Investigating Building Information Modelling (BIM) Adoption in Vocational High School Learning

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ABSTRACT

Building Information Modelling (BIM) is one of the responses of the construction industry in the face of the Industrial Revolution 4.0. The construction industry around the world is familiar with BIM Technology with various advantages, including Indonesia. The Government of the Republic of Indonesia strongly encourages the construction industry that has implemented BIM Technology with various laws and regulations both in the field of construction industry and education of prospective construction workers. This research aims to investigate the current status of BIM implementation in vocational high school construction engineering and property (Teknik Konstruksi dan Properti-TKP). The research foccused on skill competency of Building Modeling and Information Design (Desain Pemodelan dan Informasi Bangunan- DPIB) skills. This survey study used an open-ended online questionnaire. 60 teachers of vocational high school as participants of qualitative survey data came from provinces in Indonesia. Analyze data in a descriptive qualitative way. The results showed that most DPIB teachers have not implemented BIM-based learning for various reasons, including teachers have not understood and mastered BIM technology, in addition to the perception of the expensive needs of bim-based practice tools and software licenses. From the results of the training recommends the existence of BIM technology skill improvement program for teachers and include BIM learning in the curriculum of universities producing pre-service teachers, so they can implement it directly when they are as in-service teacher.

Keywords: *Building Information Modelling (BIM), Learning, Building Modeling and Information Design, Vocational High School, Indonesia.*

1. INTRODUCTION

Building Information Modeling (BIM) have been widely accepted as supporting system for effective work in construction field [1]–[4]. Articles discussing the concept of BIM in construction projects were start to published in the 80s [5], [6] while the first report on the implementation of BIM in construction was from van Nederveen & Tolman [7] who concluded that an approach to model multiple views on buildings using aspect models provides a simple and natural way to model building information. The development of BIM implementation in the construction sector has been accepted globally. Governments from many countries give respond by issuing regulation or guidance relating to BIM, such as The National BIM Standard - United States® [8], Singapore BIM guide 2.0 [9], and Australian government published BD-104 : Building Information Modelling [10]. Indonesian government is no let behind. Through the regulation of the minister of Public Work and Public Housing (PWPH), Indonesian government established that BIM-technology must be applied in construction of state building with a minimum area of 2000 m2 and more than two floors (PermenPUPR No. 22 of 2018). The development of BIM technology supported with the governments' regulations, certainly brings consequences for the increasing needs of competent construction workers in BIM Technology in the future.

The education sector, especially education in construction-related fields such as Civil engineering education, Architecture education as well as Construction engineering education, follows up on the need for BIM technology skills by trying to equip graduates with skills related to BIM technology. One of the efforts is through the integration of BIM into their curriculum learning. Zhang

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[11] reported the best practice of implementing BIM on students problem-solving skills through project execution planning in civil engineering and construction management education. The results of his study concluded that students can significantly improve their problem-solving skills through planning and role-specific communication during projects. The implementation of BIM in learning in the field of Architecture, Engineering, and Construction (AEC) education programs was also reported by Sanchez & Rodriguez-Paz [12]. Most study in this issue were taking the context of higher education [13]–[16].

As addition to higher education, educational institutions that aim to produce prospective construction workers are Building Engineering vocational high schools. There is a need to equipt, or at least introducing, the skill related to BIM technology to the building engineering vocational students. Unlike in the context of higher education, studies concerning the integration of BIM in vocational high schools' learning are still rare. Therefore, this study aims to apprehend the extent of the implementation of BIM-based learning at Building Engineering vocational high school. This study based on a case study in Indonesian education system with a consideration. Indonesian formal education system stipulates that one of the departments in vocational high school is Building Modeling and Information Design (Desain Permodelan dan Informasi Bangunan (DPIB)- In Bahasa). This shows the government's hope that BIM has started to be taught from the vocational high school degree [17]. Some of DPIB's curriculums related with BIM technology include the following: building, road, and bridge construction; land surveying; construction drawings both manually and using computer application; and construction cost estimation [18]. The DPIB Department has started running in Indonesian Education from 2017. However, there are rare study reporting the implementation of BIM technology in DPIB learning in the DPIB is. Results from this study give information about how to apply BIM to the learning that has been done and the development efforts that may be applied.

2. LITERATUR REVIEW

2.1. Building InformationModelling (BIM)

BIM is an overarching term to describe a variety of activities, which supports the representation of building elements in terms of their 3D geometric and non-geometric (functional) attributes and relationships [3]. BIM, as a process, is one of the knowledge developments in recent years that can store, organize, and exchange data from one party to another [19]. BIM-centric project delivery will provide high fidelity, geometrically, and positionally accurate. If properly developed and managed properly, the component data can be easily organized with a wealth of descriptive and operable metadata [20]. BIM helped to improve communication in the group, group sharing of resources, and supported different kinds of group collaboration. [12]. Therefore, BIM is also commonly used in education by educators to improve learning outcomes.

