BIM TECHNOLOGY: ENHANCING COMMUNICATION IN PRE-CONSTRUCTION PHASE

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ABSTRACT

Throughout the RIBA Plan of work stages, there is a lot of problem faced by the construction practitioner in the construction industry (architects, engineers, quantity surveyors, clients and contractor). One of the common problem in the industry is miscommunication. The poor performance of the Malaysian construction sector has its root in poor communication. In pre-construction of a project on the other hand, people are likely to communicate through paper documents if they are using traditional method. The disadvantage of using paper documents is there will be risk of misunderstanding by visualizing of the details of the project because not all parties might see everything in the same time. Building Information Modelling (BIM) is a technology that combined the set of processes in order to produce a better communicate and by BIM it can easily analyzed the information of the data models for the construction project life cycle. As in Malaysia, the number of organization that used BIM is still at low range and slowly increasing its performance. Therefore, the main objectives of this study are; first, to identify the factors of communication errors during pre-construction phase; and secondly to determine the impact of the application of BIM technologies in improving the communication errors in pre-construction phase in Malaysia construction industry. Data was collected through a structured survey among construction party. Respondents were chosen randomly from only Consultant Company in private sectors from various locations in Kuala Lumpur. This study indicates that the respondents had experience those impacts in their work time proved by implementing BIM, communication problem can be minimized and avoid in different aspects of pre-construction phase of a construction industry. This study further contributes to the client and various consultant on identifying the causes of miscommunication and at which level in pre-construction phase how BIM could help to improve the communication.

Key words: BIM , pre-construction, communication

INTRODUCTION

Construction process requires collaboration between people. In other context, it is necessary to have a clear and concise channel of communication to begin work. An effective communication between all parties involved is one of the key factor to a successful of building construction. In pre-construction phase of a project consist of six (6) stages of process rely on Royal Institute of British Architects (RIBA) Plan of Work. Throughout the stages, there is a lot of problem faced by the construction practitioner in the construction industry (architects, engineers, quantity surveyors, clients and contractor). One of the common problem in the industry is communication. The poor performance of the Malaysian construction sector has its root in poor communication. That makes it essential to investigate the communication issues within construction organizations in Malaysia. Based on the study made by Olanrewaju et. al (2017), which is to study analyses factors leading to poor communication on the construction sites and provides strategies to address the associated challenges. The results showed that more than 95% of construction practitioner had faced communication problems in the construction organization.

Besides, in pre-construction of a project, people are likely to communicate through paper documents if they are using traditional method. The disadvantages of using paper documents is there is risk of misunderstanding by visualizing the details of the project because people might not see everything in the same time. People tend to make mistakes, as there is a lot to catch up in one time. The traditional method originally relies on 2D (2 Dimension) drawing. Computer Aided Design (CAD) is able to produce 2D CAD drawings and documents to enable the AEC (Architect Engineer Construction) industry to design and build what the architect, client, contractor and consultant should see of the situation and the structure of a building (K.C Goh, 2013).

It does not effectively support the visualization, understanding, and collaboration within a project. The drawing details and understanding it become limited and it will take a long time to complete all the drawings needed due to the lack of coordination of the applications used and among the professionals involved in the design process based on Peniel Ang, 2013 in his research. He also stated that most of people who involved in the construction industry agreed on by using CAD drawing as the only reference and tools for the drawing and documents, the project will not be well planned, as there will be flaws from different perspective due to its performance limitation. Moreover, the well-known Computer aided design and drafting (CADD) is not solving the problem as it still has the limitation of coordination in the conventional method. Therefore, there will make no difference in the essential process of communication.

