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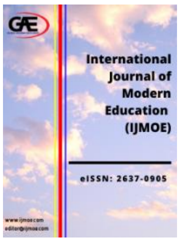

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A COMPREHENSIVE STUDY OF SOFTWARE PREFERENCES AMONG UiTM CIVIL ENGINEERING STUDENTS AND IMPLICATIONS FOR BIM EDUCATION

Mohd Azrizal Fauzi[1*], Ezliana Ghazali[2], Muhamad Faizal Pakir Mohamed Latiff[3], Zulfairul Zakariah[4]

[1] Civil Engineering Studies, College of Engineering, Universiti Teknologi MARA Cawangan Pulau Pinang, Permatang Pauh Campus, 13500 Pulau Pinang, MALAYSIA
Email: azrizal@uitm.edu.my
[2] Engineering Services Division, Ministry of Health, 62590 Putrajaya, MALAYSIA
Email: ezliana_maf@yahoo.com
[3] Civil Engineering Studies, College of Engineering, Universiti Teknologi MARA Cawangan Pulau Pinang, Permatang Pauh Campus, 13500 Pulau Pinang, MALAYSIA
Email: faizal.pakir@uitm.edu.my
[4] Civil Engineering Studies, College of Engineering, Universiti Teknologi MARA Cawangan Pulau Pinang, Permatang Pauh Campus, 13500 Pulau Pinang, MALAYSIA
Email: zulfairul@uitm.edu.my
[*] Corresponding Author

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Abstract:

This comprehensive study investigates the software preferences of civil engineering students at Universiti Teknologi MARA (UiTM) in Malaysia, focusing on the adoption of Building Information Modeling (BIM) and traditional Computer-Aided Design (CAD) software. The research specifically delves into student preferences regarding the top 10 BIM software for civil engineers, explores factors influencing their choices, identifies perceived benefits and barriers to BIM adoption, and provides recommendations for curriculum development to bridge the gap between theoretical knowledge and practical BIM application. A mixed-methods approach was employed, encompassing surveys, semi-structured interviews, and focus group discussions to gather data from a large sample size of students. Results reveal a predominant preference for CAD software, particularly AutoCAD, due to its familiarity, ease of use, and prior exposure. However, students acknowledged the potential benefits of BIM, such as improved collaboration, enhanced visualization, and reduced errors. Key barriers to BIM adoption included limited access to software, inadequate training, and concerns about industry readiness. The study emphasizes the need for educational institutions to comprehensively integrate BIM into the curriculum, provide hands-on training

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with industry-standard software, and foster collaboration with industry partners to ensure future civil engineers are equipped for the digital transformation of the construction industry. The findings offer valuable insights for stakeholders invested in cultivating a BIM-ready workforce in Malaysia.

Keywords:

Building Information Modeling (BIM), Computer-Aided Design (CAD), Civil Engineering Education, Software Preferences, Malaysia, Mixed-Methods Research, Technology Acceptance Model

Introduction

The construction industry is undergoing a transformative shift towards digitalization, with Building Information Modeling (BIM) emerging as a central pillar of this evolution. BIM is a collaborative process that utilizes a digital representation of physical and functional characteristics of a facility to facilitate design, construction, and operation processes (Eastman et al., 2011). This digital representation, known as a building information model, enables stakeholders to explore a project's physical and functional characteristics virtually, improving collaboration, enhancing efficiency, and minimizing errors (Azhar et al., 2012).

However, realizing the full potential of BIM hinges on the preparedness of future construction professionals to adopt and effectively utilize this technology. Civil engineering students, the future workforce of the industry, play a pivotal role in driving BIM adoption. Their software preferences, attitudes, and perceptions towards BIM have significant implications for the successful integration of BIM into the construction industry. Understanding these factors is crucial for educational institutions to develop curricula and training programs that equip students with the necessary skills and knowledge to navigate the digital age of construction.

In the context of Malaysia, the government has been actively promoting BIM adoption through the Construction Industry Transformation Programme (CITP) (CIDB, 2017). The CITP aims to transform the Malaysian construction industry into a world-class industry that is productive, sustainable, and resilient. One of the key strategies of the CITP is to promote the adoption of digital technologies, including BIM, in the construction industry. However, the successful implementation of BIM in Malaysia requires a skilled workforce that is proficient in using BIM software. This underscores the importance of understanding the software preferences of civil engineering students and the implications for BIM education in Malaysia.

