A lesson learned from the integration of BIM in construction engineering education in an Indonesian Polytechnic

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ABSTRACT

The Indonesian construction industry has increasingly adopted Building Information Modeling (BIM). One of the barriers to adopting BIM is BIM skills among graduates are still rare. Therefore, higher education institutions have to adopt BIM into their curriculum. However, as BIM is a new concept in construction engineering, many higher education institutions have a problem integrating BIM. Therefore, the paper proffers a syllabus to integrate BIM in a vocational higher education institution. The research methodology follows the Tyler model of curriculum development. It started with a review of prominent BIM integration into higher education research. Then, discussion with BIM practitioners from the industry to acquire information on current BIM-related job specifications in Indonesia. The team teacher then discussed and analyzed the results to create an initial syllabus. Further, the students' performance and feedback are observed during two years of course offering from 2019 to 2021. Improvement of the syllabus is based on observation and feedback results. The progress has increased students' performance in the BIM course. The students' performance is excellent even though the course was offered online due to a pandemic.

INTRODUCTION

Nowadays, building information modeling (BIM) utilization in Indonesian construction industries has increased. BIM implementation in Indonesia in 2019 was reported at 60% (Hatmoko et al., 2019) and increased from 38% in 2016 (Hanifah, 2016). Construction companies have started to adopt BIM to increase productivity (Sopaheluwakan & Adi, 2020). BIM is a new concept that helps engineers to understand construction comprehensively, starting from design (3D), construction scheduling (4D), cost information (5D), and project lifecycle (6D). Therefore, the engineer can virtually see the overall building project before developing the actual building. Engineers can view the construction 3D model and find any incorrect design, such as detecting any clash (Azhar et al., 2012).

Further, engineers can simulate the building development to perfect the solution. As a result, many companies have seen the real benefit of BIM in reducing project costs. BIM utilization in a 20-story building project in Indonesia has diminished project planning time to 50%, requires less human resources by 26,66%, %, and cut down personnel costs to 52,25% compared to the conventional method (Permatasari et al., 2016). Lu et al. (2014) studied BIM utilization contribution to cost reduction in AEC (Architecture, Engineering, and Construction) projects in Hong Kong is 6.92%.

Due to increasing infrastructure projects in Indonesia, graduates' demand for BIM capabilities is also growing. However, Indonesia is still lagging behind other developing countries (Puspita & Patriotika, 2021). Telaga (2018) showed that BIM maturity in Indonesia is still at level 1. While big companies have started to adopt BIM, small and medium companies (SME) adoption still needs to improve due to low awareness of BIM (Fitriani et al., 2018). Further, SME companies must invest in BIM software and recruit BIM-skilled engineers. As the demand is growing, industries need help recruiting graduate BIM-skilled engineers. The insufficient workforce with BIM skills shows that there is still a gap between industry and higher education. Therefore, integrating BIM into AEC higher educational institution curriculum is eminent to increase BIM adoption (Agirachman et al., 2018).

Currently, Indonesian higher institutions' awareness of integrating BIM into AEC education has increased. Universities in Indonesia have started to offer BIM courses at the undergraduate level (Gegana & Widjarnarso, 2015). However, many higher institutions still need help integrating BIM into their curriculum due to a relatively new construction concept. Another reason is the high initial cost of setting up a BIM laboratory. While some BIM software is free for educational purposes, the software requires a high-performance computing PC.

Furthermore, a densely educational curriculum poses a barrier for lecturers to add new courses to address BIM. Many lecturers also do not have BIM experience or lack BIM training. Likewise, higher education institutions must consider it wisely before adding specific BIM courses. BIM is not merely about 3D drawing or modeling but also about transforming student mindset to view construction as a whole project (Hedayati et al., 2015).

Tyler's approach is a linear and straightforward approach to curriculum development. The Tyler approach consists of school objectives, identifying students' educational experiences, organizing experience, and evaluating purposes. Although the Tyler approach has been challenged over the last 70 years, the Tyler model approach is still widely applied because of its simplicity (Cruickshank, 2018). Further, the Tyler model is logical, follows a sequential process, and teaches success based on the evaluation phase. Therefore it is suitable for developing a new course that uses unique technology such as BIM. While DACUM (Develop a Curriculum) is also a model of vocational curriculum development. DACUM requires experts to discuss job analysis (Wijanarka, 2014). BIM is a relatively new technology in the Indonesian construction industry. Therefore, BIM experts that could conduct two-day workshops for job analysis for DACUM were not readily available. Consequently, the Tyler model approach is more appropriate for this curriculum development.

