

EXPLORING THE ADOPTION OF BUILDING INFORMATION MODELLING (BIM) IN THE MALAYSIAN CONSTRUCTION INDUSTRY: A QUALITATIVE APPROACH

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Abstract

The construction industry believes that Building Information Modelling (BIM) is a platform that has the potential to promote collaborative activities in the construction industry. Thus, clients are gradually enforcing the use of BIM in their projects, resulting in many construction companies investing in BIM technology in order to fulfill clients' needs. Therefore, the goal of this study is to explore the process and the level of BIM implementation in the Malaysian construction industry. This study was conducted as an exploratory study through literature review and interviewing the organisations that have had BIM experience. The result reveals that Malaysian construction industry players are having difficulties to implement BIM because they do not know where, when and how to start as there is no national BIM standard and guideline for them to follow. Lack of government involvement worsens the current situation besides having the resistance to change from people. To reduce the resistance from people, most of the companies came out with their own strategy such as developing new BIM unit, developing training and education program, changing management style and developing new roles and responsibilities. These activities could facilitate people and the organisations in adopting BIM because BIM is not only a technology but it is also involved in changing the current practices and processes including changing managerial function and hierarchy, including roles and responsibilities. Small to medium scale pilot projects can be described as the best practice to adopt BIM in reducing the risk when migrating from the traditional approach to a new approach. This study also identified that BIM Level in the Malaysian construction industry is between Level 0 and 1.

Index Terms: Building Information Modelling (BIM), Malaysian Construction Industry, Government Roles, National BIM Standard, Training and Education, Change Management.

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1. INTRODUCTION

Today, construction industry in Malaysia is facing huge challenges from the communities to increase their productivity, quality and value. This is because, the construction industry in Malaysia has been seen as the most problematic industry such as cost overrun, delay, the production of low quality product, intensive labour as well as still using old technology [1] and [2]. These issues happen because in the construction industry, the process of construction is complex and involves many parties. Information exchanged among them mostly involves a lot of documents and drawings. This practice creates errors because of the large quantity of documents and drawings as they are mostly in paper-based format that are not properly managed which results in miscommunication among them [3]. Having wrong information in the construction process could hinder the productivity of projects because in a construction project,

information is perhaps the most important construction "material". Therefore, there is the need for managing the information properly to ensure all parties in the construction projects receive the right information and the utilisation of Building Information Modelling (BIM) is one of the platforms to meet this objective [4] and [5]. In 2009, about 50% of construction players in North America have implemented BIM in their construction projects and will use it for their next projects whereas about 20% of non-user intended to adopt it within two years' time [6]. This figure shows that they have benefited from the utilisation of BIM and believe that BIM is able to enhance the construction process. However, in Malaysia, there is very few evidence to show the percentage of construction players implementing BIM in their construction projects. Therefore, this paper aims to identify the status of BIM use by the Malaysian construction players, how they

implement it and in addition, the factors that support and hinder the implementation of BIM.

2. BUILDING INFORMATION MODELLING (BIM) ADOPTION

Although many benefits can be gained by the implementation of BIM such as increasing constructability, reducing conflict and requesting for information due to having a good visualisation approach, reducing the time for cost estimation and increasing smooth coordination and information among parties in the construction projects, the pace of adoption of BIM is still slow [7]; [8]; [9] and [10]. This happens because the majority of construction industry players see BIM as ‘disruptive technology’ that causes problems in the current construction process by transforming it into a new process according to Eastman et al., [11]. Therefore, the adoption of BIM is facing huge challenges from the construction industry players because they are reluctant to change the established traditional process. Challenges in adopting BIM can be classified into two categories which are non-technical and technical.

Basically, non-technical challenges are related to human being and organisational culture and according to Arayici et al., [12], these challenges include managing the resistance to change from people, making them understand how BIM offer them more benefits compared to 2D drafting, managing education and training people in BIM and explaining new roles and responsibilities of different stakeholders in BIM. As for technical issue, the most prominent issues arose are upgrading the technology, interoperability, compatibility and complexity [13]. Although technology plays a vital role in implementing BIM and could bring benefits to the organisations, the process of selecting the technology is vital to ensure its support to the organisation’s business goals. However, the challenges in technical aspect may occur to certain organisations based on their size, because not all organisations can afford to invest in new technology especially for small-medium enterprise compared to larger organisations [14]. Therefore, to adopt BIM, organisations should realise that they are required in changing the way of their current working process, changing in staffing needs and organisation, and changing in how a project organisation uses information [14]. They also have to change the managerial function and hierarchy, including roles and responsibilities and identify the key capabilities and skill of the individuals and organisation [15].