Building Information Model, also known as BIM is defined as a modelling technology and associated set of processes to produce, communicate, and analyze building models. BIM is a processes and technologies that are facilitated by digital, machine-readable documentation about a building, its performance, its planning, its construction and later its operation, which has been used by the AEC industries in Malaysia (K.C Goh, 2013). In Malaysia, the idea to implement BIM was introduced by the Director of Public Works Department (PWD) in 2007 (JKR, 2013). This step was a result of the government's awareness of the potential of BIM to reduce construction cost and avoid design problems in planning phase. From MyBIM Centre, it stated that 'Building Information Modelling (BIM) is modelling technology and associated set of processes to produce, communicate and analyses digital information models for construction project life cycle'. It plays an important role in industry collaboration transformation and it can replace the conventional method.

AIM AND OBJECTIVES

The paper attempts to identify ways in enhancing the common problem in construction industry, which is communication by having BIM implemented full force during the pre-construction stage. Hence, two objectives were outline, which are to identify the factors of communication errors during pre-construction phase Malaysia construction industry and to determine the impact of the application of BIM technologies in improving the communication errors in pre-construction phase in Malaysia construction industry.

COMMUNICATION IN CONSTRUCTION INDUSTRY

In the Business Dictionary, communication is defined as the process of two- ways more than one party to reach a mutual understanding. In a way, it is not only exchange ideas, feelings and information but also it connects and create meanings. The communication is the key of management and organization. Both can operate without communication between employees and employers.

Communication plays a very important role in construction industry. This is because, the industry is dependent upon large amounts of information being transmitted, especially at a rate of intensity and efficiency to meet the demands that many construction businesses require in a highly competitive market (Tam, 1999; Chen and Kamara, 2008). In addition, the most problem in construction industry faced is miscommunication between parties involved no matter at what stage of the construction. This is because the industry is dealing with peoples, materials and the plant and equipment. Therefore, they need to manage everything in order to make sure the project is successfully handled.

Based on M.E.L. Hoezen (2006), she stated that the communication in the construction industry has been studied extensively in the past and most problem of communication reported was the communication between the upper levels of the construction industry because of the interaction between the stakeholders is stronger than the interaction between the rests of employees. This is the reason why the project faced the communication problem. Communication factors might be seen as a small matter, but without a proper communication, the success rate of a project will decrease. The Table 1.0 below is the summary of the reason of poor performance of a project.

Table 1.0 Reasons of Poor Performance in Construction Industry

Researcher	Problems in construction
Musas (2008)	Design changing, site condition, improper communication channel
Rahman Ab. et. al. (2010)	Issues with the design and the documentation, project management planning site condition, technology barriers and lack of information.
Ismail (2016)	Relationship with supplier, miscommunication, human resource.
Rahman Ab. (2016)	client's poor financial, management, insufficient financial, resources, conflict and poor communication among parties involved

Kadir Ab. (2015)	Material management, Financial management, variation order causing extension of time, ineffective communication apply amongst the team.
Ali, et. al. (2014)	Shortage of labours, financial problem, inefficient work schedule, site management issues.

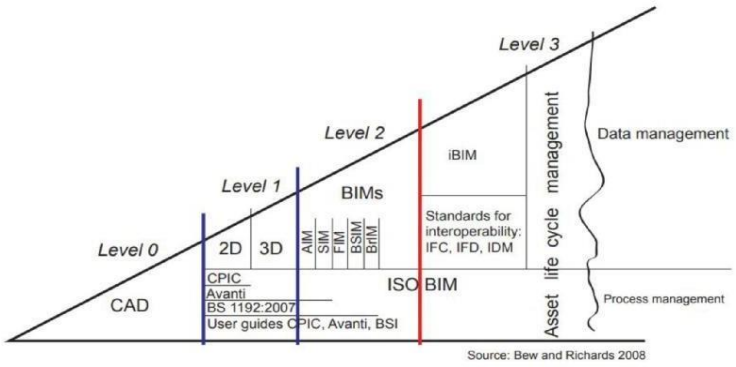
Source: Olanrewaju, A. L. (2017). Research background and theoretical framework. Roles of Communication on Performance of the Construction Sector

BUILDING INFORMATION MODELLING (BIM)

UNDERSTANDING ON BIM

According to Dale Sinclair in 2012, the most effective way to understand BIM is to refer to the widely used BIM Maturity Diagram prepared by Mervyn Richards and Mark Bew in 2008, as illustrated in Figure 1.0 below.