Several research studies have tried integrating BIM into the Civil and construction engineering curriculum. Han et al. (2013) used the Tyler approach to develop a BIM curriculum and followed three stages of curriculum development preparation, development, and improvement. During the preparation stages to obtain the benefits, challenges, and purpose of BIM, they interviewed eight experts consisting of directors and engineers to bring their expectations of BIM skills of newly graduated (Han et al., 2013). Mcgough et al. (2013) started from the level of BIM competency required for students and emphasized that the module replicates the project that the industries desire. Therefore, the graduates comprehensively understand BIM working practices and low-impact design (Mcgough et al., 2013).

Ali et al. (2016) interviewed 15 construction professionals to gain insight into BIM utilization for quantity surveyor jobs in the Malaysian construction industry. The professionals have more than ten years of construction industry experience (Ali et al., 2016). Furthermore, Wong et al., (2011) tated that the industry prefers recruiting graduates who can implement BIM practically. Therefore, understanding BIM usage in construction jobs is essential. Thus, a perspective from an industry professional is required to develop the right BIM curriculum for students.

BIM is a new concept in the construction industry; BIM is a 3D model process that integrates all stages and stakeholders in construction development. Therefore, BIM requires collaboration among stakeholders to ensure the model developed is correct. Students may have yet to be aware of the partnership. Therefore, collaboration work during learning BIM is a necessity.

Tisdel and Mulva (2007) concluded that collaboration among students, mentors, and project owners in a real-world case study increases students' interest in the BIM course. Further, the

collaborative approach makes students and mentors more adaptive to construction work's dynamic nature (Tisdel & Mulva, 2007). Similarly, Olowa et al. (2021) used BIM to teach construction project cash flow to students. The students were divided into groups. Each student represents typical roles in construction work as a developer, contractor, and subcontractor (Olowa et al., 2021). Each group was given an exercise to learn to negotiate project cash flow to meet cash flow constraints in a project. Likewise, Adamu and Thorpe (2016) stated that students require a role-playing exercise to prepare students to have the necessary skills in the construction industry. By teaching students to act in different roles, the students can understand the different perspectives of other jobs in the construction industry. Therefore, they can collaborate better.

Visualization is an essential feature of BIM that can teach students to understand the whole construction process. Kim (2012) found that rich visualization of BIM improves students' understanding of detail in building. However, BIM aims not to teach visualization or 3D models of the building but to teach students a comprehensive understanding of architectural and construction projects (Banihasjemi & Webber, 2019). Therefore, students must complete the required data to ensure the building is correctly built because BIM is a digital building representation. Therefore, improving them to quantify the material needed for the building development.

Moreover, the students can learn to understand the interaction between components in BIM. Current BIM software has many capabilities. Therefore, by understanding material information and quantity calculation, the student can also learn to calculate load structure and simulate project construction and building energy consumption. Integrating BIM into vocational higher institution perspectives from construction industry professionals is essential. Moreover, the syllabus should encourage students to collaborate in preparing them well for the workforce. Furthermore, visualization is used to help students understand the whole concept of construction development.

Lectures must carefully assess current student knowledge about construction engineering before adding BIM knowledge. Many students still need to understand individual subjects and job specifications within the construction industry. Consequently, the students still need a clear idea to implement the knowledge gained to perform a specific task in the AEC industry. Therefore, preparing diploma-level graduates' skills to meet BIM industry needs in traditional construction methods (design-bid-build) is a necessity. Therefore, the paper attempts to proffer a strategy to integrate BIM education smoothly into building construction engineering programs in Indonesian vocational higher education.

As a vocational higher institution, Astra Polytechnic offers a BIM course in Building Construction Engineering associate degree program to support the availability of BIM skilled workforces. Because the vocational institution is a job-focused education, the curriculum differs from a university. Vocational education must have at least 60% of their courses practice courses. Therefore, the syllabus should focus more on visualization. The following sections will highlight the methodology and present the proposed syllabus for Indonesian vocational higher institutions.

RESEARCH METHOD

Developing the syllabus to produce the BIM course in the higher vocational institution that meets the industry demands requires two years of development. It started from 2019 to 2021. At every end of the BIM courses, a teaching team consisting of an instructor with experience as a BIM engineer and a lecturer revisits and discusses the course to improve the course content.

