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The Level of Knowledge and Skill of UTHM Engineering Lecturers on Building Information Modeling (BIM)

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Abstract: This research is to identify the level of knowledge and skill of Universiti Tun Hussein On Malaysia (UTHM) engineering lecturers on Building Information Modeling (BIM). BIM is a new adaptation of computer-aided technology and widely used in architecture, engineering, construction (AEC), which is replacing a 2-dimensional (2D) drawing with a 3-dimensional (3D). The application of this digital technology and construction helps the construction achieve remarkable quality and productivity changes. Today, the less personal competence in applying BIM for jobs in this industry became a major issue. According to the problem, it's quite important for universities to teach this new technology in construction educational program. The investigation was done through a survey where 60 questionnaires were sent using google form via email and text to facilitate the data collection process and the complete questionnaire received back were analyzed with mean index and ranking method. The finding of this study shows that the level of knowledge of UTHM lecturer on BIM needs to be improved. Lack of awareness is the main challenge in implement BIM at university. Some of the recommendations, such as training programmed will be effective strategies in enhancing the level of BIM knowledge and skill of UTHM engineering lecturers.

Keywords: Knowledge, Lecturers, BIM

1. Introduction

Nowadays, the importance of education to humans and the development of learning resources must be emphasised. Education is key in the process of human resource as a daily human activity [1]. As a result, the lack of knowledge and skills is the challenge that must be faced in order to achieve successful competence in any professional or business organisation, as well as at the national level for economic benefit [2].

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BIM is a new technology and tool that signifies the new developments in the construction industry [2]. Today, the lack of ability to apply BIM tools is one of barrier on why educational exposure to lecturers in universities is weak. Generally speaking, there is the technology associated with computer-based technology and program or in another term, software. There are many software available that suitable to develop at universities. For example, the most common software is Automated Computer-Aided Design or Drafting for design, Microsoft Project for planning, and Esteem for detailing.

The advantages of BIM technology are its creative approach to repeatedly preserving this method so that this BIM can be applied to the project's entire life cycle. BIM should be implemented in the education of architects and other construction companies [3]. Many universities now use BIM teaching programs, which are generally limited to software application training.

Nowadays, construction industry alerted that failure to accept this trend at education institution is an essential challenge [4]. There can also be challenges to BIM integration because of inflexible or tight curricular that cannot withstand elective courses and also there can be restrictions due to graduation demands and even lack of reference materials in teaching [5]. Today, the lack of manpower to understand BIM for jobs in this industry became a significant issue [4]. To have a consistent supply of appropriate BIM workforce for the construction industry, knowledge and also skills on BIM industrial player have to be incorporated into higher education academic program.

In terms of industry, there is still a scarcity of BIM-trained professionals in Malaysia. Education and learning preparation for BIM is very important to implement the application in the Malaysian construction industry and states the requirement for BIM to be an essential part of institutions [6]. In terms of education, it is clear that universities are increasingly required to provide their graduates with appropriate knowledge and BIM skills in architecture, civil engineering, building construction, and construction project management programs.

2. Building Information Modeling (BIM)

BIM has gained popularity in recent years. It has been determined that it is one of the new ideas which will help in the expansion and transformation of the Architecture, Engineering, and Construction industry. BIM refers to the process of replacing a 2-dimensional (2D) drawing with a 3-dimensional (3D) model as part of an architectural design [7].

Today, BIM is not a new technology in Malaysia, but it is still not commonly used in the industry player. Even though a few AEC companies in Malaysia already get used to BIM application, the users are still trying to figure out how to maximize the use of BIM in Malaysia's construction industry. Due to the unique aspects of construction and the complexity of the industry, an innovative application known as BIM was developed to solve industry fragmentation and a lack of communication between the parties involved.

In the construction industry, the use of new technologies has improved design quality through the use of virtual modelling [8]. Furthermore, greater awareness of new technologies should be encouraged among academics and industry in order to adapt new technologies in construction. Nowadays, the level of knowledge and skills on BIM is important, which is a technology that facilitates data transfer and ensures cooperation between designers, engineers and contractors that can provide an effective way to estimate costs and plan schedules.