2.1 Current Building Information Modelling (BIM)

Adoption in Construction Industry

i) Building Information Modelling (BIM) in Singapore

Singapore has started promoting the implementation of BIM since 1997 by the introduction of e-PlanCheck for the submission of building plan for approval [16]. In 1995, the Ministry of National Development intended to transform the construction industry in Singapore through Information Technology (IT), and to achieve this idea CORENET (CONstruction and Real Estate NETwork) formed Cornet. CORENET has full support from the government through the Building and Construction Authority (BSA) and aims that by 2015; about 80% of the construction industry players in Singapore will use BIM in construction projects [17]. The BIM guide for the construction industry in Singapore was released in May 2011 and can be downloaded at CORENET website. By having a national guideline, it eases the implementation of BIM in Singapore. CORENET and BSA were having difficulties to shift the paradigm from the traditional approach to the innovation approach and they developed their own strategy on how to speed up the adoption of BIM in Singapore as shown in Fig-1.

Table-1: The BIM Strategies by BCA [17]

CHALLENGES FACED BY FIRMS DURING BIM ADOPTION	BCA STRATEGIES
1. Lack of demand for BIM	<ul style="list-style-type: none"> • To allow the Public Sector to take a lead, BCA: <ul style="list-style-type: none"> ➢ Collaborate with government procurement entities (GPEs) to request the use of BIM for their projects from 2012. ➢ Worked with GPEs and their industry partners in preparation for new requirements. • To Promote success stories, BCA: <ul style="list-style-type: none"> ➢ Established the Centre for Construction IT (CCIT) to promote BIM and guide businesses and professionals in the industry. ➢ Conducts seminars, workshops and conferences on the use of BIM for the industry to promote the benefits of the technology.
2. Steep learning curve to build	<ul style="list-style-type: none"> • To build BIM capability and capacity, BCA:

<p>up BIM expertise</p>	<ul style="list-style-type: none"> ➤ Launched short courses and the specialist diploma in BIM at BCA’s training arm, the BCA Academy. ➤ Engaged various tertiary institutions to include BIM training in their curricula. ➤ Provides “chaperon” services to businesses who need assistance in their first BIM project implementation and regulatory submission.
<p>3. Entrenched in current 2D drafting practices</p>	<ul style="list-style-type: none"> • To remove impediments, BCA: <ul style="list-style-type: none"> ➤ Develop a set of submission templates and guidelines to help professionals understand the new process of regulatory submission using BIM. ➤ Works with GPEs, professional bodies and buildingSMART Singapore to develop project collaboration guideline and an object library standard.
<p>4. Lack of ready pool of skilled BIM manpower</p>	<ul style="list-style-type: none"> • To incentivise BIM adopters, BCA: <ul style="list-style-type: none"> ➤ Introduce the BIM Fund, which covers the costs for training, consultancy services and purchase of hardware and software for businesses and projects. (<i>part of the Construction and Capability Fund (CPCF) for BIM adoption</i>)

Table-2: The BIM Strategies in the United Kingdom [18]

<p>Issues in Adopting BIM</p>	<p>Strategies</p>
<p>1. Lack of knowledge on how to implement BIM</p>	<ol style="list-style-type: none"> 1. Government – Industry Delivery Team will be formed to assist all Government Departments to develop their own BIM adoption strategies in order to meet the Government’s BIM mandate. The progress of these strategies is reported back to the Government Construction Board. 2. Under Government – Industry Delivery Team, a specific working group will be formed to study and establish work process and procedures to ensure the construction industry has a smooth transition in adopting BIM. 3. Forms ‘Regional BIM Hubs’ to enable SME and smaller clients to get advice from local networks. 4. British Standard Institute (BSI) will work with this team to develop a BIM standard including BS 1192-2 and PAS 91.
<p>2. Lack of Technical Skill</p>	<ol style="list-style-type: none"> 1. Develops a core set of skills and training requirements. 2. A ‘2050 Group’ will be developed to motivate and capture the technical expertise of the young generation within the construction industry. 3. Teams up with a number of professional and trade bodies to ensure that BIM can be embraced by all communities within the construction sector, especially SMEs.
<p>3. Managing Risk</p>	<ol style="list-style-type: none"> 1. Incorporated Government Soft Landings into the BIM Programme. 2. Works with private sector clients to ensure that the benefits of BIM are shared among parties such as giving some incentives.

ii) Building Information Modelling (BIM) in the United Kingdom (UK)

The UK government will require fully collaborative 3D BIM (with all projects and asset information, documentation and data being electronic) as the minimum requirement by 2016 and a staged plan will be published with mandated milestones showing measurable progress at the end of each year [18]. To ease the adoption of BIM, the Construction Industry Council (CIC) is at the forefront in developing the best practice guidance for BIM adoption and it is being disseminated throughout the industry. Besides that, the UK government is having the help from BuildingSMART to improve the adoption processes especially in data sharing. Although the UK government fully supports the adoption of BIM in their construction projects, the private sectors are also playing their roles by forming a group named BIM Industry Working Group and in March 2011 a Strategy Paper for Government Construction Client Group was published [18]. Some of the strategies in the implementation of BIM in the UK are as shown in Table-2.

