Competency Requirement for Effective BIM Modeller in Design Phase of a Construction Project

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Abstract: Building Information Modelling (BIM) technology has been well received by the Malaysian construction industry, yet the adoption is still in stage 2. Malaysian construction industry is still in implementation of CAD to BIM in design phase. The competency of BIM Modeller in fully utilising BIM is still lacking and this has curtailed the usage of BIM during design phase. According to CIDB, in order to adopt BIM, organisations need to invest in BIM tools such as BIM modeller course. Therefore, the objectives of this study were to identify the benefits of competency among BIM modeller during design phase, to determine the competency needed by BIM modeller and to propose recommendation to improve BIM modeller competency during design phase. The primary data were collected from interview with 4 BIM Modeller to achieve the first and third objectives and subsequently, the second objective was achieved based on 40 received questionnaires from BIM modeller. The data analysis method used are content analysis and descriptive analysis. The results show that all respondents agreed that growing awareness, improve design, shorten timescale and reduce cost are benefits of competency among BIM modeller. The competency that important are including ability to manipulate, navigate and review a 3D model and knowledge of BIM authoring tools. Meanwhile, a few recommendations including BIM training among worker, tactical development, enhance effective collaboration, capabilities of maintaining exchanged data and mobilizing client on importance of BIM are all agreed. The competency of BIM modeller are significant in a project to improve the project design quality. It is hoped that the findings of this study could be useful as a reference to give awareness of construction industry stakeholders towards the importance of BIM modeller competency. It also can be a guide for government and other parties to improve BIM competency level for BIM modeller.

Keywords: BIM, BIM modeller, competency, design phase

1. Introduction

Building Information Modelling (BIM) is a collaborative tool used by architectural, engineering and construction (AEC) industries based on a number of software solutions [1]. BIM is a set of technology developments and processes that has transformed the way infrastructure is designed, analysed, constructed and managed [2]. BIM can enhance and improve planning process, design and construction of projects. Nowadays, BIM has been implemented in many countries such as the United Kingdom (UK), Australia, Hong Kong, Denmark, Norway, Finland and Singapore [3]. In Malaysia, the idea to implement BIM was introduced by the Director of Public Works Department (PWD) in 2007 [4].

It was stated that the Malaysian construction industry is required to achieve the implementation of stage 2 BIM maturity by 2020, in which a minimum of 40% implementation rate of public projects valued at RM 100 million and above shall implement the corresponding approaches and processes [5]. It is stated that architects are the leading adopters of BIM in Malaysia at 42% and followed by engineers at 21% [6]. This result highlights that BIM is mainly used among professionals at the design stage, thereby further showing that the current BIM practice in Malaysia is only predominantly focusing on the interests of architects and designers. The significance of this study to BIM modeller are this research can improve knowledge of BIM modeller using BIM in phase of project design. BIM modeller that involved in designing process must have a knowledge and skills in running a technology so, the other parties can estimate the costs without having a big mistake. Besides that, BIM modeller can know more about competency needed in BIM technology for construction industry. In addition, BIM modeller can improve in terms of quality of the design and delivering the information with more details.

Most professional organizations are not very advanced in incorporating BIM competency into their certification systems, and there is no clear BIM competency policy. Developing a BIM competency with a high level of acceptance and functionality is a major task. This problem may be manifested in people who lack knowledge and skills [7]. Kym Newton and Nicholas Chileshe mentioned that lack of understanding about BIM, education and training costs, and the way of firms do business are the most challenges and barriers facilitate the industry players to implement BIM [8]. The others challenging aspects influence the adoption of BIM are authority and control over information [9] due the lack of interoperability of standardised approach in term of software and information system [10]. According to Utusan, in the earlier stage of construction industry, players like engineers, architects and others government agencies use 2D plan. But it has a variety of problem that including cost because of project that complex and complicate the situation. Because of that, arise a problem that hard to solved and the mistakes often happen during design phase. Unfortunately, the implementation of BIM in the construction industry in Malaysia is very slow [11].

