher and Kunz and also Gu with associates) argue that slow adoption of BIM in construction industry is due to certain barriers. Present findings based on focus group discussions are useful to construction industry as they reflect relevant barriers to BIM adoption. By identifying these barriers, appropriate strategies can be formulated which will ultimately lead to speedier adoption of BIM.

On the other hand, workshop participants suggest several strategies to eliminate barriers to BIM application. New technologies are resisted at the very beginning, because they call for implementation of processes and workflow changes entailing risks and unforeseen challenges. These hindrances can be reduced by conducting awareness programme through training sessions, seminars and conferences. This is the first key strategy and a vital component in the effective adoption of BIM. Secondly, the government, professional institutions and associations should develop appropriate

guidelines and frameworks for BIM application to ensure standardization. Next, training and monetary incentives are an effective means to improve BIM implementation. These three sequential steps -strategies have been proposed to enhance BIM adoption, prior to the government's enforcement of BIM implementation.

Acknowledgements

This study is supported by the research grant from the Research Cluster Sustainability Science at the University of Malaya, Kuala Lumpur, Malaysia, through Project no. RG154-12SUS.

REFERENCES

[1] Schlueter, A., Thesseling, F.: Building information model based energy/exergy performance assessment in early design stages, Automation in Construction,18 (2), pp. 153-163, 2009.

[2] Department of Communities and Local Government, Building a greener future: policy statement, 2007.

[3] Nguyen, T. H., Shehab, T., Gao, Z.: Evaluating sustainability of architectural designs using building information modelling, The Open Construction and Building Technology Journal, 4 (1): pp. 1-8, 2010.

[4] World Commission on Environment and Development, The Brundtland report: Our common future. Oxford: Oxford University Press, 1987.

[5] Motawa, I., Carter, K.: Sustainable BIM-based Evaluation of Buildings, Procedia-Social and Behavioral Sciences, 74, pp. 116-125, 2013.

[6] Azhar, S., Brown, J., Sattineni, A.: A case study of building performance analyses using building information modelling, in: Proceedings of the 27th International Symposium on Automation and Robotics in Construction (ISARC-27), Bratislava, Slovakia, 2010.

[7] Krygiel, E., Nies, B.: Green BIM. Indianapolis: Wiley Publishing, IN., 2008.

[8] Azhar, S., Brown, J.: BIM for sustainability analyses. International Journal of Construction Education and Research, 5 (4), pp. 276-292, 2009.

[9] Azhar, S., Brown, J., Farooqui, R.: BIM-based sustainability analysis: An evaluation of building performance analysis software, in: Proceedings of the 45th ASC Annual Conference, Gainesville, Florida, 2009.

[10] Autodesk White Paper, Building information modelling for sustainable design, 2005, http://www.synergis.com/uploads/resources/bim_for_sustainable_design.pdf (12.6.2012).

[11] Azhar, A., Carlton, W. A., Olsen, D., Ahmad, I.: Building information modeling for sustainable design and LEED® rating analysis, Automation in construction, 20 (2): pp. 217-224, 2011.

[12] Middlebrooks, R. E.: Realizing the Future of Sustainable Design through BIM and Analysis: Autodesk document, 2005.

[13] Fischer, M., Kunz, J.: The scope and role of informatation technology in construction, 2006, http://wwwleland.stanford.edu/group/CIFE/online.publications/TR156.pdf (24.06.2012).

[14] Gu, N., Singh, V., London, K., Bankovic, L., Taylor, C.: Building information modelling: what is in there for the architects?, 42nd Annual Conference of the Australian and New Zealand Architectural Science Association. Newcastle, ANZAScA, pp. 33-40, 2008.

[15] Tse, T.K., Wong, K.A., Wong, K.F.: The utilisation of building information models in Nd modelling: A study of data interfacing and adoption barriers, Journal of Information Technology in Construction, 10, pp. 85-110, 2005.

[16] Both, P.v., Kindsvater, A.: Potentials and Barriers for Implementing BIM in the German AEC Market: Results of a Current Market Analysis, Digital Physicality, in: Proceedings of the 30th eCAADe Conference - Volume 2, Czech Technical University, Prague, 2012.

[17] Gerrard, A., Zuo, J., Zillante, G., Skitmore, M.: Building information modelling in the Australian Architecture Engineering and Construction Industry, Handbook of research on building information modelling and construction informatics: concepts and technologies, (eds.: Underwood, J., Isikgad, U.), Hershey, PA: Information Science Reference, pp. 521-545, 2010.

[18] Arayici, Y., Khorowshahi, F., Marshall-Ponting, A., Mihindu, S.: Towards implementation of Building Information Modelling in the construction industry, Construction in the 21st Century Collaboration and Integration in Engineering, Management and Technology (CITC-V), Miami, Florida, USA, 2009.

[19] McCartney, C., Kiroff, L.: Factors affecting the uptake of building information modelling (BIM) in the Auckland architecture, engineering & construction (AEC) industry, in: Proceedings of the CIB W078 & W102 2011 Joint Conference, Sophia Antipolis, France, 2010.

[20] Ku, K., Taiebat, M.: BIM experiences and expectations: The constructors' perspective, International Journal of Construction Education and Research, 7 (3), pp. 175-197, 2011.

[21] Das, J., Leong, E.L., Lee, P., Tan, C.K.: The BIM Issue', Building Smart, 2011 http://www.bca.gov.sg/publications/BuildSmart/others/buildsmart_11issue9.pdf (16.07.2012).

[22] Eastman, C., Teicholz, P., Sacks, R., Liston, K.: BIM Handbook: A Guide to Building Information Modelling for Owner, Managers, Designers, Engineers, and Contractors, Wiley, Hoboken, NJ, 2008.

[23] Holness, G.: Future Direction of the Design and Construction Industry: Building Information Modelling, ASHARAE Journal, 48 (8): pp. 38-46, 2006.

[24] Kassem, M., Brogden, T., Dawood, N.: BIM and 4D planning: a holistic study of the barriers and drivers to widespread adoption, KICEM Journal of Construction Engineering and Project Management, 2 (4), pp. 1-10, 2012.

[25] Shen, L., Chua, D.K.H.: Application of Building Information Modelling (BIM) and Information Technology (IT) for Project Collaboration, EPPM, Singapore, 2011.

[26] Liamputtong P.: Focus group methodology: Principle and practice, Sage Publications, 2011.

[27] Bennett, K.: Interviews and focus group. In P. Shurmer-Smith (Ed.), Doing cultural geography. London: Sage, 2002.

[28] Hydén, L. C., Bülow, P. H.: Who's talking: drawing conclusions from focus groups - some methodological considerations. International Journal of Social Research Methodology, 6 (4): pp. 305-321, 2003.

[29] Burrows, D., Kendall, S.: Focus groups: What are they and how can they be used in nursing and health care research? Social Sciences in Health, 3: pp. 244-253, 1997.

[30] Krueger, R.A.: Focus Groups: A Practical Guide for Applied Research. Thousand Oaks, CA: Sage Publications. 1994.

[31] Ritchie, J., Spencer, L.: Qualitative data analysis for applied policy research, (eds.: Bryman, A., Burgess, R.G.), Analysing Qualitative Data London: Routledge, pp. 173-194, 1994.

[31] Rabiee, F.: Focus-group interview and data analysis, Proceedings of the nutrition society, 63 (4), pp. 655-660, 2004.