In summary, these two countries are enjoying the strong support from their governments to adopt BIM. Their governments recognise the benefits of BIM and try to encourage private sectors to implement BIM in their projects.

The private sectors play their role by discussing with the government to develop national BIM standard and guideline through various working group discussions. In order to promote the use of BIM, the government and the private sectors formed several working groups with specific tasks such as organising seminar to create awareness to the industry players, conducting seminar and colloquium, and developing training module and developing BIM guidelines.

3. METHODOLOGY

The objectives of this study are to identify and understand the Building Information Modelling (BIM) implementation process including the working environments that support or hinder the effectiveness of BIM by focusing on the BIM users’ experience. At the same time, the level of BIM implementation by Malaysian construction industry can be identified. To achieve these objectives, an exploratory study was conducted by using semi-structured interview with practitioners who are experienced in using BIM. The interview consisted of 25 semi-structured questions which were designed to allow respondents to express their opinion and experience freely during the interview session. The duration of the interview session was about 45 – 60 minutes. The questions for the interview were developed based on the previous literature and focused on the themes generated by the pervious literature namely; Organisation Culture, People, Technology and Government Recognition.

Through the database from Construction Industry Development Board (CIDB) and Construction Research Institute of Malaysia (CREAM), the researchers have identified five companies that have experienced the implementation of BIM in their construction projects. Letters of invitation were sent to the five companies to participate in this study, but only three out of the five companies replied and agreed to participate in this study. They gave their consent for taping the conversation during the interview session. In order to maintain confidentiality, Chell [19] urged that all respondents’ profile must be omitted during report writing and each respondent was assigned a code e.g.: INTCA1. Respondents for the interview in this study were from the middle and top management level as Smith & Tardif [20] asserted that these levels of management have the mandate on whether or not to implement BIM in their organisations. Table-3 shows the respondents' profile.

Table-3: Respondents’ profile

Company A (CA)			
Respondents	INTCA1	INTCA2	INTCA3
Years of Experience	18	8	4
Position	Top	Middle	Middle
Company B (CB)			

Respondents	INTCB1	INTCB2	INTCB3
Years of Experience	12	7	5
Position	Top	Middle	Middle
Company C (CC)			
Respondents	INTCC1	INTCC2	
Years of Experience	6	4	
Position	Middle	Middle	

In qualitative research, most of the questions arise to ensuring the credibility of the data is number of sampling. According to Margarete [21], to determine the adequate sample size is relative, some study is enough having a sample size of five and some study needs more than five in the sample besides their research philosophy. Although the number of interviews is eight, the researchers believe they are adequate because they meet the amount of sample suggested by Creswell [22]. Creswell [22] recommended the number of interviews between five and twenty-five interviews for a phenomenology study where in this study, it reflects the activities of the researcher to understand the different roles of human as social actors and to understand about their world based on their experiences. Besides that, BIM is seemly new in the Malaysian construction industry and not many companies have implemented BIM in their construction projects and it’s hard to get more than five companies that have been implementing BIM. In addition, Yin [23] explained that qualitative study is more on focusing toward analytic generalisation rather than statistical generalisation.

3.1 Method of Data Analysis

In qualitative approach, it is a huge challenge for the researchers to interpret the data as per claimed by Patton [24], “The challenges in analysing qualitative data is to make sense of massive amounts of data, reduce the volume of information, identify significant patterns, and construct a framework for communicating the essence of what the data reveals.” This is because data for qualitative mainly consist of words, which can have several meanings and could lead into wrong interpretation. Therefore, Miles & Huberman [25]; Strauss & Corbin [26] and Patton [24] suggested that content analysis as one of the methods to analyse qualitative data by identifying the quotes, coding the quotes, and categorising the code and lastly mapping approach being used to find the relationship between the different categories. Thus, in this study Content Analysis was being used to analyse the data gathered from the interview session.

4. FINDING AND DISCUSSION

As discussed in the Methodology section, interviews with the practitioners focused on four themes; I) Organisational Culture, II) People, III) Technology and IV) Government

Recognition as well as how these themes could be major factors to ensure the success of the implementation of BIM in the Malaysian construction industry. Out of the five invitations to participate, only three companies were willing to participate in this research. These three companies are identified as Company A (CA), Company B (CB) and Company C (CC). Table-4 shows the general background of these companies. CA is a developer and has implemented Building Information Modelling (BIM) since 2010 while CB is a project management consultant which has started using BIM since 2008 and its first project using BIM was designing oil and gas project platform. CC is a developer company and has started using BIM since three to four years ago and the main objectives are to quantity taking off and design coordination for contractors.

