Journal of Creative Practices in Language Learning and Teaching (CPLT)
Volume 13, Number 1, 2025

Factors Influencing The Teaching of Building Information Modeling (BIM) Among Civil Technology Lecturers in Vocational Colleges in Sabah

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Received: 15 January 2025
Accepted: 4 March 2025
Published: 25 May 2025

CITE THIS ARTICLE:

Rasmet, R. R., Shaafi, N. F., & Mohd Hisham, M. H. (2025). Factors affecting the teaching of Building Information Modeling (BIM) course among Civil Technology lecturers at Kolej Vokasional in the Sabah zone. *Journal of Creative Practices in Language Learning and Teaching*, *13*(1), 133-145. 10.24191/cplt.v13i1.4233

ABSTRACT

The integration of Building Information Modeling (BIM) into vocational education presents challenges in aligning pedagogy with industry needs. While BIM adoption has increased in Malaysia's construction sector, the readiness of vocational lecturers to teach BIM remains uncertain. This study examines key pedagogical factors influencing BIM instruction in vocational colleges in Sabah, focusing on lecturers' competencies, institutional facilities, and teaching aids. Using a descriptive quantitative approach, the study identifies gaps in BIM-specific training, inadequate facilities, and limited access to interactive teaching resources. Findings suggest that enhanced lecturer competency through targeted professional development, upgraded infrastructure, and improved digital teaching aids are critical for

effective BIM instruction. This study contributes to TVET pedagogy by highlighting the need for structured training programs and industry collaboration to ensure that BIM education fosters both technical and creative learning approaches. Strengthening BIM instruction will ultimately improve graduates' employability and adaptability in the evolving construction landscape.

Keywords: Building Information Modeling (BIM), vocational education, lecturer competency, institutional facilities, teaching aids, creative pedagogy, TVET Instruction

INTRODUCTION

Education plays a vital role in a nation's economic development, with technological advancements shaping modern learning. In Malaysia, the government has focused on enhancing Technical and Vocational Education and Training (TVET) through National Technical Education and Vocational Training (TVET) institutions. However, despite these efforts, there are still gaps in ensuring that graduates possess the necessary skills for the workforce (Ridzuan & Rahman, 2022). As part of this effort, Building Information Modeling (BIM) has been integrated into the curriculum of Vocational Colleges (KV) under the Construction Technology program. This requires lecturers to adapt their teaching methods and adopt creative, interactive approaches that connect traditional construction methods with modern technology.

BIM is not just a tool for design and construction management; it also enhances vocational education by fostering creative and interactive learning. Its application goes beyond technical instruction, encouraging the use of digital tools and collaborative learning to engage students in problem-solving, critical thinking, and effective communication. This makes BIM a valuable tool in language learning, where students can explore both the technical and communicative aspects of the construction industry through real-world applications.

However, integrating BIM into TVET programs is challenging. Lecturers need to be proficient in BIM software and use creative teaching strategies to engage students. Successful BIM integration relies on lecturers' technical and pedagogical skills, as well as institutional support for professional development (Shing et al., 2015). Additionally, the lack of infrastructure and access to updated BIM software in some TVET institutions can hinder the effectiveness of BIM education.

Theories like Vygotsky's Social Constructivism and the Technological Pedagogical Content Knowledge (TPACK) framework help justify the importance of creative teaching methods in BIM education. Social Constructivism highlights the value of collaborative learning, which aligns well with BIM, as students can work together on projects to understand technical and communicative concepts. The TPACK framework also supports the integration of technology, pedagogy, and content knowledge, ensuring that lecturers use both digital tools and effective teaching strategies to enhance learning (Mishra & Koehler, 2006).

This study aims to explore the factors influencing BIM instruction among Civil Technology lecturers in vocational colleges in the Sabah zone. Specifically, it will address the question: What are the impacts of lecturers' competencies, institutional facilities, and teaching aids on the effectiveness of BIM instruction? By exploring these factors, this research seeks to offer insights into enhancing BIM education within TVET institutions, incorporating creative pedagogical practices that ensure students develop the necessary skills for success in the evolving construction industry (Shing et al., 2015).