2.1 BIM tools

In recent years, the architecture, engineering, and construction industries are seeing an improvement in using of the software application that processes building information models for visualization of building projects. User’s models have changed from traditional 2D drawings and written specifications to parametric object-oriented 3D models created with modern modelling software such as ArchiCAD, Revit Architecture, and all plan architecture embedded with information to detail any historical structure [9]. Each tool has its own set of functions, and they used the analysis result based on software to manage various activities in a building or construction project [10]. Lastly, there are several companies

in Malaysian are involved with BIM by providing consultancy services, training, and BIM tools to support BIM implementation in the construction industry.

2.2 BIM application in Malaysia

BIM application is the most recent technology in the AEC industry, consisting of a set of tools for managing construction projects efficiently and effectively. BIM applications in construction projects provide numerous benefits to building and construction, such as improving structural connections and assisting in faster design decisions [11]. BIM technology has recently been introduced and applied in engineering construction as a result of the development and stimulation of related policy. In China, the IDS package and architecture software such as INVENTOR were used as core software in the BIM design of the Xingu Mountain tunnel. As a result, the BIM application in this project established a solid foundation for the development of BIM technology [12].Furthermore, according to industry insiders, the key challenges to the expansion of BIM are a lack of experts, a lack of information interoperability, and changes in workflow [13]. The findings of the analysis, the primary applications of BIM in Malaysia are "amount take-off and estimation," "collision detection and coordination," "integration and collaboration of stakeholders," and "design and visualization." Finally, according to the findings of this study, Malaysian construction industry productivity is likely to rise in order to meet population demand [14].

2.3 BIM implementing process and technology

The use of BIM has provided significant benefits to the construction industry [7]. These relationships explain the demand for launching BIM adoption and promote information among parties, raise awareness, and improve readiness to be implemented in their work environment in promoting BIM implementation. BIM application in construction projects can reduce waste and safety issues in construction, resulting in project completion quality. Implementing BIM in the construction industry can improve overall project quality and the industry's image [15]. According to the findings of this study, the adoption and use of BIM technology concepts within organizations has a significant impact on professionals and management skills [16]. The results of the investigation show that BIM education and learning is not quite enough and it should be developed and improved Gained BIM competencies in FCEA research study programs marge the essential knowledge of study field and digital technology managed [17].

2.3.1 Benefits of BIM

In recent years, by applying BIM in construction projects has provided a variety of functionalities as well as important benefit to the industry. As stated by CRC Construction Innovation, the main advantage of BIM is its accurate geometrical representation of building parts in an integrated data environment [18]. Other than that, adopting BIM can reduce design costs by gaining early access to the construction market. The benefits of using BIM in building construction can be seen throughout the construction process. Finally, BIM in construction projects provides numerous advantages and can improve project quality [19].

2.4 Knowledge of BIM learning competencies

In the beginning, it is necessary admit that scientists do not agree on the meaning of the term competency. BIM Task Group has acknowledged that BIM is such a wide-open subject with analyses differing throughout the supply chain that have spent a year just trying to define BIM [20]. For a subject that is open to various interpretations, teaching BIM has its challenges and opportunities. Studied over 100 US-based AEC programs and also discover inconsistencies on how BIM was adapted and accepted by many institutions, based on cultural, economic and academic differences [21]. The process-oriented approach taken for teaching BIM to graduate students is an interesting example that covers many fields such as cost estimating scheduling and 4D Simulation, MEP Design Coordination, 3D Point Clouds and power Simulation [22]. Individual traits, professional knowledge, and technical abilities required by an individual to perform a BIM activity or deliver a BIM related outcome are referred to as specific BIM competencies [23]. These abilities, activities, or outcomes must be measurable in comparison to performance standards and can be acquired or improved through education, training, or development.

2.4.1 BIM in higher education

There is still a lack of stabilization of industrial needs in terms of manpower to the construction industry in the education sector, particularly in higher education institutions. Nowadays, education is insufficient on improving BIM skilled talent of software because it primarily focuses on theoretical knowledge. According to the findings, 73% of participants believe that the industry is simply not clear on what BIM is [23]. This result is a marked improvement in previous years among the market industry. As good as an improvement, this last result would certainly be rather if higher education establishments allowed graduates to leave university without any awareness of BIM themselves. The biggest obstacle in adapting BIM software on engineering education to meet the demands is a lack of university resources. The importance of learning BIM in higher education is helping to ensure that students migrating into the industry are knowledgeable and skilled in implement BIM. Finally, because BIM is a new concept, there is considerable uncertainty about how to implement BIM in universities and determine the various teaching and learning strategies of BIM in education.