Table-4: Summary of general information for each company

Company	Type of Company	BIM Experience
CA	Developer	3 years
CB	Project Management Consultant	5 years
CC	Developer	3-4 years

From the information gathered from the interview session, the concept of BIM implementation by CA, CB and CC has been developed as shown in Fig-1.

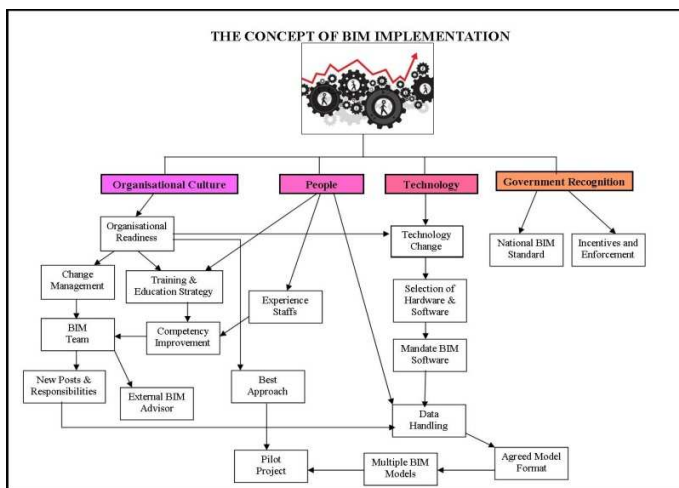


Fig-1: The concept of BIM implementation from the interviewees

4.1 Organisational Culture

Although there are many evidence of the benefits that could be gained by the Malaysian construction industry by implementing BIM via literature and case studies conducted by developed countries, the implementation of BIM in

Malaysia is still low and stagnant. One of the reasons is the low level of knowledge about BIM and the majority of respondents believe that the majority of construction players in Malaysia do not know how, when and what to start. This happens because there is no standard for BIM implementation guideline at the national level for them to follow. In Malaysia, many of the boards or organisations are trying to be a BIM champion by developing their own version of BIM implementation guideline; however, all these versions resulted in confusion among construction players.

[...] One of the issues in implementing BIM in Malaysia is the national BIM implementation guideline does not exist, because everybody in Malaysia develops their own guideline without proper guideline from the expert, even for definition of Level of Development / Details (LOD) is varied from one organisation to another organisation. Because BIM in Malaysia still in infant stage so there is urgency to set up a committee or team that recognised by the government to control and to produce the national BIM implementation guideline [...] Interviewee INTCC1

In addition, they still doubt the effectiveness of BIM because of the limited data that has proven the effectiveness of BIM in the Malaysian context. Many case studies show the benefits that could be gained by implementing BIM are not in Malaysia, and they might feel that BIM is not suitable for the environment of the Malaysian construction industry. They were referring to the failure of fully implementing Industrial Building System (IBS) in the Malaysian construction industry, although the government fully supports and encourages this approach. This situation happens according to Fox & Hietanen [13] because of lack of BIM knowledge and lack of highly skilled staff that are able to handle BIM technology and it causes the majority of industry players unable to see how BIM benefit them. Therefore, to increase the existence of BIM in the Malaysian construction industry, a series of awareness program is one of the approaches that could be taken by the government to promote the use of BIM in the construction projects.

[...] One of the factors why BIM is not popular is the level of awareness of BIM and the knowledge about BIM still low. We can say, theoretically BIM could increase the productivity and efficiency, but in reality it's not proven in the Malaysian construction industry. There are no data available for us to explore and study when it comes to Malaysia context. Most of the data presented during the seminar or discussion are from overseas. Sincerely when our top management urges us to using BIM technology, most of us felt doubt and fear that BIM in Malaysia will fail like the failure in fully implementing Industrial Building

System (IBS) in the construction project [...] Interviewee INTCB2

Besides resistance from the external environment, these companies are also facing the resistance within their organisation. Issues of knowledge, afraid of the unknown and the resistance to change appear in working condition among the staff are common issues these companies face. To manage these issues, CA, CB and CC organised BIM awareness programme among their staff and at the same time disseminate the BIM knowledge among them. After their staffs are aware of the existence of BIM and the needs of the implementation of BIM for future construction projects, CA and CC develop their BIM needs and objectives by developing their own BIM roadmap. By having this BIM roadmap, the staffs at CA and CC know where they are heading to. From their roadmaps, CA and CC are currently trying to migrate from BIM Level 0 to BIM Level 1 which is migrating from 2D working environment to 3D working environment. CA is targeting that by the year 2016, they will fully implement BIM at Level 2 while CC targets by the year 2015, and it will achieve BIM Level 2.