LITERATURE REVIEW

In recent years, the integration of Building Information Modeling (BIM) into the construction industry has been pivotal for improving project efficiency and accuracy (Alenin et al., 2020). BIM, a digital representation of physical and functional characteristics of structures, offers significant advantages in optimizing building designs and construction processes (Gulhane, 2021). However, the adoption of BIM in Malaysia has been relatively slow, with challenges such as high implementation costs, a lack of awareness, and insufficient training, which has resulted in a limited uptake within the industry (Othman et al., 2020).

In educational settings, particularly within technical and vocational education training (TVET) institutions such as Vocational Colleges in Sabah, teaching BIM presents specific challenges. A key factor influencing BIM instruction is the competency and teaching experience of the lecturers. As noted by Mara and Morar (2023), effective teaching requires a deep integration of knowledge, skills, and professional attitudes, which enable lecturers to manage complex teaching situations. However, many instructors in Sabah are not directly involved in teaching BIM courses, which limits their exposure to the latest developments in this field. While there is a general effort among some instructors to self-update their knowledge of BIM, the overall competency level remains moderate, suggesting a need for more structured professional development and specialized training in BIM.

Additionally, institutional facilities play a critical role in the successful delivery of BIM education. According to Hong et al. (2021), well-equipped educational environments significantly enhance the learning experience, particularly in technical fields like BIM. The availability of computer labs with essential software, such as Revit, and sufficient internet access are vital for effective BIM instruction. In line with this, Adewoye and Olaseni (2022) emphasize that access to modern computing resources is crucial for effective computer-based learning. At Vocational Colleges, the facilities are generally considered sufficient, with high ratings for the availability of classrooms, labs, and essential software.

Moreover, the use of teaching aids, including advanced technologies like Augmented Reality (AR) and Virtual Reality (VR), has been recognized as a powerful tool for enhancing BIM teaching. Lhendup (2023) highlights that these technologies can significantly improve student engagement and understanding by providing immersive and interactive learning experiences. The positive impact of AR and VR in BIM education has been supported by findings that show these tools help visualize complex building designs and structures, thus improving students' spatial awareness and conceptual understanding. However, as noted by Figueroa-Flores and Huffman (2020), the effective use of AR and VR requires specialized training for lecturers, which is an area that needs further attention in teacher development programs.

In conclusion, the successful implementation of BIM education in Vocational Colleges in Sabah requires a multifaceted approach. This includes ensuring that lecturers possess the necessary competencies, have access to quality facilities, and can effectively utilize modern teaching aids. Furthermore, continuous professional development and institutional support are essential for enhancing the overall effectiveness of BIM instruction in TVET institutions.

METHODOLOGY

This study employs a descriptive quantitative approach to systematically examine the factors influencing Building Information Modelling (BIM) teaching. Data were gathered through structured questionnaires targeting Civil Technology lecturers teaching the BIM course (EDM 3012) in vocational colleges across the Sabah zone. The sample of 54 lecturers was selected using purposive sampling to ensure participants had direct experience in BIM instruction, thereby enhancing the relevance of the findings (Creswell & Poth, 2018). To establish the reliability and validity of the instrument, a pilot study was conducted, and Cronbach's alpha coefficient was used to measure internal consistency, ensuring that the questionnaire effectively captured the intended constructs (Tavakol & Dennick, 2011). Content validity was verified through expert reviews from experienced BIM lecturers and TVET specialists, a standard practice to ensure the instrument accurately reflects the domain of interest (Lewis, 2017). Data analysis involved descriptive statistics, including frequency and mean analyses, to interpret key trends in lecturer competency, institutional facilities, and teaching aids. While descriptive statistics provided fundamental insights, further research could employ regression analysis to explore deeper correlations between these variables and instructional effectiveness (Field, 2013). The results offer empirical evidence to inform targeted improvements in BIM pedagogy within vocational education (Shing et al., 2015).

Research Design

This study adopts a descriptive quantitative research design to systematically investigate the factors influencing BIM instruction. The quantitative approach allows for the collection of structured data to analyze trends and relationships between variables (Creswell & Poth, 2018). This research design was chosen as it provides measurable and objective insights into lecturer competencies, institutional facilities, and teaching aids, ensuring the reliability of findings in a vocational education context (Gay et al., 2012). By utilizing a descriptive design, the study aims to provide clear and accurate representations of the current state of BIM teaching practices in vocational colleges (Field, 2013), which is essential for targeted improvements in pedagogy.