2.4.2 Readiness in seeking of learning of BIM

The concept of readiness has been discussed, and [20] stated that the concept of readiness cannot be defined because it is dependent on contexts, situations, and the individuals involved [24]. Today, students in Malaysian public universities show a high level of readiness in terms of entrepreneurial willingness and capabilities. Academic readiness in universities refers to the integration of BIM knowledge and skills in order to enable education and training of BIM competence for the industry's increasing market needs [25]. The level of readiness could be an indicator of how much each organization is ready to execute BIM in their organization and project. To know the qualitative of this research, a questionnaire survey was created to identify the level of knowledge and skill of UTHM engineering lecturers on BIM. The survey checks the overview of BIM, the level of knowledge and readiness of UTHM lecturers in teaching and learning BIM. In Malaysia, many universities are having problem due to lack of information regarding BIM in the university among students and lecturers.

3. Material and method

This is method that is used to analyze the data that has been collected from the completed survey by questionnaire as the validation for this study. In this study, the used of questionnaire as the method for gathering data was considered in this analysis. The data collection approaches are via internet mediums such as WhatsApp, e-mail, and google form to facilitate the data collection process. After all, the data collected and analyses being done, the result will show whether the data is reliable and valid or not.

There are four parts in this questionnaire which is Part A, Part B, Part C and Part D. This research will be conducted at Universiti Tun Hussein Onn Malaysia (UTHM) and restricted to engineering lecturers. Table 1 showed type of part in questionnaire.

Table 1: Type of part in questionnaire

PART A	• Respondent's background (name, age, gender, faculty)
PART B	• This section is to rank knowledge and skill regarding BIM from previous literatures review. • This section uses five-point of agreement Likert scale for respondents to choose.
PART C	• This section is to identify the readiness of UTHM lectures in teaching and learning of BIM. • This section uses five-point of agreement Likert scale for respondents to choose

Table 1: Type of part in questionnaire (Continued)

PART D	• This section is about comment and suggestion lecturers on BIM • This section uses five-point of agreement Likert scale for respondents to choose. • In this section, respondent required to comment and give suggestion towards the usage of BIM application in Malaysia

The data obtained were analysed by using SPSS program version 10. The data obtained were processed using frequency analysis and mean index. To make it more understandable, a graphical bar chart was performed. The data analysed using SPSS produced more accurate data, and the results can help achieve the objectives of this study.

4. Results and Discussion

The analysis of the data was divided into two parts in this chapter. Quantitative analysis is the numerical analysis for questions that ask the level of knowledge and skill of the UTHM engineering lecturer and the readiness of UTHM lectures in teaching and learning BIM. The data collected were analyzed using computer software that is SPSS Inc Version 21 and Microsoft Excel Spreadsheet 2013. The result of this analysis is presented as frequency, mean index, standard derivation, while the discussion of the results is presented in better understandable diagrams.

4.1 Part A: Demographics (General Information of Respondents)

Part A is about the respondent's background. From the questionnaire that has been distributed, total feedback of 60 showed various backgrounds. Based on the questionnaire that has been distributed, most of the respondents are male, which is 35 people (53.8%), and the majority of respondents are aged between 21-30 years (55%). From Table 4, 26 respondents (43.3%) are from FKAAB, 11(18.3) from FKEE, 13 (21.7) from FTK, and minority respondents are from FTK 10 (16.7%) faculty, as shown in Table 2.

Table 2: Respondent demographics from part A

N0.	Description	Frequency	Percentage (%)
1	**Gender**		
	Male	35	58.3
	Female	25	41.7
2	**Age**		
	21 to 30	33	55
	31 to 40	10	16.7
	41 to 50	11	18.3
	51 an above	6	10
3	**Faculty**		
	FKAAB	26	43.3
	FKEE	11	18.3
	FKMP	13	21.7
	FTK	10	16.7

4.2 PART B: The level of knowledge and skill of UTHM engineering lecturers in BIM

For part B, the survey was about the level of knowledge and skill of UTHM engineering lecturers in BIM. The Likert Scale method was used for this section. Respondents were given a scale ranging from strongly disagree to strongly agree on a scale of one to five. All the questions in this part were constructed based on the literature research in the earlier chapter.