Meanwhile, for CB, its approach is different from CA and CC because of the size of the company and as a Small Medium Enterprise (SME), it must act fast with the experience of handling oil and gas project previously. This experience makes CB more aggressive compared to CA and CC; they use the BIM element as a 'wow factor' in bidding the construction project tenders. It has started this approach since 2013 and currently, it is focusing on BIM Level 2. Each company has their own strategy on how they implement BIM and it does depend on the size and their business goals. It is found that CA, CB and CC are implementing BIM by phases, which is currently focusing on design stage and trying to move from 2D working environment to 3D working environment.

According to Richards and Brew [27], the level of BIM adoption can be differentiated based on their levels of maturity as follows;

- **BIM Level 0:** Usually in 2D environment with unmanaged CAD coordination, most formats are papers and electronic e.g. Pdf file. These formats are treated as the main data exchange mechanism.
- **BIM Level 1:** Managed CAD in 2D or 3D format with a collaboration tool (extranet) providing a common data environment, possibly using some standard data structures and formats.
- **BIM Level 2:** Managed 3D environment held in separate discipline 'BIM' models and tools with attached data. Data exchange is mainly on the basis of proprietary of exchange formats. This approach may include 4D programme data and 5D cost data.
- **BIM Level 3:** Fully-open process with a single project model and data integration and exchange

using IFC standards; the process is managed by a collaborative model server.

[27]

It is undeniable that there are some risks that need to be faced when implementing new technology or approach. In order to manage the risks, CA, CB and CC agreed that a pilot project with small to medium scale is an ideal approach to implementing BIM for the first time. From the pilot project, the company could learn something and at the same time it can be a stepping stone for their staff to increase their competency and knowledge by attending the training provided by their organisations. Working together with BIM expert is a must for first-timers and it could speed up the BIM adaptation process and minimise the risk.

To manage this pilot project and at the same time manage the risks, CA and CC have the support from their top management to create a new unit named 'BIM Implementation Team' with new posts and responsibilities just to handle the pilot project (as shown in Fig-2). According to Eastman et al., [11] and Fox & Hietanen [13], several case studies revealed that to ensure the success of implementing BIM, there is the need for all project teams to be able to use BIM technology. Therefore, creating BIM capable team by CA, CB and CC is the most appropriate approach to manage the risk. This team consists of BIM Manager, BIM Coordinator, BIM Technologist and BIM Modeller and all the posts are filled by their own experienced staff that could handle or have the knowledge about 3D software. At the early stage, this team should have collaboration with external parties which have experienced BIM technology in order to develop individual competency and to facilitate them. Hartmann & Fischer [28] revealed that training is a vital factor in the success of implementing new technology but the level and type of training should ideally be based on the tasks to be performed by different departments or persons within an organisation. Therefore, each company must have their own education and training strategy to minimise the cost such as developing its own education and training syllabus that are suited to their needs. This team is responsible to develop BIM implementation guidelines, BIM execution plan, selection of BIM technology, selection of staff, training and education strategy and syllabus, contract and technical support. The team in this department will support other project teams when implementing BIM for other construction projects.

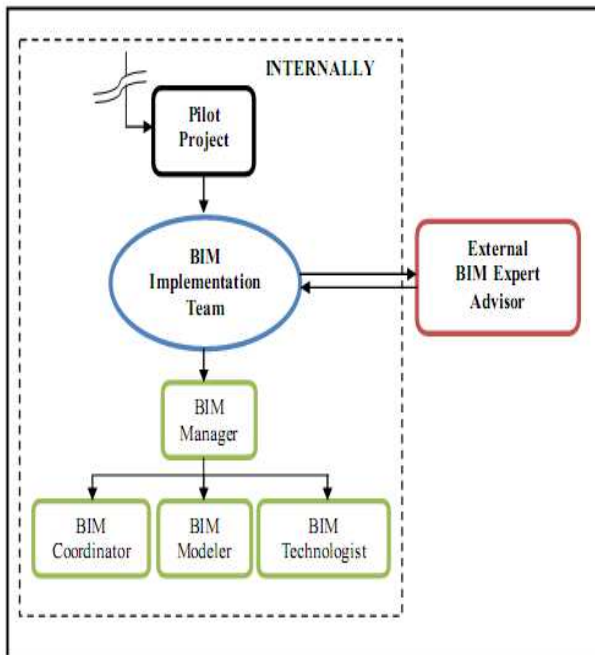


Fig-2: BIM Implementation Team structure for CA and CC

[...] To ensure the success of the BIM pilot project our top management suggest forming a new unit to handle this BIM pilot project and the next BIM project. This unit will provide the information related BIM especially on the training and upgrading current infrastructure and giving support and advice to others unit when related to BIM. [...] Interviewee INTCA2