Sample and Population

The study population comprised Civil Technology lecturers teaching the BIM course (EDM 3012) in vocational colleges within the Sabah zone. A purposive sampling technique was used to ensure that participants had direct experience with BIM instruction (Etikan et al., 2016). A total of 54 lecturers from four vocational colleges were selected, representing a diverse range of teaching backgrounds. The rationale for selecting this sample was to capture a comprehensive understanding of the challenges and practices in BIM pedagogy, as purposive sampling allows for the inclusion of individuals who are particularly knowledgeable about the subject matter (Palinkas et al., 2015).

Research Instrument

A structured questionnaire was developed as the primary research instrument. The questionnaire consisted of four sections: (A) demographic information, (B) lecturer competency, (C) institutional facilities, and (D) teaching aids. Each section was designed to address key research objectives, using a Likert scale to assess respondents' perceptions. The instrument underwent a validation process to ensure content accuracy and relevance.

Research Procedure

The study followed a systematic data collection procedure to ensure accuracy and reliability (Creswell & Poth, 2018). First, ethical clearance was obtained from the relevant institutional review board, in accordance with ethical research standards (Haverkamp, 2005). Next, the questionnaire was developed and validated through expert review and a pilot study, which is a standard practice to ensure the instrument's content validity and reliability (Tavakol & Dennick, 2011). The data collection process was conducted in three phases (refer to Table 1), as outlined in research methodology to ensure structured and organized data gathering (Flick, 2018).

Table 1. Data collection phases

Phase	Activity	Details
Phase 1: Preparation	Ethical approval & instrument validation	Approval was secured, and the questionnaire was tested for validity and reliability.
Phase 2: Distribution	Online and face-to-face questionnaire distribution	Participants received clear instructions on completing the questionnaire.
Phase 3: Data Collection	Collection over one month	Participants were given adequate time to respond, ensuring a high response rate.

The questionnaire was distributed both online (via Google Forms) and in printed form during scheduled meetings with lecturers at vocational colleges in the Sabah zone. This hybrid approach was adopted to maximize participation and ensure inclusivity, which is commonly used to increase response rates and accommodate participants with varying preferences (Nulty, 2008). Data collection spanned one month, allowing sufficient time for responses from all selected vocational colleges (Dillman et al., 2014). To maintain data integrity, responses were monitored, and follow-ups were conducted to address any inconsistencies or missing information, a standard procedure to enhance the accuracy and completeness of survey data (Babbie, 2013).

Data Analysis Method

In order to collect, record, and analyze the data received from this survey, a software known as the *Statistical Package for Social Science* (*SPSS*) version 23 was utilized. Using an analysis based on the Likert scale, the researcher analyzed the data by looking at the frequency, the mean, and the percentage. It was determined that the data gathered in the form of frequencies and percentages for the items listed were adequate for analysis and for summarizing the findings associated with each research topic investigated in this study (Field, 2013; Pallant, 2016) (refer to Table 2).

Table 2. Summary of study data analysis

Objective	Research Question	Instrument	Analysis	Thesis Titles References
Identifying the factors that influence the teaching of Civil Technology lecturers for the EDM 3012 Building Information Modeling course at Kolej Vokasional in the Sabah zone, from the perspective of the lecturers' competencies.	What is the factors that influence the teaching of Civil Technology lecturers for the EDM 3012 Building Information Modeling course at Kolej Vokasional in the Sabah zone, from the perspective of the lecturers' competencies.	Questionnaire	• Frequency and percentage • Descriptive Statistics (Min)	*Cabaran Pensyarah Kolej Vokasional Dalam Menghadapi Transformasi Vokasional*
Identifying the factors that influence the teaching of Civil Technology lecturers for the EDM 3012 Building Information Modeling course at Kolej Vokasional in the Sabah zone, from the perspective of the institutional facilities	What is the factors that influence the teaching of Civil Technology lecturers for the EDM 3012 Building Information Modeling course at Kolej Vokasional in the Sabah zone, from the perspective of the institutional facilities	Questionnaire	• Frequency and percentage • Descriptive Statistics (Min)	*Faktor Pencapaian Hasil Kerja Amali Pelajar Diploma Aliran Kejuruteraan Mekanikal Di Kolej Vokasional Zon Selatan*
Identifying the factors that influence the teaching of Civil Technology lecturers for the EDM 3012 Building Information Modeling course at Kolej Vokasional in the Sabah zone, from the perspective of the lecturer's teaching aids.	What is the factors that influence the teaching of Civil Technology lecturers for the EDM 3012 Building Information Modeling course at Kolej Vokasional in the Sabah zone, from the perspective of the lecturer's teaching aids.	Questionnaire	• Frequency and percentage • Descriptive Statistics (Min)	*Faktor Pencapaian Hasil Kerja Amali Pelajar Diploma Aliran Kejuruteraan Mekanikal Di Kolej Vokasional Zon Selatan*