Figure 1.0: BIM Maturity Diagram



This diagram is important as the maturity levels (level 0, 1, 2 and 3) of BIM development. Below are the explanations on how BIM developed throughout the years from the beginning.

Level 0

Level 0 of BIM, it shows that before BIM is invented, the 2D CAD is used through the whole process of the construction project. Mostly on the design process. The important point to be derived from the diagram (from the horizontal line separating data and process management which does not commence until level 1 BIM) is that common standards and processes in relation to the use of CAD failed to gain traction as the use of CAD developed.

Level 1

On level 1 of BIM, the construction industry increasingly acknowledged the use of 2D and 3D information. Especially the architects, they started to use 3D software as a conceptual design tool during pre-construction of (typically RIBA stages C & D) and they used for a better visualization purpose presented to the clients.

Level 2

In Level 2 of BIM, the technology is improved in the performance of data management. For example, the role of the Model Manager needs to be considered and the roles and responsibilities of the various designers and contracting parties need to be clearer, particularly in relation to Performance Specified Work. Lead Designer has to clarify the inputs that they required at each stage of the design in order to co- ordinate the design as it progresses. If there are more than one party in the design team, in this Level 2 BIM it requires the design team to work using "plug and play" working methods because then the work need to be combined with the integrated team's work.

Level 3

In Level 3 of BIM, the limitation of the technology is become lesser. The performance of the data management and the process management is improved. The greatest BIM challenges arise when moving from level 2 BIM to level 3 BIM. With level 3 BIM it will be possible for stated by Dale Sinclair, 2012.

BIM IN RIBA PLAN OF WORKS

In RIBA Plan of Work 2015, BIM applications can be applied to all construction project phases, which are pre-construction phase, construction phase and post-construction phase and even in use phase. Table below shows BIM application in a construction project for every phase, consisting of pre-construction phase, construction phase and post-construction phase. BIM collaborates between construction players facilitates the design process decision. Moreover, detection of clash and clash analysis during the design stage can reduce time and construction cost.

Table.2.0: The application of BIM in Construction Project in RIBA Plan of Work.

Phase	Stage	Uses of BIM
Pre-construction	Existing conditions modeling	→Enhances accuracy of existing conditions documentation.
	Planning	→Identifies schedule sequencing or phasing issues.
	Design	→Facilitates better communication and faster design decision. →Perform clash detection and clash analysis. →Increases design effectiveness.
	Scheduling	→Enables project manager and contractor to see construction work sequence, equipment, materials and track progress against logistics and timelines established.
	Estimate	→Enables generation of takeoffs, counts and measurements directly from a 3-Dimensional (3D) project model.
	Site analysis	→Decreases costs of utility demand and demolition.
Construction	Construction	→Enables demonstration of construction process, including access and exit roads, traffic flows, site materials and machineries. →Provides better tracking of cost control and cash flow. →Enables tracking of work in real time, faster flow of resources and better site management.
Post-construction	Operation / Facilities management	→Keeps track of built asset. →Manages facilities proactively. →Enables scheduled maintenance and provides review of maintenance history.