[...] We start internally, by selecting five to seven experienced staff to form a BIM department and we start to do a research related to BIM especially on the BIM implementation guideline. From there, we start searching external party that has been experienced using BIM technology. We learnt from them and develop our competency and our version BIM implementation guideline and the BIM execution plan almost completed. To ensure our staff keep abreast with BIM knowledge and increase our competency, we develop our own syllabus for training and education as our training and education strategy. [...] Interviewee INTCC2

In contrast, due to the size of company and its status as SME, CB collaborates with external party to form a BIM expert group or some sort of Joint Venture approach especially for bidding a project tender (as shown in Fig-3). It uses BIM element as the ‘wow factor’ during a tender meeting. It acts as an external force to educate the clients about BIM. In other words, it is more toward bottom up approach to promote the use of BIM in construction project. Although this approach is a little bit difficult to convince the clients, the effort could

create the awareness of the existence of BIM and at the same time, they disseminate BIM knowledge to the clients.

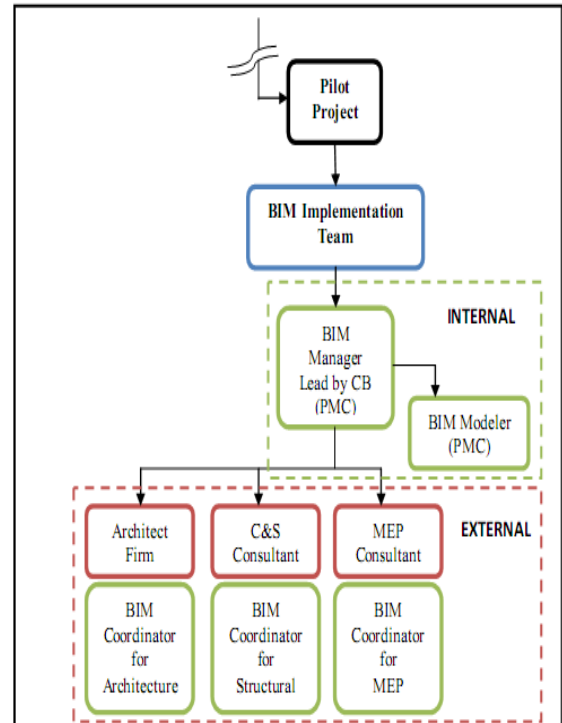


Fig-3: BIM Implementation Team structure for CB

From the interviews, it was found that, CA and CC enjoy a strong support from their top management to change; therefore, they found it easy for them to do an innovation in their approach. For CB, it acts differently because of its status as an SME company.

In summary, it can be concluded that the readiness for any organisation to change has become a turning point for any company to implement BIM because to change an established work process to a new work process requires bold steps. Furthermore, it is related to the cultures that support the innovation culture within organisations. On top of that, it is important for organisations to have a strong support from the top management. Top management can be a 'Change Agent' for the company. They are able to change the existing work culture and their attitude will influence the acceptance of BIM among the staff. Gilligan & Kunz [29] and Premkumar & Potter [30] revealed that top management support has been recognised as an important variable in technology implementation studies and commitment from them is the major success factor for adopting BIM technology. From the interview, it was found that organisations that have significant support from the top management are able to use BIM in their construction projects.

4.2 People

People play a major part in implementing Building Information Modelling (BIM). To ensure the success of BIM implementation, the people within the organisation should be equipped with BIM knowledge and training. Education is one of the strategies to equip people with skill and knowledge. However, to make people move into an unknown environment is challenging. This situation also happens at Company A (CA), Company B (CB) and Company C (CC) despite having full support from the top management, they found it difficult to push their staff to change from using 2D work process to the 3D work process. According to CA and CC, this situation happens due to being afraid of the unknown and the reluctance to change.

[...] Most personnel are afraid to embrace BIM due to unclear and unforeseen circumstance to what is really happening and afraid of changing from comfortable daily routine to new work process. [...] Interviewee INTCA3

[...] At the first time when we explain our approach for the next project will use BIM technology, we received various reactions from our staff. It happened because, some of them have no idea what is BIM, they may hear, see but they totally not know how it works and some of them keen to move into new technology because of they have a support from the management and they have some basic knowledge about BIM. [...] Interviewee INTCC2

This is supported by Dewan at al., [31] where resistance culture in the organisation especially that comes from the staff cannot be eliminated; however, this resistance could be managed by developing education and training to increase individual knowledge. Education and training alone cannot overcome this issue because some of the personnel undergo training just because they have been forced by the management to attend the training programme.