Major obstacles may not yet be fully recognized by the industry because most companies do not have experience and skills using BIM [12]. Implementation of Building Information Modelling (BIM) was expected to bring improvement in current practices of Malaysian construction industry. In the design phase, there is a lack of a ready pool of skilled workers who are able to develop BIM strategic plan and effectively utilise it. These create boundaries for BIM nature in Malaysian construction industry specifically in the design phase to achieve its best practices [13]. CIDB stated that a reason why BIM application are delayed in Malaysia construction industry are because the lack of competency among BIM professionals [14]. Roslan et al., also stated that the capability to innovate BIM in Malaysia construction industry are low [6]. In order to adopt BIM, it is important for organisation to invest in BIM tools such as competency training for BIM modeller [14].

Therefore, this study was conducted to solve the issue for government to implementing the BIM in Malaysia construction industry and help improving BIM modeller competency needed. This study was focused on benefits of competency among BIM modeller, to determine competency needed by BIM modeller during design phase and to propose recommendation to improve competency of BIM modeller during design phase. Qualitative and quantitative methods was used for data collection with both interview and questionnaire survey as the data collection instrument. This study involved BIM modeller or BIM coordinator in Malaysia construction industry. According to CIDB in 2020 there are 146 BIM modeller all around Malaysia [15].

2. Literature Review

2.1 Definitions

Definition of BIM is the process of generating and managing the physical and functional information of a building project. The output of this process is call building information models. These models are ultimately digital files that describe all aspects of the project and support decision-making throughout the project cycle. BIM is not just about 3D modelling. It actually involves more than that. Subsets of BIM and BIM systems and similar technologies not only include 3D (width, height, and depth) but may also include more dimensions such as 4D (time), 5D (cost), and even 6D (as-build operations) [16]. In terms of technology perspective, Isikdag states that BIM is a simulated project comprising a 3D model project component that links all the information needed as well as with regard to project planning, design, construction or operation as described [17]. CIDB defined BIM as a modelling technology and associated set of processes to produce, communicate, analyse and use of digital information models throughout construction project life-cycle [14].

Competency can be defined as successfully or effectively perform a specific task, activity, role or any unique skill can be considered as competency. BIM competency is one of the required qualifications in the procurement process. These competency, activities or outcomes must be measured against performance standards and can be obtained or improved through education, training and development [18].

2.2 Benefits of Competency Consideration among BIM Modeller

2.2.1 Growing Awareness

The concept of BIM in the engineering community is not new, it has been around since the 1990s when 3D modelling was employed in the oil and gas industry of which Malaysia has significant interests. Sophisticated 3D analysis, including clash detection, has been used in the structural steel sector for many years. Large and medium size firms already have exposure to at least some sort of 3D modelling. There is much industry confusion over what BIM is, with most engineers mistaking 3D CAD modelling for BIM. This misunderstanding is causing some engineers to perceive BIM as just another fad that will disappear. Overall, there is a growing awareness as evidenced by increasing numbers of seminars, conferences, workshops, publications, journals and media on BIM [19].

2.2.2 Improves Design

The 3D modelling and sophisticated analysis capabilities were considered to improve overall design quality, generally the final designs were more accurate and with fewer errors. The ability to visualize complex concepts was valuable, even for experienced engineers. The technical demands of the parametric 3D modelling process were considered as a constraint on creativity by the older generations but less constraining to the younger generations who grew up with IT. Owing to construction projects being prototype in nature, there is an inherent inability to prove design quality improvement as there are no control projects to compare against. There are no metrics to assess quantifiable improvements. Design quality indicators may have some utility but has not been tested anywhere [19].

2.2.3 Shorten Timescale

Clash detection was considered as a valuable tool for shortening overall project timescales by reducing site complications. The design phase was considered as lengthening owing to the added work burden of modelling in 3D, however, this was considered as a temporary condition that improves as familiarity and capability with 3D and BIM improves. The engineers that had mature 3D capability considered that office/studio productivity was greatly improved. Similar to design quality, the lack of a control project with managed variables dictates that assessments of project timescale improvements can only be subjective. Improvements in engineering firms' productivity are more objective and after an initial reduction there is a long-term productivity improvement resulting from 3D modelling [19].