2.2. Building Information Modelling (BIM) as learning tools in the construction field

BIM is a didactic methodology in construction education at a time when educators in Architecture, Engineering, and Construction (AEC) are faced with the challenge of educating students so that their professional roles will be properly aligned with the digitization of the construction industry to improve not only their productivity but also their decision-making capabilities. Education mediated by technological innovations, such as BIM, has been proven to support the motivation, satisfaction and performance of students both academically and professionally.

Intrinsically there are two aspects of BIM that require the attention of AEC educators and researchers. The first, from an instrumentalist worldview, which is generally recognized and largely studied is that AEC graduates will understand the use and application of BIM in the industry. This is taken to be a short-term industry need where "teaching BIM is prioritized". The second aspect, based on substantivism, is the use of BIM as a platform or medium for

AEC education. In addition, and for both aspects, curriculum design and evaluation criteria have again become a major challenge, especially in dealing with the various ways of integrating BIM into the AEC curriculum in any educational institution with a unique context, policy, and strategy.

BIM for Construction Education (BfCE) is a term used in this study to refer to all academic efforts in educating AEC students either on how to use BIM and/or utilize BIM to improve learning. Previous research by the authors has confirmed a number of existing cases of BfCE reported in academic literature and shows that this is dominated by the field of architecture and the field of construction management increases over time. There are two literature reviews on general BIM education found [21] focusing on the curriculum design framework.

Figure 1. BIM Dimension.

2.3. Building Modelling and Information Design Vocational High School

Building Modeling and Information Design is a department that learns about building planning, building construction, and building repair. its activities are learning to draw the design of houses, buildings, and apartments, calculating the cost of buildings, carrying out construction, and maintaining building construction.

Purpose of Building Modeling and Information Design Skills Competency: Doing work as a Drafter/Photographer in building planning work. Doing work as a Drafter / Interpreter in the work of building implementation. Doing the work of building drawing services independently / entrepreneurially in the Drawing Studio.

3. METHOD

This type of research is descriptive research to answer the proposed research problems. In this study, researchers wanted to describe the level of utilization of BIM in the learning process in the Competency of Building Modelling and Information Design Skills (DPIB) in Indonesia. Researchers are doing the research using Expost Facto approach because the researcher is related to the variables that have occurred and do not require the treatment of the variables studied.As stated in the purpose of DPIB Skills Competency, student learning outcomes lead to expertise in building modeling. To find out the current learning conditions and to know the extent of the implementation of BIM in learning, a survey was conducted. The research respondents were 57 people, consisting of 53 teachers from Central Java Vocational High School, 1 teacher from West Java Vocational School, 1 teacher from Southeast Sulawesi Vocational School, and 2 teachers from West Papua Vocational School. As many as 28% of respondents are female teachers and 72% of respondents are male teachers.

Data was collected from 27th of June, 2022 until 5th of July 2022 with an online survey method using Google Form. Questionnaire consists of 24 questions containing multiple choice, short answers, and check list. The first part contains questions regarding teachers' personal data and their status as educators (totaling 9 items). The second part contains questions about BIM knowledge, the implementation of BIM in SMK, and the initial steps of various education institutions in implementing BIM (totaling 15 items). Quantitative descriptive analysis was used to analyze data in the form of multiple choice and thematic analysis to analyze data from open-ended questions. The focus here is on the 13 questions in the questionnaire which are dominated by open-ended questions. For each of the following questions, respondents were asked to tick the options provided:

- Have you ever attended BIM training?
- Have you ever obtained BIM certification?
- Have you implemented learning using BIM in SMK?

For each of the questions above, participants were asked to tick 'already' or 'not yet'. For the third question, if they ticked 'already', they were asked to explain further by answering the open-ended questions provided:

- What lessons have applied learning with BIM technology?
- What are your reasons for applying BIM technology to learning in SMK?
- What software do you use to implement learning with BIM technology?
- What software is most suitable for DPIB students?
- What are your obstacles and solutions in implementing BIM technology into learning in SMK?

Meanwhile, if they tick 'not yet', they are asked to answer the open-ended questions below:

- What are the reasons and obstacles that you have not applied BIM technology to learning?
- What do you think teachers should do to implement BIM technology into learning?
- What do you think your school should do to implement BIM technology into learning?
- What do you think the Education Department should do to implement BIM technology in schools?
- What do you think universities should do to produce DPIB professional teacher candidates?

4. RESULT

Based on the survey results, it can be seen that only 14% of the total number of respondents have attended BIM training. According to them, the use of BIM in learning is very important to increase students' understanding of the lessons delivered. In addition, the implementation of BIM in learning is an effort to apply the latest technological developments and is a demand from the Business World and the Work Industry World (Dunia Usaha dan Dunia Industri Kerja - DUDIKA). The results of questions asked to teachers regarding the understanding of BIM showed that 61% of respondents defined BIM as a method or process, while 39% of respondents defined BIM as a 3D software. Meanwhile, research that has been conducted shows that 13% of teachers from all respondents have applied BIM technology to learning in Software Applications and Building Interior Planning (Aplikasi

Perangkat Lunak dan Interior Gedung - APLIG) lessons. As many as 13% of these teachers, 22% of them use AutoCAD, 11% use ArchiCAD, 11% use SketchUp, and 56% of them mention other software, as shown in Figure 2.