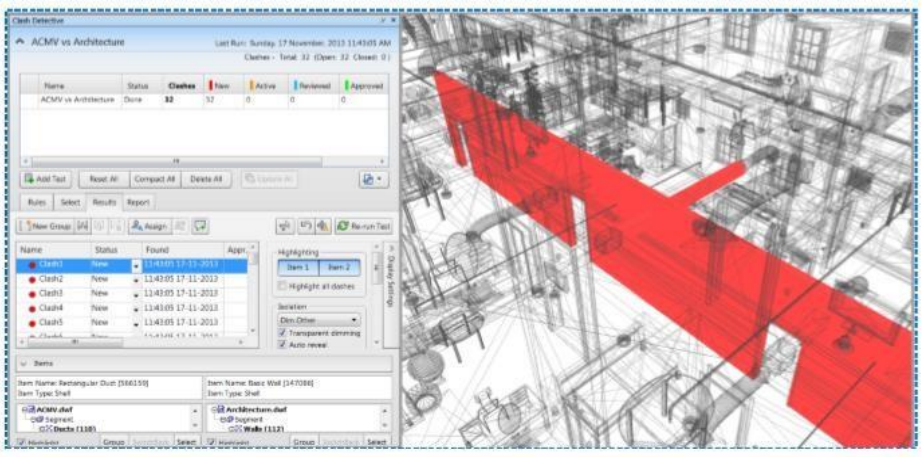
There are five stages involved in the pre-construction phase based on RIBA plan of work. The stages are existing condition modelling, planning, design, scheduling, estimate and site analysis.

The first stage of the pre-construction, the existing condition modelling, by using BIM it will help to enhances the accuracy of existing condition modelling before everything starts. Followed by planning, which the clients started to appoint their consultants to start plan the project structure and a proper project planning needs to be scheduled. The linkage of the functional components of the design in BIM will help the designers and client communicate by relating parts of the drawing. (Figure 2.0)

Figure 2.0: -A building design enriched with linked components that bring it to be virtually real

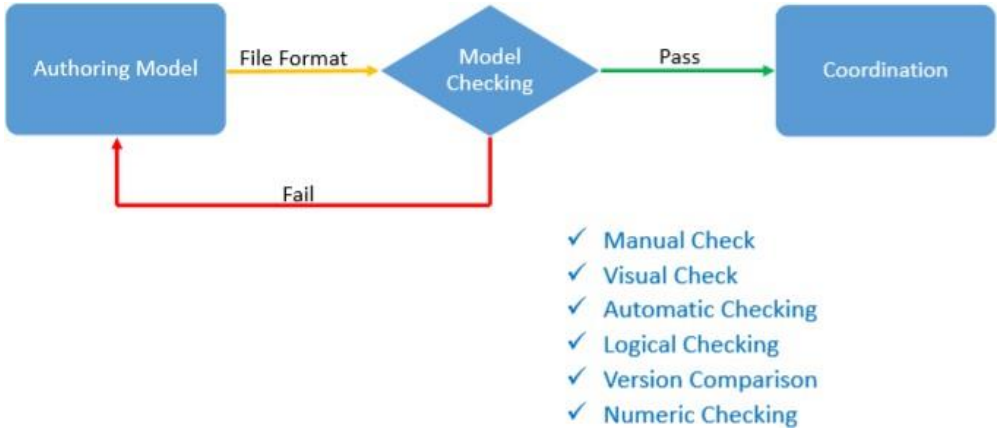
Next is Design stage which the clients have already appointed the architect to produce the design concept and prepare the develop design including the structural design, building services systems and comes out with the specifications needed for the project (RIBA Plan of Work, 2013).

Figure 3.0: BIM clash detection



By using BIM, it will help the process of design faster than a regular time and it facilitates better communication as this stage involves architect and structural engineer to work together. BIM will detect if there is any clash in the design and drawing and comes out with clash analysis as shown in the figure 3.0. This feature of BIM will increase the design effectiveness.

Figure 4.0: Model Checking Work Flow



(Source: Karthik V, Lead BIM Process Manager/ Operations Director, 2014)

The scheduling stage is one of the vital stages in the early construction phase. The whole project activity planning is structured in the schedule stage. This is to make sure every stages of every phase of the project to have better control and to make sure everything is planned properly in terms of duration and work activities. Usually this stage is taken care by the project manager. In other way, by implementing BIM throughout the projects, it will help the project manager and the contractor to see construction work sequence clearer, the management of equipment and material become easier and by BIM, it can track the progress against logistics and timelines established for the project. The work flow of the model design checking is as above in Figure 4.0

The estimating stage in the pre-construction is the most important stage of all. Conventional method involves less integration of design and cost. As the design goes more detail and involves changes on any drawing and related document, they are not reflected in the remaining drawings and cost estimation. The miscommunication among consultants seldom come into place where the changes sometimes being informed verbally or misunderstanding on the changes. Thus, as BIM come into place, cost estimations can be very precise as the drawings produced. This is because specifications and cost estimations produced automatically while the drawings are being created. Again, BIM enables a link to be created among all constructions drawings and cost estimations.