This comprehensive study delves into the software preferences of civil engineering students at Universiti Teknologi MARA (UiTM), a prominent public university in Malaysia. The research centers on the top 10 BIM software for civil engineers, analyzing students' inclinations towards both BIM and traditional Computer-Aided Design (CAD) software. This investigation aims to identify the preferred software among UiTM civil engineering students, discern the factors that influence their software choices, examine the perceived advantages and disadvantages of BIM adoption, and ultimately propose recommendations to enhance BIM education and curriculum development. The ultimate goal is to bridge the gap between theoretical knowledge and practical BIM application, ensuring that future civil engineers are adequately prepared for the industry's ongoing digital transformation.

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By addressing these objectives, this study seeks to contribute to the growing body of knowledge on BIM adoption in academia and offer valuable insights for stakeholders invested in cultivating a BIM-ready workforce in Malaysia. The study also seeks to contribute to the broader discourse on BIM education and adoption in the context of developing countries, where the challenges and opportunities may differ from those in developed countries.

Literature Review

BIM Adoption in the Construction Industry
BIM adoption has gained momentum globally, with various countries and regions experiencing different rates of implementation. This variation can be attributed to factors such as regulatory frameworks, industry culture, and technological infrastructure (Ahuja et al., 2020; Kouch, 2018; Jung & Joo, 2011). In developed countries like the United Kingdom, BIM has been mandated for public sector projects (Bew & Richard, 2010; RICS, 2023), while developing countries like Malaysia are still in the early stages of BIM adoption.

Numerous studies have documented the benefits of BIM adoption in the construction industry. These benefits include improved project outcomes, enhanced collaboration among stakeholders, reduced costs, and increased efficiency (Barlish & Sullivan, 2012; Eastman et al., 2011; Succar, 2009; Juan et al., 2017; Shibeika & Harty, 2015; Succar & Kassem, 2015). BIM enables better decision-making, clash detection, and visualization, leading to improved project planning and execution. However, despite these benefits, BIM adoption faces several challenges, including lack of awareness, resistance to change, cost concerns, and interoperability issues (Ahuja et al., 2020; Jung & Joo, 2011). These challenges are particularly pronounced in developing countries where there may be limited resources and expertise available for BIM implementation.

BIM Education
Integrating BIM into civil engineering curricula is crucial for preparing students for the demands of the modern construction industry (Olowa et al., 2023; Taylor, 2010). Several studies have investigated the effectiveness of BIM education, emphasizing the importance of hands-on experience, project-based learning, and industry collaboration (Cheng et al., 2016; Eastman et al., 2011; Witt & Kähkönen, 2019; El-Gohary, 2019). However, challenges such as faculty training, software availability, and curriculum integration persist (El-Gohary, 2019; Farooqui, 2016). These challenges are often magnified in developing countries where there may be a shortage of qualified BIM educators and limited access to BIM software.

BIM Software Landscape for Civil Engineers
BIM software, or platforms, cater to diverse functions in building construction, ranging from design modeling and drawing production to structural analysis, construction scheduling, fabrication detailing, and facility management (Eastman et al., 2011; Novatr, 2023). Table 1 presents a list of the most common BIM software used in the market and industry. These software are selected based on their prevalence in industry surveys, expert opinions, and their comprehensive features catering to various aspects of civil engineering projects.

Each of these software offers unique features and capabilities, catering to various aspects of civil engineering design, analysis, and construction. Autodesk Revit, for instance, is widely used for architectural design and documentation, while Tekla Structures is popular for

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structural engineering and detailing. Bentley Systems offers a comprehensive suite of BIM software for infrastructure projects, while Graphisoft ArchiCAD is known for its user-friendly interface and strong visualization capabilities.

Among these, Autodesk Revit stands out as a versatile BIM software widely employed for architectural design and documentation (Sun et al., 2023). It enables the creation of detailed 3D models, facilitates collaboration among disciplines, and generates construction documents, making it a popular choice among architects and engineers alike.

Table 1: Top 10 BIM Software for Civil Engineers

Software	Type of Software	Developer
Autodesk Revit	BIM	Autodesk
Tekla Structures	BIM	Trimble
Bentley Systems	BIM	Bentley Systems
Graphisoft ArchiCAD	BIM	Graphisoft
Vectorworks Architect	BIM	Vectorworks, Inc.
Trimble SketchUp	3D Modelling/BIM	Trimble
Nemetschek Allplan	BIM	Nemetschek
Dassault Systèmes CATIA	3D Modelling/BIM	Dassault Systèmes
Autodesk Civil 3D	Civil Engineering/BIM	Autodesk
Autodesk InfraWorks	Infrastructure Modelling/BIM	Autodesk

Given its extensive use in both academic and professional settings, Revit will be a focal point in this study, serving as a representative BIM software. Its capabilities will be compared to those of SketchUp, a non-BIM 3D modeling software widely used in Malaysia's architectural firms (Mohd-Nor & Grant, 2014), to understand the nuances of students' software preferences and the implications for BIM education.