2.2.4 Reduce Cost

As with quality and time metrics, the lack of control projects prevents objective assessment. The speculation was that improved design accuracy, especially clash detection, would reduce variation orders and claims. With regard to ECS firms adopting BIM, there was consternation that some clients were beginning to request BIM capability of consultants yet were unwilling to pay higher fees. It was felt that higher fees were justified on the basis of improved and extended services being provided value – added and the cost incurred in moving to a 3D and BIM environment. It was noted that – the few, large developers that had achieved some modest BIM success were paying enhanced fees to consultants to support their adoption of BIM. These were considered exceptions but notably they were the organizations achieving dividends from BIM use. A small increase in consultants' fees as a percentage of overall project costs were considered trivial and frustration was noted that most clients were short-sighted and not attuned to benefits BIM could provide those [19].

2.3 Competency Needed by BIM Modeller in Design Phase of a Construction Project

The competency are divided to technical skills and non-technical skills. Table 1 will show the competency needed by BIM modeller [20]:

Table 1 - Competency Needed by BIM modeller (Kjartansdottir et al., 2017)

Technical skills	Non-technical skills
Ability to manipulate a 3D model	Communication skills in using BIM
Ability to navigate a 3D model	Negotiation in using BIM
Ability to review a 3D model	Conflict management in using BIM
Knowledge of Building Information Model authoring tools	Authority in using BIM
Knowledge of 3D laser scanning tools	Leadership in using BIM
	Attitude in using BIM

2.4 Recommendation for Improving BIM Modeller Competency

There are five methods in improving BIM modeller competency on this literature review.

2.4.1 BIM Training Among Workers

The BIM training in the construction industry should begin with the development of an IT expert group that will introduce the training plan to designers and other staff [21]. Training involves the choice of hardware because BIM tools require selective hardware to run better. Server settings and settings library for modelling objects. In addition, hiring BIM consultants also needs to assist the design team. Their progress, their willingness to move from old technology to BIM, and their enthusiasm for BIM also require assistance and monitoring. For example, some senior managers assume that designers perform well in computer skills and that they have good knowledge of building virtual buildings, but they still lack architectural skills [22]. Therefore, BIM consultants will help trigger the skills of the designers in order to use the BIM platform to virtualize buildings. In addition, the successful improvement of training methods requires the training of internal and external stakeholders in the organization and informs the adopters of their current progress, including changes made and previous improvements implemented [23].

2.4.2 Tactical Development

In short, architects should only provide architectural elements in the model. Next, engineers will play their part in the analysis structure. In addition, detailed MEP 3D models should not be performed at the same time as the building drawings are generated to avoid multiple revisions [21].

2.4.3 Enhance Effective Collaboration

Design reviews require the collaborative design team in project development to provide appropriate project information, their use, and context to review and obtain feedback. Therefore, it is very important to strengthen the effective collaboration of the design team in the design review to obtain ideas for improvement [21]. In addition, teamwork management can make the team successful and make the business development huge [16]. The traditional design review collaboration is based on drawings, faxes, and actual meetings. However, through the practice of the BIM model, WebEx tools such as Webex and Microsoft Live Meeting can be uses for design review, which can promote efficient collaboration among professional designers. [21].

2.4.4 Capabilities of Maintaining Exchanged Data

The exchange of data in the design should be kept in a useful form for a long period of time in order to provide data protection, leading to practical improvements to future projects [16]. In short, there are various types of architectural design software built with industry-based curriculum (IFCs). IFC is a standard format for exchanging BIM information [24]. IFC supports open standard data formats that allow long-term access for all users. As introduced by the National BIM Standard (NBIMS), IFC improves building project planning, design development, construction phases, operation and maintenance of building information models by promoting the use of standardized, machine-readable and building information models. All keys can be accessed. Participants and stakeholders in the construction project life cycle [16]. The application of IFC also made it possible to integrate and interoperate between designers of different design disciplines [25]. In addition, IFC supports interoperability, which means that data can be exchanged between users using separate software applications.