Based on the data analyzed, each question for each part of the questionnaire is ranked based on the mean index. The questions were sorted in order of highest mean index to lowest mean index. The highest mean index indicates that UTHM engineering lecturers have a high level of BIM knowledge and skill.

In contrast, the lowest mean index suggests that the level of knowledge and skill of UTHM engineering lecturers on BIM low. In this study, standard derivation is used to measures the dispersion of the data. The greater the value of standard deviation, the further the data tend to be dispersed from the mean. Table 3 below show the mean index, standard derivation and rank for the level of knowledge and skill of UTHM engineering lecturers on BIM.

Table 3: The mean index, standard derivation and rank for the level of knowledge and skill of UTHM engineering lecturers on BIM

Identify the level of knowledge and skill of UTHM engineering lecturers on BIM	No of scale					Mean Index	Stdev.	Rank
	1	2	3	4	5			
Part B: Level of knowledge and skill of UTHM engineering lectures on BIM								
B1- Already know about Building Information Modelling (BIM)	3	3	7	18	29	4.12	1.121	2
B2 - Already know the basic knowledge of Building Information Modeling (BIM)	3	6	14	21	16	3.68	1.127	5
B3 - Lecturers have a sufficient training education related to BIM	4	8	11	12	25	3.77	1.307	4
B4 - BIM Lack of skilled talent is one of the main reasons why BIM is pacing slow in education	3	1	6	24	26	4.15	1.022	1
B5- University already provided any training / education on using BIM software? (Example: Revit/Tekla)	5	8	8	22	17	3.63	1.262	6
B6 - No inquiries on policy/course training modules from the government to be implemented BIM in R&D activities in institutions of higher education	2	5	12	19	22	3.90	1.100	3

Based on the result, lack of skilled talent is one of the main reasons why BIM is pacing slowly in education. This is due to the fact that BIM is a relatively new technology that has yet to be widely adopted in universities. The most major barrier issue that organizations face when implementing BIM is a lack of personnel skills and knowledge [26]. In terms of continuous learning for professional upskilling and reskilling, the government has established MyBIM Centre as a BIM training center that provides a variety of rigorous BIM proficiency training at an affordable cost and time [27]. Then, the engineer's organization has supported the implementation of a new BIM application training course.

The second-ranking with a mean index of 4.12 and standard derivation of 1.121 is the majority of respondent’s state that they already know about BIM because they have heard it before. However, only half of the respondents have a basic knowledge of BIM, with a fifth ranking and a mean index of 3.68. Furthermore, because BIM is not widely used at universities, most respondents lack basic knowledge regarding BIM skills, which makes implementing BIM at universities complex. This has been a problem since 2013, as past reports have shown that a lack of BIM knowledge is one of the significant issues. Then, BIM is also at a low level in university because BIM has just been introduced at the university level [28]. The Federal University has launched a new educational programme called "Artificial Intelligence in Capital Management" [29]. The system provides the overall teaching of environmental design and information modelling concepts through a practice-oriented technique.

For the third-ranking with the mean index of 3.90 and standard derivation of 1.100 are no inquiries on policy or course training modules from the government to implement BIM in R&D activities in higher education institutions. BIM is a new thing and not be so widely known in Malaysia. In Malaysia, only a few institutions or industries have been exposed to BIM. According to BIM education, universities are still looking for the best way to implement the best and most efficient BIM education in Malaysia and prepare employees with BIM skill talents [21]. To ensure that BIM education and training are effective, the government should strengthen the Centre of Excellence for BIM Research and Development to ensure that the technology is constantly updated in line with advances in global construction technology [30].

Based on the table above, lecturers who have sufficient training education related to BIM have rank with a mean index of 3.77. The parameter used to construct the questions was based on several journals that mention integrating BIM into higher education. In addition, government and industry collaboration in providing in-house training, seminars, and workshops to improve BIM knowledge and expose lecturers to the real-world BIM situation to promote their interest in BIM [30] . BIM education and training can be a guideline for Malaysia in order to empower BIM education, as the initiative has increased the number of skilled talents in those countries.