CONVENTIONAL METHOD VS BIM

There were lots of stages, areas or even aspects of documentation, drawings and process discussed by various scholars on the lack of integration using conventional method, which results in miscommunication. Table 3.0 below highlighted on the comparisons of conventional and BIM in pre-construction process.

Table 3.0: Comparisons between Traditional Method and BIM in Pre-Construction Process

Traditional Method Review	Building Information Modeling (BIM) Review
Overlay (hard copy) printed out drawing	BIM Work Flow: Paperless
Highlight the Issues by Handwriting (Mark-ups)	Digital mark-ups in integrated 2Dor 3D model
Each parts of the drawings should be updated individually (plan, Details, Schedules etc.)	Update at 3D model will automatically updates in integrated 2D views, schedules etc.
Storage of the drawings & how long to keep?	Stored in hard disk with revision history and maintain its life long without using physical space
Every design change or correction will repeat the above process which involves cost & time.	Design changes will be quick & easy which gets update to all the associated items.
Assume or imagine, blaming game, long process.	Digital Element/ object clash detection process with accurate report.

(Source: Karthik V, Lead BIM Process Manager/ Operations Director, 2014)

METHODOLOGY

The following studies review, analyses, discuss on the factors of miscommunication during pre-construction phase, and link it with impact of BIM application. The paper however on focus on pre-construction phase of the project. This research focused on the new technology, BIM that could be implied in order to replace traditional method for a better result. However, this research is limited to pre-construction phase of BIM, which convey RIBA plan of work. In some part of the research, the researcher studies on project management that relate to communication throughout the project. The research focused in the Kuala Lumpur area because over the years, it was reported that in Malaysia over 7,000 participants have successfully trained and certified with BIM programmes based on my BIM Centre portal. Quantitative studies were conducted in searching for resolute conclusive for the factors of the issue and how BIM could affect in solving the issue.

The questionnaire was designed with three sections, which are Section A: demographic, Section B: communication failure during pre-construction stage and Section C: how BIM could enhance the communication in pre-construction phase.

Hundreds (100) questionnaires were distributed to the selected construction related worker with 61 number at 61% response rate. Relative Index Method calculates the average mean of respondents answered. Besides, the Relative Importance Index or Weight used as relative importance analysis. In other hand, for some part of the section 3 and 4 of the questionnaires, the method used to analyze the results is by using the scale index interval.

RESULTS AND ANALYSIS

Fifty percent (50%) of the respondents were having between two to four years working experience while 10 % of them have more than 4 years' experience. 49% of them have worked and work with both, client and contractor on behalf while, 31% of respondents worked with client and the rest of 20% worked with contractor. More than 90% of the respondents were aware of BIM and implemented BIM in their good company.

MISSCOMUNICATION DURING PRE-CONSTRUCTION STAGE

There were 52% of respondents highlighted that scheduling stages is where the miscommunication among construction parties occurs most whilst of them mentioned on the design and planning stage. Table below showed the factors of miscommunication during design stage

Table 4.0: The General Factors of Miscommunication in Pre-Construction Phase

No.	The factors of miscommunication during pre-construction phase	Frequency Analysis				Mean Score	Categories
		4	3	2	1		
1	Lack of understanding of technical knowledge	1	1	40	19	1.74	Strongly Agree
2	Not exercising full authority	2	2	50	7	1.98	Undecided
3	Lack of commitment from the client	4	3	44	10	2.00	Undecided
4	2D drawing unable to provide holistic picture of the object	2	3	46	10	1.97	Slightly Agree
5	Limited information or data can be included in 2D design.	3	0	49	9	1.90	Slightly Agree
6	Separated documents needed to get a complete view of the project.	4	0	42	15	1.82	Slightly Agree
7	Contractor does not understand the concept of client	5	7	45	4	2.25	Not Agree
8	Conflict between the architect and C&S Engineer	2	3	43	13	1.92	Slightly Agree