2.4.5 Mobilizing Client on Importance of BIM

Many stakeholders are afraid of change. The client believes that if the merger conditions change due to the merger of 3D or BIM models, it will affect competitive bidding. This will limit their potential number of bidders and eventually increase the price of the project [26]. This may be because customers do not understand the new technology and its advantages. Therefore, they are afraid of BIM. In fact, it is difficult for the construction industry to implement BIM without customer demand.

3. Research Methodology

The qualitative method was chosen for data collection for first and third objectives of this study. Semi-structured interview were used to collect the data and information from the targeted respondent. From this process, information shaped views and advice can be achieved. This information are important because every respondent have their own opinion and justification. By the interview method, additional information can be obtained. Before the interview session started, question must be drafted. The semi-structured interview was used for this study. Chua (2006) stated, the semi-structured interviews allows both interviewer and respondents to have flexibility in provide and discuss the data and information [27]. Four BIM Modeller were interviewed, all of whom had experience with BIM design in their projects and were willing to collaborate and provide information for this study. The data obtained was analysed and arranged systematically so that it can be formulated properly. The interview data is analysed and transcribed. After the process of analysis data have been done, the benefits of competency among BIM modeller and recommendation to improve the competency during design phase were identified.

As for second objective, quantitative approach using questionnaire survey was used to obtain a structured and more systematic approach. A five-point Likert scale was used in the questionnaire survey to ensure a sensitive measurement of the respondents'. The questionnaires was distributed to 108 respondent and 40 respondent were received for data analysis. The respond rate was 37% and it was acceptable as stated by Fincham that e-mail response rates may only approximate 25% to 30% without reinforcements [28]. The data collected from the survey was then analysed using descriptive method.

4. Result and Discussion

4.1 Respondents Background

In order to complete this research, interview session and questionnaires survey with professionals such as BIM modeller have been carried out. Table 2 shows the respondents background for interview involving 4 personnel who had experience as BIM modeller. This study used semi-structured interview by phone call. The interview sessions were carried out through linked in, email and phone call to make appointments. The entire process of making appointments and interview sessions were take about a month to complete.

Table 2 - Respondent's background for interview

Respondents	Department	Position	Years of Working Experience as BIM modeller
R1	BIM Consultant	BIM Modeller	4
R2	Engineering	BIM Modeller	2
R3	BIM Design	BIM Modeller	1
R4	Engineering	BIM Modeller	3

Table 3 shows the respondents background for questionnaire survey involving personnel who had experience in using BIM. The researcher had succeeded in distributing 108 questionnaires to construction industry who had experience as BIM modeller. This study used random sampling, so there were no specified numbers from each construction industry. The sample size in this study was 108 respondents. The questionnaires distributed through the Google's form, 40 valid questionnaires were received and analyse. Therefore, the response rate was at 37%. The demographic of 40 respondents are summarized in Table 3. Result show almost one-third (75%) of respondents were male and the rest were female (25%). Most of the respondent are 21 -30 years old with 70% followed by 31 – 40 years old with 25% and 5% for respondent with 41 and above. As for experience in using BIM, 77.5% of respondent have 0-5 years' experience compared to 5-10 years with 22.5% and there are no respondent with 10-15 years of experience. Most of the respondent have using Revit architecture with 82.5% and followed by Revit structure (50%) and other software with 52.2%. The respondent mostly are from consultant organization with 70% followed by contractor with 30% with developer and clients with same 2.5% and the others are 10%.