The curriculum development follows Tyler's approach. The first stage of the Tyler approach is to determine the objective of teaching BIM in vocational higher education. Therefore, to obtain the aim of BIM teaching, the first step is to review the literature to receive insight from previous BIM integration to higher institution research. Therefore, the teaching team can learn from the content of BIM courses from other countries and the expectation of the course's outcome for undergraduate and diploma levels.

Because the orientation is skill-based at the diploma level, the designed course prepares students to work after graduation. Therefore, the course must be a practice course. Likewise, using proprietary software in the study is preferable to open source. Furthermore, the students can take the certification exam after completing the course or graduate to be more competitive in the job market.

The second step is to gain an industrial perspective on BIM usage in the construction industry in Indonesia through discussion with construction industry professionals. The team teacher discussed with a BIM manager and BIM engineer of one Indonesian construction company to understand the task of BIM engineers in their company. The discussion was an open discussion to know the expectation of the industry. The first and second steps aim to develop the objective of BIM teaching.

Following the discussion results, the third step is to analyze the task to understand the skill required to complete the BIM-related job. During the meeting, the team agrees that the job description must have a clear boundary between bachelor and diploma levels. At the same time, the industry is more relaxed regarding education level as long as the employee can finish the task. However, the job description impacts syllabus development in an educational institution. The job task analysis results provide a learning and organizing experience for the students as the second and third stages of the Tyler approach.

The Polytechnic has two classes consisting of 15 students in a regular class and 30 students in an employee class 2019. For the year 2020, there were 24 students in the regular class and 17 students in the employee class. A regular class has students without working experience, and an employee class caters to construction company employees. Therefore, some students have had experience with BIM before. However, the syllabus content of the two types must be similar, and both classes can follow the course. Therefore, the syllabus starts from the beginning, regardless of students' experience of BIM.

The team teacher observed the students during the course to see whether the students could follow the system. The observation is important because the system was the first in the polytechnic. The observation results provide insight for the team to revise course content. Further, the team analyzes the midterm exam and final project. The analysis is based on the average exam and final results score. The results and feedback from students were used to improve the course content. The students' feedback was obtained at the last meeting of the class. The students spoke about their experiences while attending the class. Over the two years of the BIM course, there has been a change in content and software to the curriculum and overcoming licensing problems. The complete research method diagram is shown in Figure 1.
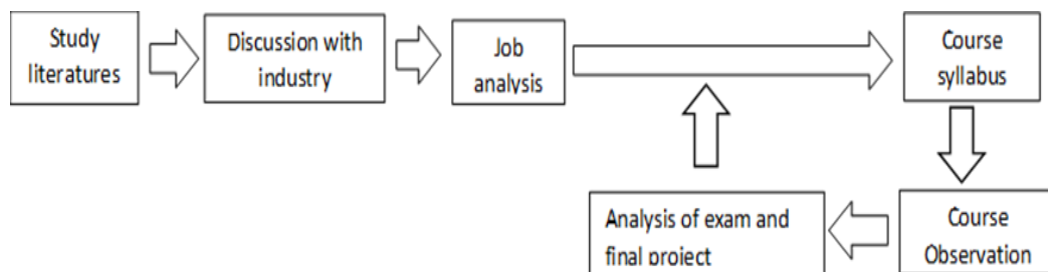

Figure 1. Research Methodology

RESULT AND DISCUSSION

After discussions with industry professionals, Indonesia's construction industry still follows a traditional design-bid-build (DBB) process. The result is similar to Marzuki and Tamin (2017) study, which reported that 99% of Indonesian public works still use the DBB process. The process follows a sequential process, which does not overlap with the following procedure. Therefore, the project owner separately awards contracts to the architectural and construction companies. The architecture company creates a design and makes the construction documents. The project owners then invite qualified contractors to bid for the projects. If necessary, the contractors must estimate the total construction cost for particular construction works. The contractors also could ask subcontractors to calculate the cost of the pieces.

Further discussion with industrial professionals discovered that small and medium (SME) companies in Indonesia still use 2D and 3D drawings. The professional statement is supported by

research from Hatmoko et al. (2019) that stated the Indonesian construction industry still used 2D drawings because the document approval from the government still used 2D drawings. The situation means that the Indonesian construction industry is still in the pre-BIM stage [3]. Therefore, there is a need for big construction companies to redraw the drawing into BIM manually. Therefore, the companies require construction workers who can redraw 2D and 3D drawings into BIM. Furthermore, the worker must also be able to put material detail into IM so that the construction material costs can be calculated automatically using BIM software. The task is to support the quantity surveyor (QS) profession.