Based on the table 4.0, the variables listed eight (8) factors of miscommunication during pre-construction phase. Overall, there is one (1) factor listed that most of the respondent disagree with or they chose undecided with which is the fact that contractor does not understand the concept of client. Most of the respondents have had worked with contractor and client so the respondents really do not think contractor has no problem in understanding the concept of client. Besides, there are two (2) factors that the respondents answered undecided, which is lack of commitment from client and not exercising full authority. For example, an architect's drawing which is not entirely clear, when submitted to the client will raise communication issue between the contractor and client because the drawing itself cannot be clearly understood by the contractor. In other hand, the rest of the factors listed were agreed by most of the respondent with mean index between 1.74 to 1.98. Firstly, the respondents agreed the factor of 2D drawing unable to provide holistic picture of the object as one of the reason communication error in pre-construction phase especially in design stage. This is because 2D drawings are not able to portray the object as a whole and the construction details as well and it may cause wrong interpretation to those read it.

Factor of 2D drawing unable to provide holistic picture of the object as one of the reason communication error in pre-construction phase especially in design stage. This is because 2D drawings are not able to portray the object as a whole and the construction details as well and sometimes will cause wrong interpretation to those read it. Based on Peniel Ang, 2013 in his research, by using CAD drawing as the only reference and tools for the drawing and documents, the project will not be well plan, as there will be flaws from different perspective due to its performance limitation. Separated documents needed to get a complete view of the project was also agreed by most of the respondents to be the factor of communication error in between the design stage as mentioned earlier, by using CAD it can be the reason of misunderstanding (Goh et. al, 2016). This is because, by only referring to drawing and document it will not be enough to build planning due to its lack of coordination and this will cause misunderstanding between the parties involve. All of the parties conventionally were be given sets of drawings, enclosed documents and they were asked to comprehend all of those in a limited time for faster decision making by the client. This does not allow the workers involved to visualize the whole process, material used, scheduling, cost and the building itself. Hence, the issue of lack on the understanding of technical knowledge comes.

HOW BIM ENHANCE COMMUNICATION IN PRE-CONSTRUCTION PHASE

Table 5.0: BIM Enhance communication in Pre-Construction Phase

No.	Impact by Implementing BIM during Pre-Construction stage	Frequency Analysis				Mean Score	Categories
		4	3	2	1		
1	BIM display all the data which were included in the model.	0	0	41	20	1.67	Strongly Agree
2	By BIM it improves virtualization and visualization	0	0	35	26	1.57	Strongly Agree
3	BIM combines all the concepts from all the parties involved in the project.	0	0	41	20	1.67	Strongly Agree
4	BIM provides images for each unit structure of the building accurately and clearly.	0	0	35	26	1.57	Strongly Agree
5	The management process is easier when using BIM	2	8	41	10	2.10	Undecided
6	Improve design quality that is understood by all parties involved.	0	0	41	20	1.67	Strongly Agree
7	It provides a platform for the parties involved in the project to share their information and knowledge.	0	3	41	17	1.77	Slightly Agree

8	The communication problem between parties can be prevent by BIM during design process.	0	2	49	10	1.87	Slightly Agree
9	Improve the relationship between client and contractor	3	23	27	8	2.47	Not Agree
10	Cooperation (collaboration) between the parties involved	0	15	34	12	2.05	Undecided
11	Build a strong project team in the construction industry	1	19	34	7	2.27	Not Agree
12	The efficiency of communication with the use of BIM increase while improving the image of Malaysia in the construction industry.	0	1	26	34	1.46	trongly Agree