Table 3 - Respondent's background for questionnaire survey

Characteristics		Frequency	Percentage (%)
Age	21-30 years old	28	70%
	31- 40 years	10	25%
	41 and above	2	5%
Gender	Male	30	75%
	Female	10	25%
Respondent experience in using BIM during design phase	0 – 5 years	31	77.5%
	5 – 10 years	9	22.5%
	10 – 15 years	0	-
	>15 years	0	-
Software used	Revit architecture	33	82.5%
	Revit structure	20	50%
	Others	21	52.5%

Organization	Developer	1	2.5%
	Contractor	12	30%
	Clients	1	2.5%
	Consultant	28	70%
	Others	4	10%

4.2 The Benefits of Competency among BIM Modeller during Design Phase

From the interviews, all respondent agreed that competency among BIM modeller will help on growing awareness of BIM in Malaysia construction industry. R1 commend that

"When the awareness are growing by many number programme like seminars, workshops, publication and other else, it will help the BIM modeller to solve the issue during design phase"

This are strongly supported with John Rogers stated that there are increasing seminars, workshop and media on BIM in Malaysia construction industry [19]. R2 added that, BIM modeller also will convince to use the BIM system instead of using CAD, so the courage to use the BIM will improve the design. R3 mentioned that, growing awareness not just helping on the improve design but also improve in the understanding on the project impact to the environment.

In addition, it was found that all of the respondents agreed that competency of BIM Modeller are really important in improving the design. R2 and R4 mentioned,

"The competency of BIM Modeller will improve the design because when BIM Modeller reduce the time taken to draft in the design phase, they can quickly detect a clash in a 3D model"

This statement is supported by John Rogers with same result of research. As for R1 and R3, they both have same perspective that BIM already made with a detailed and accurate calculation so the result of design would be improved by BIM Modeller [19].

Furthermore, all of the respondent are also well aware that competency of BIM modeller are very important in shorten the timescale of project. R1 mentioned that

"Identify the clash during design phase can avoid variation order in construction project".

This perspective also supported by R2 in the interview. R3 and R4 stated that competency of BIM will smooth the workflow between parties, so it can shorten the timescale of the project.

Finally, all of 4 respondents are agreed that competency of BIM can help in reduce cost for construction project. As for R1 and R2, they both stated that through many aspects such as coordination phase by review the model in the software thus reduce the time taken from a party to party in attending coordination meeting, saving time and petrol. Another one is the estimation of material by software is close to cost need than doing it manually. So this aspect will help in reducing the cost in construction project. R3 added that generally,

"Every project will have a low cost when the timescale is short"

So, when BIM is making the progress/workflow smooth and can avoid any future problems, it will also reduce the time and cost of projects. R4 mentioned that, project will have better improvements in risk management and reworks job if the competency of BIM modeller are excellent. The response from respondents are collected and analysis of the interview are summarized in Table 4 below:

Table 4 - Current perspective on competency needed during design phase among BIM modeller

Questions	R1	R2	R3	R4
1. How the growing awareness can help BIM modeller during design phase?	The awareness are growing by increasing number programme like seminars, workshops, publication and other else, it will help the BIM modeller to solve the issue during design phase	BIM modeller also will convince to use the BIM system instead of using CAD, so the courage to use the BIM will improve the design.	Growing awareness not just helping on the improve design but also improve in the understanding on the project impact to the environment.	BIM modeller would be more understand on BIM and project
2. How the competency of BIM can improve design in design phase?	BIM already made with a detailed and accurate calculation so the result of design would be improved by BIM modeller.	Competency of BIM Modeller will improve the design when BIM Modeller reduce the time taken to draft in the design phase	BIM already made with a detailed and accurate calculation so the result of design would be improved by BIM modeller.	they can quickly detect a clash in a 3D model
3. How did the competency on BIM	Identify the clash during design phase	Identify the clash during design phase	Competency of BIM will smooth the	Competency of BIM will smooth the

can shorten the timescale of projects?	can avoid variation order in construction project	can avoid variation order in construction project	workflow between parties, so it can shorten the timescale of the project.	workflow between parties, so it can shorten the timescale of the project.
4. How did the competency on BIM can reduce cost of overall project?	Through many aspects such as coordination phase by review the model in the software thus reduce the time taken from a party to party in attending coordination meeting, saving time and petrol. Another one is the estimation of material by software is close to cost need than doing it manually.	Review the model in the software thus reduce the time. Another one is the estimation of material by software is close to cost need than doing it manually.	Every project will have a low cost when the timescale is short. So, when BIM is making the progress/workflow smooth and can avoid any future problems, it will also reduce the time and cost of projects.	Project will have better improvements in risk management and reworks job if the competency of BIM modeller are excellent.