The building construction technology study program in an Indonesian Polytechnic needs to be specifically addressed QS program. However, due to the demand for construction industries jobs. The program graduate must be able to redraw 2D and 3D illustrations to BIM software and develop the BIM model. The discussion result aligns with the Ali et al. (2016) study of BIM in Malaysia for a diploma-level QS program. Diploma graduates are limited to mastering BIM for visualization and quantification. Conversely, degree-level graduates are expected to integrate construction project planning and scheduling tasks in BIM. Table 1 presents the BIM framework for QS students in Malaysia.

Table 1. BIM skills for QS students in Malaysia

Object	Visualization	Quantification	Planning & Scheduling	Management
Medium	1. Draughtsmanship 2. Construction Technology 3. Construction Services	1. Measurement 2. Cost Estimating	1. Cost Planning and Scheduling 2. Cost Analysis	1. Contract 2. Professional Practice 3. Project Management
Diploma level outcome	Capability to acknowledge the 2D design and basic 3D model	Ability to perform quantity take-off software and use spreadsheet software to calculate the total material cost.	1. Capability to utilize software to acknowledge cost planning and scheduling fundamental principles. 2. Capability to utilize digital data to acknowledge project economic value.	Capability to acknowledge legal implications, procedural aspects of a project, and project complexity.
Degree level outcome	Capability to acknowledge the 2D design and basic 3D model	Ability to perform quantity take-off software and use spreadsheet software to calculate the total material cost.	1. Capability to utilize software to evaluate cost planning and scheduling fundamental principles. 2. Capability to utilize digital data to evaluate cost analysis project economic value. 3. Capability to integrate 4D and 5D through BIM in the project.	1. Capability to assess legal implication, procedural aspect of a project, and project complexity. 2. Capability to manage a project.

Source: (Ali et al., 2016)

Based on Table 1, QS education at diploma and degree levels has similar outcomes for visualization and quantification. The difference between those two is planning, scheduling, and management objects. The degree-level graduates should evaluate the economic cost of a project through digital data and BIM. Moreover, the graduate also should be capable of assessing legal aspect implications and managing a construction project.

The QS education framework in Malaysia is similar to the industry professional explanation of BIM engineer job specifications in Indonesia. In Indonesia, diploma-level BIM engineers make

the BIM based on 2D and 3D drawings and perform quantity take-off. The degree-level engineers then check the result and calculate the project's economic value and schedule. Further, the engineers use the model and calculation to make a bidding document. Table 1 shows that QS education in Malaysia focuses on quantification objects. By contrast, in Indonesia, the expected outcome for diploma-level BIM engineers in the Indonesian construction industry is the capability to perform quantity take-off and make a BIM model correctly. In particular, following the Tyler model, the objective of teaching BIM is the ability to convert 2D and 3D drawings to BIM and create BIM 3D models.

The BIM syllabus must gradually progress from 2D and 3D to BIM from an industry perspective. Furthermore, vocational education aims to train graduates who are relatively ready to work. The students must have skill competency after completing each year of study. Therefore, the BIM syllabus also must consider the occupation that can be filled after completing each course.

Table 2 shows BIM integration in the construction engineering syllabus of vocational higher education institutions. Students learn to draw 2D and 3D using drawing software in semester 2 of the technical drawing course. Therefore, in the subsequent semester, the students should be able to draw and read 2D and 3D documents. The institution divided BIM courses into two-semester, the 3rd semester and the 4th semester. The courses are divided into two parts because the first semester teaches fundamental BIM, and the 2nd semester is for advanced BIM. Therefore, Table 2 explains stage 2 of the Tyler model.

Table 2. BIM Integration in Vocational Higher Education Syllabus

Semester	Object	Outcome	Occupation
2	Visualization	Capable of drawing 2D and developing 3D models using drawing software.	Drafter
3	Visualization	Capable of converting the 2D and 3D drawings to BIM software.	BIM Technician
4	Visualization	Capable of making 3D architecture models.	BIM Junior Engineer

The polytechnic created a 3rd-semester course named Building Information Modelling functions as a transition from technical drawing to BIM. Therefore, in this course, the students learn the architectural part of BIM. The students practice making BIM models starting from building layouts, column grids, structural design, floors and roofs, exteriors, and interiors. The course consists of mechanical, electrical, and plumbing (MEP), and reinforcement modeling. The team teacher creates a mid-term exam to check the student's understanding. The exam is to convert a 2D drawing into BIM to conform to the job specification of BIM engineers in the Indonesian industry.