Based on the Table 5.0 the variables listed eight (12) impacts by implementing BIM during pre-construction phase. By all the listed impacts, there are two (2) impacts of BIM that most of respondents not agreed with which is by implementing BIM, it improves the relationship between client and contractor. The second impact that the respondent did not agreed with, is by implementing BIM, it builds a strong project team in the construction industry. It is because in Malaysian construction industry, BIM implementation is not fully used until the 6D and 7D BIM feature. So this is why, the respondents did not experience the positive impact as a project team. However, as it is crucial for the client especially to start implement BIM and it will be fully used up to 7D level. BIM brings the information contained in 2D drawings, 3D drawings, and cost estimation together in one database and then creates a link between all components (figure 1.0). Once a link is established between all the components, the information contained in the BIM database of one component will have an effect on the other. In addition, the content of one component can be accessed through the other. This allows for easily switching, navigating, and customizing the whole database through a single component.

Besides, there are two (2) impacts that the respondents can't decide if they agreed or disagree which is by implementing BIM, the management process will be easier and more cooperation between parties involved in the project. The reason stated before the features of BIM implementation is not fully used yet in Malaysia. Furthermore, the rest of impacts listed were agreed with most of the respondents. The respondents slightly agreed that BIM provides a platform for the parties involved in the project to share their information and knowledge as stated in the literature review. It is one of the BIM basic feature as all the information such as the details of the procurement, the drawings, submittal processes and other specifications are linked in BIM stated by Faizul (2016).

By implementing BIM, the communication problem between parties can be prevent especially in design process of pre-construction phase of a project. Most of the respondents were slightly agree with BIM provide effective communication between the parties involved. This is because BIM technology is able to create a two ways communication between the parties involved, resulting in a more meaningful communication and collaboration. Apart from the above impacts explained, the respondents were strongly agreed with half of the BIM implementation impacts toward the pre-construction phase of a project, which include BIM display all the data, which were included in the model. Implementation of BIM improves virtualization and visualization because it combines all the concepts from all the parties involved in the project and last but not least, BIM provides images for each unit structure of the building accurately and clearly.

Most of the respondents with the mean score index between 1.46 and 1.68 agreed with this statements because, as been stated by K.C Goh (2013), BIM is a verb to describe tools, processes and technologies that are facilitated by digital, machine-readable documentation about a building, its performance, its planning, its construction and later its operation. This shows that the respondents had experience those impacts in their work time proves by implementing BIM, communication problem can be minimized and avoid in different aspects of pre-construction phase of a construction industry.

CONCLUSION

The miscommunication occurs is usually because of understanding factors that cause of lack of communication between parties involve. The researcher had listed eight factors of miscommunication in Table 4, within the factors listed, 91% of the respondents were agree that all the factors are the reason why the pre-construction phase of a project faced miscommunication. Hence, when BIM come into place with it is digital database, it allows integration automatically thus able to undertake the complex process and analysis required in improving a better pre-construction communication than the conventional method. This study aims to benefit the construction players who mostly involve during pre-construction stage as to full swing on BIM

implementation. By incorporating BIM at the pre-construction, this will reduce the hiccups during post-construction stage. Policy maker may benefits from this research as a way forward to enforce a full implementation of BIM thus to be one of the steps recommended to expedite a project timeline, improve quality and within budget control. It also provides high significant for the employer to invest in implementing BIM as the data showed detail and technical benefits of BIM implementation. This research though attempts several limitations such as mostly organizations practice various types of software with BIM integration that they found out it still a major issue to get one model standardize and readable by all consultants. This leads to recommendation for any researcher to conduct further research on identifying similar wavelength of software for consultants in BIM realization. Though it is concluded that BIM would enhance the communication, most analytics on the other hand envisage that BIM will not be in full effect in most architectural firms for at least 10 years. Therefore, further study can be done in facilitating the development and application faster than in a ten-year time.

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