4.3 The Competency Required by BIM Modeller During Design Phase

The second research objective is to identify the competency needed by BIM modeller during design phase. In order to critically identify the competency needed by BIM modeller during design phase the research objective is analysed through questionnaire survey. In general, the competency are divided to two category as technical skills and non-technical skills. Descriptive analysis was used to analyse demographic data obtained through this study. The introduction analysis aimed to determine the characteristics of each variable in the study sample through descriptive statistical analysis [29].

4.3.1 Competency Required by BIM Modeller During Design Phase (Technical Skills)

According to the questionnaire form, respondents were asked about competency needed by BIM modeller during design phase. In this section, 5 questions were asked by the researcher to the respondents. This first 5 question are part of technical skills. A 5-point likert scale was used to measure the level of agreement of respondents. The detail of scale as showed in Table 5 below and for the purposes of interpretation, this study divides the mean score into three levels as showed in Table 6.

Table 5 - The detail of scale for items

Scale	Interpretation
1	Strongly disagree
2	Disagree
3	Neutral
4	Agree
5	Strongly agree

Table 6 - Determining the level of mean score [30]

Mean score	Level
1.00 - 2.49	Disagree
2.50 – 3.49	Neutral
3.50 – 5.00	Agree

Table 7 shows a mean score and a standard deviation for competency needed by BIM Modeller in terms of technical skills. The highest score means is 4.35 which is the majority of respondents strongly agree that the ability to review a 3D model is competency needed for BIM modeller during design phase. Besides that, they also strongly agree that ability to navigate and manipulate a 3D model also needed in competency for BIM modeller during design phase with 4.3 and 4.2 mean score. Therefore, they strongly agree that knowledge of BIM authoring tools also competency needed by BIM modeller during design phase with 4.0 mean score. However, majority of respondents are neutral on

knowledge of 3D laser scanning tools with 3.0 mean score. They did not sure or moderately about knowledge of 3D laser scanning tools.

Table 7 - Mean score for competency (Technical Skill) needed by BIM modeller

Item	Mean score	Standard deviation	Level
Ability to manipulate a 3D model	4.2	0.85	Agree
Ability to navigate a 3D model	4.3	0.78	Agree
Ability to review a 3D model	4.35	0.83	Agree
Knowledge of Building Information Model authoring tools	4.0	0.8	Agree
Knowledge of 3D laser scanning tools	3.0	1.17	Neutral

4.3.2 Competency Required by BIM Modeller During Design Phase (Non-Technical Skills)

According to the questionnaire survey, respondents were asked about competency needed by BIM modeller during design phase. In this section, 6 questions were asked by the researcher to the respondents. This 6 question are part of non-technical skills. A 5-point likert scale was used to measure the level of agreement of respondents. The detail of scale as showed in Table 5 on top and for the purposes of interpretation, this study divides the mean score into three levels as showed in Table 6.

Table 8 shows a mean score and a standard deviation for competency needed by BIM Modeller in terms of non-technical skills. The highest score means is 4.25 which is the majority of respondents strongly agree that attitude in using BIM are competency needed by BIM modeller during design phase. Besides that, they also strongly agree that communication skills in using BIM are needed for BIM modeller competency during design phase with 4.2 mean score. Therefore, they strongly agree that conflict management in using BIM are competency needed during phase with 3.9 mean score and they also agree that leadership in using BIM are competency needed for BIM modeller during design phase with 4.0 mean score. However, majority of respondents with 3.8 mean score that negotiation in using BIM are competency needed for BIM modeller. Same as authority in using BIM with 3.7 mean score as competency needed by BIM modeller.