In the 4th semester, the polytechnic created a course named Civil Manufactured. The objective of the study is to teach advanced BIM. Project scheduling (4D) and cost estimation (5D). However, the industry demands that diploma-level graduates can perform quantity take-off. Therefore, the syllabus focuses on 5D BIM, where the students learn to put detailed information on building materials and quantification from a construction project. Moreover, in practice, project scheduling is part of project management which is the role of a degree-level engineer.

Teaching project scheduling is more complex than quantity take-off because the students need to visualize the time dimension of the project. By contrast, teaching quantity take-off is more straightforward. By adding information about material price, the BIM software can automatically calculate the material volume and the associated cost. Thus, the students verify the project quantification using spreadsheet software. However, the syllabus still consists of 4D BIM to teach students the construction project schedule concept and additional knowledge.

The BIM course started in the odd semester of 2019. The course is conducted full day or 8 hours every week. The teaching team observed the pace of students in completing the targeted exercise. BIM is a practice course taught in the laboratory. Thus, in each lab session, the instructor hands out training. The instructors demonstrate and explain the module's key concepts so the students can follow the module. At the beginning of the course, the students focus on completing the drawing instead of understanding the concept. The teacher also found that the students initially thought BIM

software was another drawing tool. Many students found it challenging to draw and ensure that all the dimensions were correct; otherwise, the mistakes affected the whole model. The teaching team needs to remind the students of the engineering concept behind the exercise, including the software's database.

The objective of BIM teaching in the polytechnic is the capability to model based on 2D drawing. Therefore, the third step of the Tyler model is to organize the student experience to make a model based on the 2D illustration. Thus the students must learn the basic concept of modeling. Therefore, the course content until midterm exams consists of building layout, architectural, and structural design. The software used until the midterm exam is Revit Autodesk and Tekla. Revit Autodesk is used to make a BIM model, and Tekla is for reinforcement modeling. However, the midterm exam does not include reinforcement modeling. Therefore, the exam only asked the students to make a BIM model from a 4-story building of 2D drawing. The midterm exam results show that the students can convert a 2D illustration into a BIM model with an average score of 86 out of 100. The students learn to make interior and exterior BIM models for the rest of the semester. The course should cover MEP based on the syllabus created. However, the students needed help following the contents. Therefore, the MEP module was moved to the next semester.

At the end of the semester, there was a final group project as a final exam. Each group of students consists of four students. The group was then asked to make a BIM model of a 4-story building. There was no restriction on building purpose, but the students' BIM model must be a complete model, including architectural components and structural layout. Because the students only had studied basic structure load calculation and were exposed to limited building codes. Therefore, the common sense of students to make the model is essential. The students presented the models to the team teachers. Furthermore, the project grading is based on the completeness, complexity of the model, and engineering logic of the designed model.

The students were given two weeks to complete the project. The majority of the students were excited about the projects. In the final presentation, all groups made interesting buildings with high complexity. However, none of the groups can complete the model 100%. Furthermore, the average score of the students is 77. The reasons for that are insufficient time and high-spec computer requirements to complete the model because the student could not access the laboratory and had to do the project at home. The project also did not require the students to make the reinforcement modeling. Therefore, the project can be completed only using Revit Software Autodesk.

The advanced BIM course named civil manufacture started in the even semester of 2019/2020. It started in February 2020. The course consisted of MEP, project scheduling (4D), and cost estimation (5D). However, since March 2020, most courses have had to be done online due to the pandemic, hampering students' learning. The institution only allowed teaching of the line for practice courses. While the course was a practice course, because the course could be done using a computer, the course was then conducted online. The study was undertaken still 8 hours a day.

However, the learning process poses some issues due to the pandemic, where most students returned to their homes. The students had problems with computer requirements, poor internet connection, and high internet costs. Therefore, the class was divided into two sessions. Morning sessions were from around 8:00 to 9:00, and the afternoon session was from 13:30 to 14:30. During the morning session, the instructor explained the exercise for the day. The instructor then checked the student's progress later in the afternoon session.

Although the teaching team tried their best to optimize the learning process, problems occurred every session. Notably, the infrastructure problems discourage some students from attending class. However, the students had to submit their work to the server at the end of the class. So that the team teacher can still track the student's progress. Despite the challenge, the students still observe the exercise passionately.

The average student's exercise completion rate was 75%, with one student completing 100% and only two completing below 60%. Because of the pandemic, the teaching team decided to skip the midterm exam. The final project was used as a final exam. The students are divided into groups similar to the previous semester. They are asked to add MEP to the last semester's model or a new model. However, considering the students' computer equipment and the pandemic situation, the final project did not include quantity take-off. Even though quantity take-off is one of the significant skill

criteria, the students could make good MEP models despite the online course. The average score for the final project was 84, and only one group needed to remember to make a mechanical model.