[...] From my point of view, attending training cannot fully reduce the resistance in embracing BIM because, training is only the starting point for participants to know what is BIM and how it works. The staffs that undergo the training, there are two types of staff. The first type is the staffs that have an attitude not too keen because they have been pushed by the management and after completed the training they still reluctant to use new technology because it not compulsory. The second types of staffs are the staffs that have high motivation to use new technology. [...] Interviewee INTCC1

To tackle the first type of staff, creating new posts by giving a clear job scope is being practiced by CA, CB and CC. By having a clear job scope, they have a clear picture of what they

will do after completing the training besides reducing the fear of the unknown.

[...] By giving the scope for new posts will motivate them to undergo training and the same time it will make them understand why they needed to undergo this training. [...] Interviewee INTCB2

To speed up the process of learning, some companies recruit new employees with minimum experience for handling and creating 3D models in any 3D software such as ArchiCAD which was done by CB. By having this strategy, CB felt that they could encourage knowledge sharing attitude among them and at the same time, able to reduce the cost of training. This approach is also supported by Eastman et al., [11] where to create a BIM environment and at the same time to speed up the adoption of BIM, the management should check the process of recruitments by reviewing the applicants' qualification, experience and skills in handling BIM technology. Besides that, to reduce the resistance from the staff, motivation and strong support from the management can complement education and training for the staff to embrace and use BIM technology besides creating new posts for them.

4.3 Technology

Without technology, the implementation of Building Information Modelling (BIM) will not be successful as technology will complement organisations and people who are ready in implementing BIM. For Company A (CA) and Company C (CC), they have conducted a comprehensive study before selecting BIM software and upgrading the hardware and infrastructure. For them, this study is very critical to ensure the software they purchased can meet and fulfil their BIM objectives. O'Brien [32] revealed that by selecting the wrong technology, it not only affects the investment, but at the same time it affects the performance of the organisation. Therefore, comprehensive study must be carried out especially on the level of complexity of software because according to Kunz & Fischer [33] and Giligan & Kunz [29], the complexity of BIM software is one of the factors that hinder the widespread use of BIM. Therefore, less complex technology is more favourable and easier to adopt by the staff.

For CA and CC, their BIM units conduct these tasks and these units are guided and facilitated by Information Technology (IT) Department.

[...] In order to implement BIM, we have done a lot of research and its consumed time and cost to identify the right software and infrastructure to be upgraded. We change our Personal Computer (PC) to Workstation with high end graphic card, memories and large monitor and server. At the same time we upgrade our network system to ensure models can be uploaded and downloaded with a decent speed. [...] Interviewee INTCC1

[...] For purchasing a new software and hardware for upgrading, our unit collaborates with IT Department. We are forming a committee that we call as BIM Information and Communication Technology (ICT) committee to access the vendors' capabilities and to check the hardware and the software supplied by the selected vendors meet our requirements. [...] Interviewee INTCA1

Upgrading current hardware, software and infrastructure are compulsory for any organisations in implementing BIM in their construction projects. Although it would increase the operational cost, with thorough study in the selection of hardware, software and infrastructure, the cost could be minimised.

The most challenging task for BIM unit is the selection of BIM authoring software and because of interoperability issues and to meet the BIM objectives CA, CB and CC mandated a specific BIM software package. According to Eastman et al., [11], interoperability is the "ability of seamless exchange of data between different BIM applications". Although the implementation of BIM in CA, CB and CC lies at BIM Level 1 where issues of interoperability can be abandoned, but for the future and research, software with the ability to exchange data between them should be taken into consideration. For CA, CB and CC, they use Autodesk family as their BIM software platform. All parties involved will submit their models in the agreeing format, i.e; .RVT, and these models which consist of architect model, structural model and MEP model will be stored at CA, CB and CC server for coordinating meeting (as shown in Fig-4). For further research, CA and CC will try to integrate these models and study the issues that arise from the integration process.

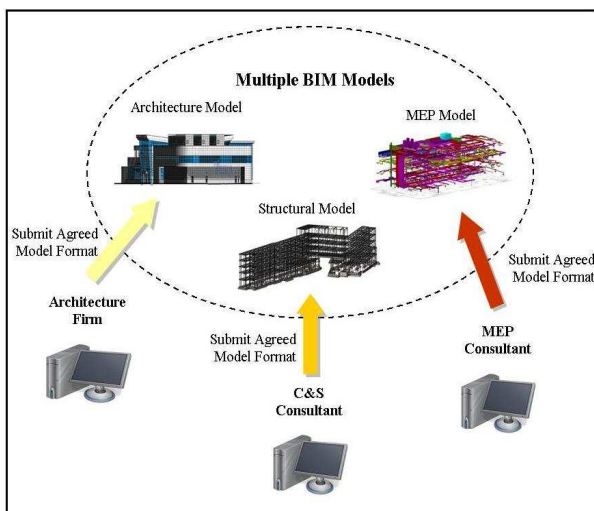


Fig-4: Model submission

4.4 Recognition from the Government

Generally, in Malaysia, there is little effort from the government in pushing Building Information Modelling (BIM) implementation. To ensure widespread implementation of BIM, the government should play the main role to promote the implementation of BIM in the Malaysian construction industry. Currently, it is clearly shown that the private sectors are taking the lead in the implementation of BIM despite having a hiccup during the real implementation. This is a good sign for BIM implementation in the Malaysian construction industry because to ensure the success of the implementation of new construction technology, there is a need for the element of 'push and pull' from both parties as shown in Fig-5.