Pilot Study

A pilot study was conducted with 10 lecturers to assess the reliability and validity of the research instrument. Cronbach's alpha ($\alpha = 0.947$) indicated high internal consistency, confirming the instrument's suitability (Tavakol & Dennick, 2011). Content validity was ensured through expert review by BIM lecturers and TVET specialists (Creswell & Poth, 2018). A descriptive quantitative approach was used to examine factors influencing BIM instruction. Data were collected from 54 Civil Technology lecturers teaching the BIM course (EDM 3012) in Sabah vocational colleges, with purposive sampling ensuring relevant expertise. The instrument's reliability and validity were confirmed through the pilot study and expert reviews. Data analysis included descriptive statistics (frequency and mean) to interpret trends in lecturer competency, institutional facilities, and teaching aids (Field, 2013). The results provide evidence to inform improvements in BIM pedagogy within vocational education (Pallant, 2016).

RESULTS AND DISCUSSION

This section critically examines the study's findings in relation to previous research and theoretical perspectives, providing in-depth interpretations beyond statistical summaries. By addressing the challenges identified, this discussion aims to offer practical implications for improving BIM education in vocational colleges.

Lecturers' Competency and Experience

The study found that while lecturers have a strong foundation in Civil Technology, their exposure to BIM-specific training is limited. Many lecturers have not received formal BIM training, leading to a lack of confidence in teaching the subject effectively. These findings align with previous studies (Wan & Cui, 2021), which highlight that TVET instructors often struggle with technological advancements due to inadequate professional development programs. Vygotsky's Social Constructivism underscores the importance of guided learning and mentorship, suggesting that targeted workshops and hands-on industry training could bridge the existing competency gaps.

A respondent stated, "We are expected to teach BIM, yet we have never been formally trained in its application. Most of us rely on self-learning, which is not always effective." This highlights the necessity for structured upskilling programs. Future efforts should include partnerships with industry stakeholders to provide real-world exposure for lecturers, ensuring they remain updated on BIM applications in practice.

Institutional Facilities

Institutional support in terms of infrastructure and digital resources plays a crucial role in effective BIM instruction. The study revealed inconsistencies in the availability of BIM-enabled computer labs and software across different vocational colleges in Sabah. Colleges with better-equipped facilities reported higher engagement levels in BIM-related coursework, confirming findings from previous studies (Hong et al., 2021) that emphasize the relationship between infrastructure and learning effectiveness.

According to TPACK theory, the integration of technological tools in teaching is most effective when coupled with pedagogical and content knowledge. However, a major challenge in vocational colleges is outdated hardware and limited access to licensed BIM software. One lecturer remarked, “The computers in our lab do not support the latest BIM software, making it difficult to teach students using real-world applications.” Addressing this issue requires government funding allocations for infrastructure upgrades and subscription-based access to industry-standard software.

Teaching Aids

Teaching aids such as interactive BIM software, digital learning materials, and industry-relevant case studies were found to enhance students' comprehension of BIM concepts. However, limited access to these resources in some colleges hindered effective teaching. This finding resonates with research by Aina and Ogegbo (2021), which emphasizes that inadequate teaching aids reduce student engagement and comprehension.