In 2020/2021, the pandemic continues; however, teachers and students have adapted to online learning. both building information modelling and civil manufacturing courses were conducted online. Learning from the previous year, the teaching team discussed improving teaching material. As a result, the team simplified each exercise and added quantity take-off and working drawings. Therefore, in 2020/2021, the contents until the midterm exam consist of dimension, architectural elements, structural elements, simple quantity take-off, and working drawing.

The concept of the midterm exam is still similar to last year's. The students were still asked to make a BIM model from a 2D drawing. However, because of syllabus content addition, the students were asked to perform quantity take-off and create a working drawing. The performance was similar to last year's last student. The average score of the students was 87. The final project is also similar to the previous year. The students had to make a group of 4 or 5 students. Then they had to make a BIM model of a 4-story building, but with reinforcement modeling. The grading criteria are also similar. The student's performance was better than last year, with an average score of 92. The score reflected that improving the syllabus with simplified exercises could improve students' understanding of students. Furthermore, despite the content addition, online learning did not affect student performance.

Civil manufacturing course or advanced BIM in 2020/2021 was still in a pandemic. Learning from last year, the team teacher also improved the course syllabus. The content was similar to the previous year but still consisted of MEP, BIM 4D, and 5D. However, exercises were made more straightforward than the last year. Therefore, the students could complete the activity within 8 hours practice session. The grading criteria are also similar, and only the final project is at the end of the semester. The students were also asked to add MEP from the BIM model they had made previously. However, because the students were better prepared to do online classes than last year, they could complete 4D and 5D exercises. Therefore, the final project included project scheduling and cost estimation. The student's performance was slightly better than last year, with an average score of 81.

Based on the observation in the industry and advice from the professionals. The team teacher eventually used Autodesk Revit for BIM architectural and MEP modeling, Tekla for reinforcement modeling, and Autodesk Naviswork for BIM 4D and 5D modeling in the course syllabus because the software was widely used in the industry. However, feedback from the students, particularly in the BIM course, installing three software is becoming a burden for students' computers. Because Autodesk Revit also has a capability for reinforcement modeling as Tekla. Therefore, in 2021/2022, the course only uses Autodesk Revit and Naviswork.

The designed BIM courses are divided into two semesters to prepare students to meet industry standards. The Building Information Modelling course is offered in the third semester to give fundamental BIM skills. The course is a continuation of technical drawing. Furthermore, the students learn architectural, structural, and reinforcement modeling during the 3rd semester. Then, the students could learn advanced BIM in the 4th semester. Civil manufacturing's advanced BIM course teaches MEP modeling, project scheduling, and cost estimation.

The team teacher needs two years of observation to create the appropriate syllabus. The students who studied BIM have excellent performance despite a pandemic that forces students to learn online. The student grades increase following syllabus improvement. Therefore, observing students during the course is essential to fine-tune the course content. Furthermore, the students' results show that the student can follow the syllabus. Therefore, the students are ready to take the BIM junior engineers job after graduating. Moreover, the student's grades validate that the syllabus is suitable for higher vocational students.

CONCLUSION

Construction companies in Indonesia are starting to use BIM. At the same time, the government policy drives BIM usage in Indonesia. The companies have seen the benefit of BIM in reducing construction time and cost. Particularly during a tender process where BIM accelerates the project cost calculation process. Therefore, Indonesia's demand for a workforce with BIM skills is

eminent. However, higher education institution in Indonesia offering BIM courses is still rare. The one that gives BIM courses still needs help effectively integrating the industry demand and curriculum. Notably in higher vocational education, where the approach is practical. Therefore, the paper proffers a syllabus to integrate BIM in a vocational higher education institution. The syllabus has resulted from applying the Tyler model curriculum development. The works of literature study and construction industry professional discussion serve to identify the teaching objective of the course. Further, analysis of the task of BIM engineers serves as input for designing and organizing learning experiences for students. In the last stages, the course evaluation during two years of BIM teaching from 2019 to 2021 is analyzed to improve the syllabus. Further, the syllabus has been applied to the students. Therefore, higher vocational education in building construction can use the research results as references to develop a strategy to integrate BIM into the building construction engineering curriculum. A natural continuation of this research is to obtain feedback from the graduates who work in the BIM sectors.

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