Table 8 - Mean score for competency (Non-Technical Skill) needed by BIM modeller

Item	Mean score	Standard deviation	Level
Communication skills in using BIM	4.2	0.78	Agree
Negotiation in using BIM	3.8	0.86	Agree
Conflict management in using BIM	3.9	0.91	Agree
Authority in using BIM	3.7	1.12	Agree
Leadership in using BIM	4.0	0.83	Agree
Attitude in using BIM	4.25	0.70	Agree

The findings for second objective was achieved through questionnaire survey on the competency needed by BIM modeller during design phase. From the results, they are demonstrated to total of 11 competency needed by BIM modeller. The competency are divided to technical and non-technical skills. The technical skills have all agreed by the respondent with high mean score. The ability to manipulate, navigate and review a 3d model are all have high mean score with 4.0 and above. Except for knowledge of 3D laser scanning tools with 3.0 mean score which is considered as neutral. This result of questionnaires are same as stated by Kjartansdottir of the competency needed during design phase in practicing BIM [20]. As for non-technical skills, all of the variables were agreed by respondent as attitude are the most agreed by respondent with 4.25 mean score and finished by authority in using BIM with 3.7 mean score. This was supported by Jefferies as communication, negotiation, conflict management, authority, leadership and attitude are all important competency needed [31].

4.4 Recommendation to Improve BIM Modeller Competency During Design Phase

The third research question is "What are the steps to improve competency of BIM modeller during design phase?" To achieve this research question, semi-structured interviews were conducted to have better understandings. In general, five recommendations have been discussed.

All of respondent are agreed that BIM training among the workers can improve the BIM competency level. R2 mentioned that,

"Training are the most important part for BIM modeller to enhance their skills and competency using BIM during design phase"

R1 and R2 stated that proper plan for practice such as understanding the standard design requirement are really important for BIM modeller competency during design phase. As for R3, he trust that a perfect proper plan for practice

are to understand the basic of designing and does not jump to advanced phase, this will help to improve the competency of BIM modeller during design phase.

Secondly, it was agreed by the respondents that tactical development was one of the method to improve the BIM competency level for BIM modeller during design phase. All of the respondent agreed that the role of architecture and structure must be provide by stage starting from architecture part, structure, mechanical and then electrical part. This tactical development was to avoid repeated revisions on the design phase.

Thirdly, all respondents agreed that enhance effective collaboration between BIM project team play a vital role in improving the competency of BIM modeller during design phase. R1 and R2 mentioned that, by sharing the knowledge's and experience between the team can help in improving the competency. R3 added that

"When BIM project team held a meeting to identify and solve the issue between architecture, structure, mechanical and electrical BIM modeller, all of the parties usually get a new input for their skills and knowledge. So, it was really helping in improving the BIM modeller competence during design phase"

As for R4, he stated that with effective collaboration between project team it would have better planning on workflow and coordination

The fourth strategy of exchange of data between the software was not agreed by all the respondents. R1 disagree by stating that,

"There will be no good in improving the competency of BIM modeller during design phase because the capabilities of maintaining the exchanged data between the BIM modeller are not much input if there were differences in product or software".

However, R3 and R4, were both agreed that capabilities of maintaining the exchanged data would be a great help in improving the BIM during design phase. R3 stated that, the exchanged data would make them easier to gain information and smoothen the process besides improving their software knowledge and skills. R4 then mentioned that, it would help in improving the accuracy of quantity of the projects in addition to hone up their skills.

Lastly, as for mobilizing client on importance of BIM strategy would be an important method to improve BIM modeller competency during design phase and it was all agreed by the respondents. When the clients already aware of BIM advantages, then a BIM modeller would be a high demand in construction industry making the BIM modeller to improve their technical and non-technical skills on BIM to improve their own competency. As for all the respondent individual recommendation, R1 and R3 have same opinion on improving the competency for BIM modeller, they stated that BIM modeller should join the training and practice based on the design requirement and to have a competent software training. As for R2, he mentioned that the encouragement from company are important to help improving the competency of BIM modeller. R4 added that,

"More site experience on construction are also vital part to improving the BIM competency modeller".