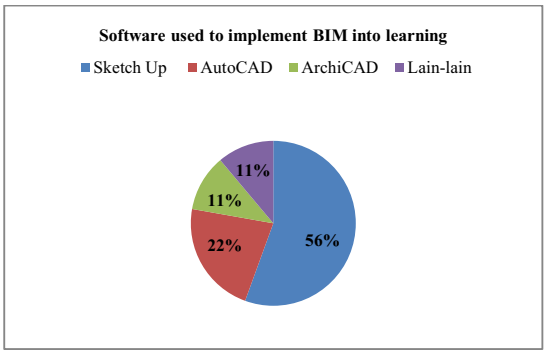

Figure 2. Software used to implement BIM into learning.

Based on the survey results, teachers who have not implemented BIM in learning reached 87% of all respondents. High computer specifications, lack of knowledge related to BIM, and lack of special training related to BIM technology are the main obstacles in implementing BIM-based learning in schools. The results of open questions regarding the initial steps that teachers can take regarding the implementation of BIM, one of which is by participating in BIM technology training activities. In addition, it is necessary to form a special team to obtain information related to the development of BIM technology in education so that it can be applied together. The results also show that there are suggestions from teachers for schools as formal education providers, including upgrading facilities and infrastructure, facilitating teachers with BIM technology training, and cooperating with institutions or agencies that have implemented BIM.

Socialization of BIM technology, improvement of devices that support BIM, as well as curriculum adjustments need to be carried out by the Education Departments. For the organizers of the Education Personnel Education Institution (Lembaga Pendidikan Tenaga Kependidikan – LPTK) recommended to improve the quality of DPIB teacher candidates by compiling a new curriculum that requires students to master BIM technology. The competency skills of prospective teachers must also be in accordance with the lessons in SMK. All of these efforts will certainly not run smoothly if they are not supported by good cooperation between educational institutions (LPTK-SMK-Education Departments). Figure 3. and Figure 4. show the demographics of respondents' age and teaching experience.

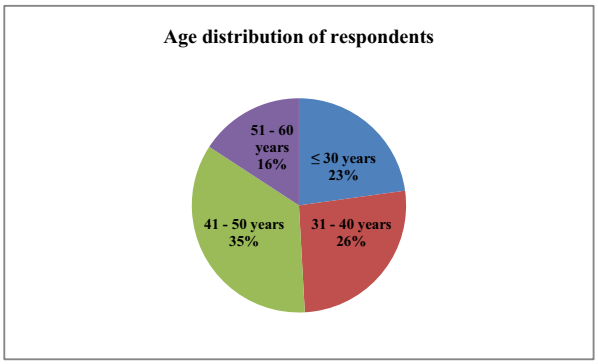

Figure 3. Age distribution of respondents.

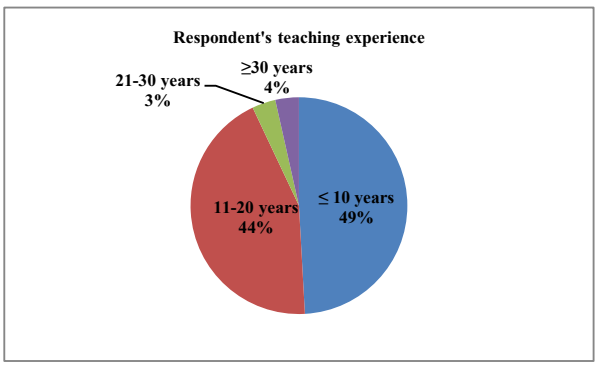

Figure 4. Respondent's teaching experience.

5. DISCUSSION

Implementation of BIM in schools that require teacher skills and adequate school facilities, but there are still many obstacles that hinder the implementation of BIM technology. To implement BIM in vocational learning requires a high specification of computer equipment to support the BIM program. Meanwhile, in reality, most of SMKs do not have these facilities. In addition, the application of BIM in SMK requires adjustments to the curriculum and materials, it takes a long time.

The implementation of BIM in vocational high schools requires the help and support of many education actors. The initial role of schools is to prepare for the needs for implementing BIM technology for students, namely improving facilities and infrastructure, providing facilitation for teachers to carry out training on BIM technology, and carrying out collaboration with institutions/agencies that have implemented BIM. Teachers should also deepen their knowledge of BIM and its application to learning. Meanwhile, integrating the application of BIM into vocational high schools requires support from the education office. Socialization related to BIM technology is expected to be carried out more intensively for both students and educators.

6. CONCLUSION AND RECOMMENDATION

The results showed that most DPIB teachers have not implemented BIM-based learning for various reasons, including teachers have not understood and mastered BIM technology, in addition to the perception of the expensive needs of bim-based practice tools and software licenses. The results of the training recommend the existence of BIM technology skill improvement program for teachers and include BIM learning in the curriculum of universities producing pre-service teachers, so they can implement it directly when they are as in-service teachers.

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