Lastly, the data obtained shows that the question on university already provided any training or education on using BIM software such as Revit and Tekla get lowest ranking with the mean index 3.683 and standard derivation 1.262. Finally, the high cost of providing BIM laboratories complete with BIM hardware, software, and the BIM instructor is a barrier for universities. Although most lecturers are aware of the benefits of implementing BIM technology in the classroom, not all lecturers have access to the necessary software.

4.3 Part C: Readiness of UTHM engineering lecturers in teaching and learning of BIM

For part C of the questionnaire is based on the second part of the objective which is the readiness of UTHM engineering lecturers in teaching and learning BIM. This part consists of five questions that are also constructed based on the literature research done before. Likert scale was also given to the respondents to choose based on the respondent's level of agreement. Table 4 below show the mean index, standard derivation and rank for the Readiness of UTHM lecturers in teaching and learning of BIM.

Table 4: The mean index, standard derivation and rank for the Readiness of UTHM lecturers in teaching and learning of BIM

Readiness of UTHM lecturers in teaching and learning of BIM	**No of scale**					**Mean Index**	**Stdev.**	**Rank**
	1	2	3	4	5			
Part C: Readiness of UTHM engineering lecturers in teaching and learning of BIM								
C1- Ready to adapt BIM for teaching and learning	2	3	9	16	30	4.15	1.071	1
C2 - Lack of expertise regarding to BIM subject	1	8	8	27	16	3.82	1.033	3
C3 - Have sufficient materials in teaching	4	6	16	13	21	3.68	1.242	5
C4 - Not ready to adapt BIM as a tool in education	2	8	11	22	17	3.73	1.118	4
C5 - Lack of usability and complexity of the software	2	3		9	20	26	4.08	1.046

BIM implementation is consistently predicted by an organization's readiness to adapt the technology and apply it in university. However, the bar chart in Table 4 represents the mean index of readiness of UTHM lecturers in teaching and learning BIM is very low. This shows that the university has not widely implemented BIM in education.

The data obtained shows that ready to adapt BIM for teaching and learning is scored the highest ranking with the mean index of 4.15 and standard derivation of 1.071. It shows that many lecturers are ready to adapt BIM for teaching and learning. By developing BIM courses and introducing them in universities, polytechnics, and technical colleges, a wide range of BIM knowledge can be delivered, including BIM concept and theory, fundamental modelling for architecture and structure, BIM coordination, and various BIM software training for individual BIM competence. The collaboration of government and industry in providing a seminar and workshops to improve BIM knowledge and expose lecturers to real-world BIM situations is also a catalyst for lecturers' readiness to adapt BIM in teaching and learning.

The second-ranking with mean index 4.08 and standard derivation 1.046 is the majority of respondent's state that lack of usability and complexity of the software is one of the hitches. The teachers or lecturers also lacked real industry experience and accreditation in BIM operation, which can contribute to the difficulty of understanding the BIM system and the uncertainty of BIM software (Revit, Bentley, etc.) [31]. Furthermore, limited funding in providing BIM laboratories fully equipped with BIM hardware, software, and a BIM instructor is a barrier for universities due to the high cost.

Third-ranking with the mean index of 3.82 and standard derivation of 1.033 is lack of expertise regarding the BIM subject. There is an obvious that lack of BIM expertise in university, especially those who capable of managing and running BIM subject. The majority of respondents agreed that the main barrier is a lack of expertise. In addition, lack of educators that expertise in the subject is one of the hitches why BIM knowledge isn't very extensive at university [32]. Educators have not been trained to teach BIM content, which give a negative impact on the curricula they design and deliver [33].

Not ready to adapt BIM as a tool in education showed the average index of 3.73 with the standard derivation 1.118 as a fourth ranking place. BIM tools are very important in BIM technology. However, because BIM is a new tool, many people are unfamiliar with it. Concerning that, limited funding in providing BIM laboratories fully equipped with BIM hardware, software, and a BIM instructor is a barrier for universities due to the high cost [34]. In addition, lack of ability to apply BIM tools is one of the barriers to why educational exposure to BIM tools to lecturers in universities is weak [35]. The majority of the lecturers in university do not expose to BIM technology is the factor why lecturers not ready to adapt the BIM tool in education.