The response from respondents are collected and analysis of the interview are summarized in Table 9.

Table 9 - Interviewees view towards the recommendation of improving the competency of BIM modeller during design phase

Question	R1	R2	R3	R4
1. Based on your experience, what are the best method to improve the competency of BIM modeller during design phase?	Join the training and practice based on the design standard requirement	The encouragement from the company	To have a competent software training.	Get more site experience on construction sequences.
2. How the proper plan for practice can help improve the BIM competency level?	Must understand the standard design requirement	To start BIM in design phase first and coordination work after to avoid site issue	It will help the BIM Modeller to understand the basic of designing and not jump to advanced phase. This will improve the competency level of BIM	Better planning in schedule, and constructible drawing issued to contractor.
3. How tactical development can improve BIM modeller	It is compulsory to follow the sequences to avoid multiple revision. Do more	Structured step of designing	Less multiple revision	Could improve the speed of design process

competency?	detail design and involve the project on site			
4. How team management make the team successful and improve BIM modeller competency?	Share knowledge's and experiences between team members	Knowledge sharing among team members	By having a good communications between every team member.	To have better planning on workflow and coordination.
5. How exchange of data between the software can help BIM modeller improve their competency?	No good in improving the competency of BIM modeller during design phase because the capabilities of maintaining the exchanged data between the BIM modeller are not much input if there were differences in product or software	BIM modeller would gain more information	It would make them easier to gain information and smoothen the process.	To Improve the accuracy of quantity in projects
6. Why did the client afraid of change from CAD TO BIM?	Lack of expertise in BIM Software	Because they didn't understand the pros of using BIM instead of CAD	It will help the client to understand that BIM is to reduce risk and time. BIM is more complicated since it needs to have a server in order to make a file available to everyone.	They might not afraid, but reluctant. This might involve a large capital in term of training, software subscription, and IT to start.

The findings from the interview indicates that BIM training among workers, tactical development, enhance effective collaboration, capabilities of maintaining exchanged data and mobilizing client on importance of BIM were agreed upon by all interviewees as recommendation to improve BIM competency during design phase. It is believed that all the variables are important in BIM competency by BIM modeller during design phase. Majority of the perspective have been discussed and get the approval from the respondent. The recommendation of BIM modeller are based on the project conducted. The perspective has been discussed with supporting statements by the interviewees and some points were supported by local and oversea researches. As stated by Arayici, there are five main recommendations, especially BIM training among workers, tactical development, enhance effective collaboration, capabilities of maintaining exchanged data and mobilizing client on importance of BIM. These recommendations are common with the recommendation identified by the various interviewees [23].

5.0 Conclusion

This study has provided an overview on the current perspective on BIM competency during design phase, the competency needed by BIM modeller during design phase and recommendation to improve BIM modeller competency during design phase. Qualitative and quantitative method was used in this research approached via semi-structured interview and questionnaires. The respondents of this research is BIM modeller.

Based on the research findings, all the research objectives were successfully achieved. The current perspective on competency needed by BIM modeller during design phase related to growing awareness, improves design, shorten timescale and reduce cost are significant. Then, competency needed by BIM modeller during design phase are technical skills such as manipulate, review and navigate a 3D model are important followed by knowledge of BIM authoring tools and knowledge of 3D laser scanning tools are needed. In addition, recommendation for improving the competency of BIM modeller during design phase are BIM training among workers, tactical development, enhance effective collaboration, capabilities of maintaining exchanged data and mobilizing client on importance of BIM are all agreed.

Although the research have achieved its objectives, there were some unavoidable limitations. The limitations that surfaced throughout the whole research are including there are no clear data about company that appoint BIM modeller in their construction team, the focus of this research is only during design phase and not the entire construction project

life cycle. In conclusion, this research has explained all the data and information regarding to competency needed by BIM modeller during design phase and how to improve it. The researcher has completed the research as well as achieved the objectives in this research. It was hope that this research can be a guide for government and other parties to improve BIM competency level for BIM modeller.

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