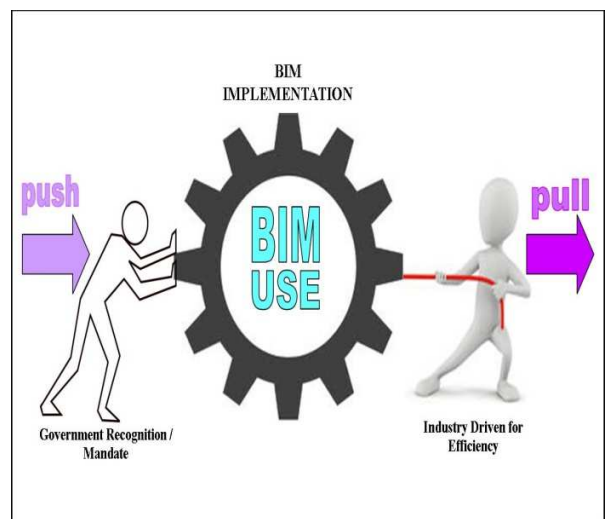


Fig-5: The Elements of 'Push and Pull' in implementing BIM

For the 'push' element, the government should mandate the use of BIM in their construction projects. The United Kingdom (UK), the United States of America (USA), Singapore, Hong Kong, Australia and Denmark have established a policy whereby public construction projects are required to use BIM [34] and [16]. They have also established BIM working group or BIM steering committee to support BIM adoption within their countries [16]. However, at the same time the government should develop the National BIM Standard and National BIM Execution Plan, because these guidelines will ease the implementation of BIM by the players in the Malaysian construction industry.

On the other hand, for the 'pull' element, the construction players should play their roles by trying to implement BIM for smaller scale projects as their pilot projects. This step will provide a lot of information to them and could increase their confidence to implementing BIM. By having knowledge about BIM, automatically, the 'pull' element can be the domain force in the implementation of BIM in the Malaysian construction industry. It is because the industry players are

aware of the benefits that they could gain by implementing BIM in their construction projects. Without the 'push and pull' elements the implementation of BIM will still be stagnant. This is what we have learned from the implementation of the Industrial Building System (IBS) where there is lack of 'pull' element from the construction players to use IBS in their construction project. Although there are lots of 'push' by the government such as regulating the use of IBS components for public construction projects and giving tax relief to those who are using IBS components in their construction projects, the percentage of using IBS components is still low.

[...] Everybody plays their role to ensure the use of BIM technology increase. The client plays a major role such as if the client enforces the use of BIM therefore other parties will follow. The government should play more role such as produce national BIM standard and implementation guideline for Malaysian construction industry; because when implementing BIM we need someone to look after and monitor and without BIM standard each party will come out with their own standard and can cause conflict and confusion among construction players to follow which standard. [...] Interviewee INTCC1

CONCLUSIONS

Changing from the traditional approach to Building Information Modelling (BIM) implementation is not an easy process. It includes decision making and the change in management strategies. To make these changes, top management of the organisations must play a major role especially during the transition time from the previous workflows to BIM workflows, convincing people about the potential of BIM, developing education and learning strategies and understanding new roles. The management should be aware that when implementing BIM, there are possibilities of having a downtime especially during the transition time. Besides that, they must be aware that they must bear the initial cost when they decide to implement BIM. To minimise the risk, the management should assess their staff capabilities, identify BIM experts and develop their own BIM guideline and BIM execution plan and to do this, forming a BIM unit is one of the approaches available. Implementing BIM fully cannot be achieved overnight; it is advisable to do it phase by phase which is moving BIM level 0 to BIM level 1 and the implementation during the design stage. Technology plays a significant role to ensure the success of BIM implementation, therefore, the organisations should mandate BIM authoring software package that can be used by all parties to ensure the BIM objectives are met. By doing this, all parties will submit their model based on the agreed model format and it is easier for the organisations to access the model. Recognition and support from the government are still low, but currently the government strives to improve the productivity of the construction industry in Malaysia and implementing BIM in

public construction projects is one of the agendas. Due to the lack of knowledge of BIM and the low level of BIM uptake by the Malaysian construction players, the implementation of BIM in the Malaysian construction industry thus lies between BIM level 0 and BIM level 1.

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