Next, from the data obtained shows that the question on lecturers has sufficient material in teaching is the lowest ranking with mean with the mean index 3.68 and standard derivation 1.242. One of the major impediments to developing engineering education is a lack of material and conservative practices at universities. One of the most significant challenges is the lack of BIM textbooks and other educational resources, as well as the limited number of courses available to students. Furthermore, BIM lecturers should be at the forefront and important step that engineering education should focus on, as well as initiate close collaboration with industry players [36] . To be successful, the lecturer must integrate both traditional learning methods, which necessitates complex teaching-learning assignments that allow for the application of formal project management theories through role-playing in simulated environments of real-world projects [37].

4.4 Part D: Comments and Suggestions

Based on question in part D the respondents did give the comment and suggestions about the usage of BIM application in university. The comments and suggestions are separated into several points. The second question is the respondent's comment and suggestion towards using BIM application in Malaysia, especially in university. For this question, there are various feedbacks from the respondents. To summarize it, the answers are concluded into several points. The summarization is in the discussion part.

4.4.1 Government support

In general, less effort from the government towards BIM implementation is why BIM in universities is at a low level of stagnant [38]. Based on the respondent's comments and suggestions, the government should play a vital role in promoting BIM implementation in university and giving full support regarding funds and training to the lecturer. Through this effort, BIM implementation can be successful process and increase the achievement in BIM development in university in the future. In terms of ongoing learning for professional upskilling and reskilling, the government has established MyBIM Centre as a BIM training center offering various intensive BIM proficiency training at an affordable cost and time [30].

4.4.2 Clear guidelines

Based on the questionnaire's part C, most respondents agree that lack of standard information and limited availability of usage guidelines in Malaysia, especially in the university, is one of the challenges in implementing BIM. According to the comment and suggestions from respondents, clear guidelines and standard specifications for universities from the industry would be helpful for lecturers to apply BIM subject at university. Currently, agencies and boards of organizations such as CIDB and Building SMART are developing guidelines documents for BIM implementation in the Malaysian construction industry, where the BIM platform will become a project requirement throughout Malaysia [39].

4.4.3 University Support

BIM education is viewed as crucial in developing BIM-skilled talent, especially in terms of enhancing their performance and skills in the field. Based on the comments and suggestions from the respondents, exposure to BIM applications at the university should be from the beginning by creating a specific subject for BIM in engineering. Furthermore, comprehensive BIM training should be provided in tertiary education, whether through a software application or on-the-job training, to expose potential talents to the real-world environment while increasing awareness and interest in BIM among lecturers. Malaysia's construction industry and the Ministry of Education must collaborate to develop a strategy for developing BIM-skilled talent [30] .

4.4.4 Level of BIM uses

Nowadays, every technology has it owns level. To achieve success as a developed country, the citizen must be fulfilling the knowledge of BIM. Currently, exposure to BIM in universities is not so widespread, and still learning process plus the development are not as promising as the countries which have been having implemented BIM in universities. To make BIM application usage at capacity, some of the respondents suggest that make BIM usage as a process-driven skill to all the lecturers, provide more training and education programs. The role of lecturers in increasing BIM knowledge and expertise is important, and it should begin at the secondary and tertiary levels to ensure that students are aware of and ready to accept BIM technology.

5. Conclusion

BIM knowledge and skills are important for BIM implementers to express their confidence in teaching. Throughout the literature review and data analysis, it can be concluded that knowing the level of knowledge and skills of UTHM engineering lecturers on BIM is very important before BIM can be introduced more widely in the university. BIM is in its early stages of development in Malaysia, so there needs a requirement to promote it into higher education institutions. The main reasons are a lack of understanding, technical issues that prevent users from using the software. Finally, lecturer's knowledge of BIM should be improved so that they can teach students on how to adapt BIM at university. Lots of BIM knowledge can be delivered by introducing BIM courses in universities, polytechnics, and technical colleges by creating BIM courses, such as BIM concept and theory, fundamental modelling for architecture and structure. Next, the main reason why lecturers lack of readiness in teaching and learning BIM because they do not have sufficient material in teaching, not ready to adapt to BIM as a tool in education, and lack usability and complexity of the software. The majority of lecturers lacked the real-world industry experience and accreditation in BIM operation,

which can contribute to the difficulty of understanding the BIM system and the uncertainty of BIM software. Finally, in order to improve the readiness of lecturers and those who already working in the industry, the change in mindset and willingness to adapt BIM must be accelerated through upskilling and reskilling to keep up with current technology advancement.

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