While traditional teaching methods remain common, BIM education requires more interactive approaches, such as simulation-based learning and collaborative digital modeling. A participant shared, “If we had access to interactive BIM models and project-based assignments, students would grasp the concepts much faster.” Moving forward, vocational colleges should integrate virtual BIM environments to allow students to engage in hands-on design and problem-solving tasks, reinforcing active learning principles.

Practical Implications for BIM Education

The findings highlight key action areas for improving BIM education:

i. Lecturer Training: Regular upskilling programs and industry collaborations should be implemented to enhance BIM teaching competency.
ii. Infrastructure Investment: Government and institutional stakeholders must ensure sufficient funding for BIM-equipped laboratories.
iii. Innovative Teaching Approaches: Interactive learning tools, case-based simulations, and real-world project collaborations should be prioritized in BIM pedagogy.

By addressing these challenges, vocational colleges can foster a more effective BIM learning environment, ensuring graduates are well-prepared for industry demands.

Lecturers' Competency and Experience

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CONCLUSION AND RECOMMENDATION

This study provides critical insights into the challenges and opportunities associated with BIM instruction in vocational colleges, particularly in the Sabah zone. The findings indicate that three key factors significantly influence BIM pedagogy: lecturer competency, institutional facilities, and teaching aids. Addressing these areas is crucial for improving the quality of BIM education and ensuring that graduates are equipped with the necessary skills for the evolving construction industry.

Enhancing Lecturer Competency

A major challenge identified in this study is the lack of formal BIM training among vocational college lecturers. This gap limits their ability to effectively teach BIM-related concepts and applications. To bridge this gap, structured professional development programs, including industry-driven workshops, certification courses, and hands-on training, should be prioritized. Collaborations between educational institutions and industry partners can facilitate continuous upskilling and knowledge exchange, ensuring that lecturers stay updated with advancements in BIM technology and pedagogy.

Improving Institutional Facilities

The study also highlights disparities in institutional resources, particularly regarding BIM-equipped laboratories and software accessibility. Many vocational colleges lack the necessary infrastructure to provide students with practical BIM training. To address this, institutions must invest in modernizing computer labs, securing access to industry-standard BIM software, and integrating digital learning platforms. Government funding and industry partnerships should be leveraged to facilitate these improvements, ensuring that students receive practical, hands-on exposure to BIM technologies.

Expanding Teaching Aids and Resources

The availability of innovative teaching aids plays a crucial role in effective BIM instruction. However, limited access to interactive digital tools, case studies, and simulation-based learning materials hinders the learning experience. Future initiatives should focus on developing and integrating interactive BIM learning modules, virtual simulations, and project-based learning approaches to enhance student engagement and comprehension.

Future Research Directions

While this study provides valuable insights into BIM instruction in vocational education, further research is needed to explore:

- The impact of industry collaboration on lecturer competency development.
- The effectiveness of digital and immersive learning tools in BIM education.
- The role of policy frameworks in standardizing BIM training across vocational institutions.

By addressing these challenges and implementing targeted interventions, vocational colleges can significantly enhance BIM education, ultimately improving graduate employability and industry readiness. This study underscores the importance of continuous innovation in teaching methodologies to align vocational education with the demands of the modern construction industry.This study highlights the necessity for enhancing BIM instruction in vocational colleges by addressing three key factors: improving lecturer competency through targeted professional development, upgrading institutional facilities, and increasing the availability of teaching aids. Future research should explore the integration of industry partnerships to facilitate hands-on BIM training for lecturers and students. Policymakers and lecturers must work together to ensure that BIM education aligns with industry demands, thereby improving graduate employability in the construction sector.A

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Conflict of Interest

The authors declare that there is no conflict of interest during the progress of the study.

Acknowledgement

The authors would like to express their gratitude to Universiti Teknologi Malaysia and Universiti Malaysia Sabah for the supports during the data collection and writing publication.

Authors' Contributions

Mohd Hizwan bin Mohd Hisham: Conceptualization, Methodology, Data curation, Visualization, Investigation, Writing-Reviewing and Editing. Ruzaini Rafiuddin Bin Rasmet: Methodology, Data Collection and Writing-Original draft preparation. Nur Farha Shaafi: Writing-Reviewing and Editing.

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