Software Preferences and Barriers in the Malaysian Context

In the Malaysian context, the adoption of BIM is still in its early stages, and there is limited research on the software preferences of civil engineering students. However, studies from other developing countries suggest that CAD software, particularly AutoCAD, remains popular due to its familiarity, ease of use, and lower cost (Abanda et al., 2018). This is despite the growing recognition of the potential benefits of BIM.

Several barriers to BIM adoption have been identified in the Malaysian context, including lack of awareness, resistance to change, cost concerns, and limited access to BIM software and training (CIDB, 2017). These barriers need to be addressed to accelerate the adoption of BIM in the Malaysian construction industry.

Theoretical Frameworks

This study is grounded in the Technology Acceptance Model (TAM) (Davis, 1989) and the Theory of Planned Behavior (TPB) (Ajzen, 1991). TAM posits that perceived ease of use and perceived usefulness are key determinants of technology adoption. TPB suggests that attitudes, subjective norms, and perceived behavioral control influence individuals' intentions to adopt a technology. These theories provide a framework for understanding students' software preferences and their willingness to adopt BIM.

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Methodology

Research Design

This comprehensive study employed a sequential mixed-methods research design, beginning with a quantitative phase followed by a qualitative phase. The quantitative phase involved a survey to gather data on software preferences, perceived benefits and barriers, and influencing factors. The qualitative phase involved interviews and focus group discussions to delve deeper into the reasons behind these preferences and perceptions. This approach allowed for a more comprehensive understanding of the research problem by combining the strengths of both quantitative and qualitative methods.

Participants

Participants were undergraduate civil engineering students from UiTM. A stratified random sampling method was used to ensure representation from all year levels and specializations within the program. The sample size for the survey was 500 students, while 20 students participated in the interviews and focus group discussions.

Data Collection

Quantitative data were collected via an online survey using Google Forms. The survey consisted of Likert-scale and multiple-choice questions, assessing software preferences (including specific BIM software), perceived benefits and barriers to BIM adoption, and factors influencing software choices.

Qualitative data were collected through semi-structured interviews and focus group discussions. Interviews were conducted individually, while focus groups consisted of 4-5 students each. The discussions explored students' experiences with BIM and CAD software, their perceptions of BIM implementation, the challenges they faced, and their recommendations for improving BIM education. All interviews and focus groups were audio-recorded and transcribed verbatim for analysis.

Data Analysis

Quantitative data analysis involved descriptive statistics (e.g., frequencies, percentages, means, standard deviations) and inferential statistics (e.g., independent t-tests, chi-square tests, ANOVA, and multiple linear regression). These analyses were conducted using SPSS software to identify statistically significant differences and relationships between variables.

Qualitative data analysis was performed using thematic analysis. The transcribed data from interviews and focus group discussions were coded and categorized into themes, identifying patterns and recurring concepts related to software preferences, perceived benefits and barriers, and recommendations for BIM education. This process involved multiple rounds of coding and refinement to ensure rigor and trustworthiness of the findings.

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Results

Quantitative Findings

Software Preferences

The survey results revealed a predominant preference for CAD software (78%) over BIM software (22%) among UiTM civil engineering students (Figure 1). Among CAD software, AutoCAD was the most preferred (92%), followed by MicroStation (5%) and others (3%) (Figure 2). Among BIM software, Autodesk Revit was the most preferred (55%), followed by Tekla Structures (20%) and Bentley Systems (15%) (Figure 3).

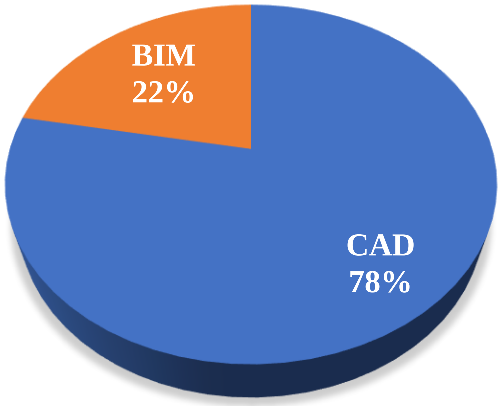

Figure 1: Distribution of Students by Preferred Software Type

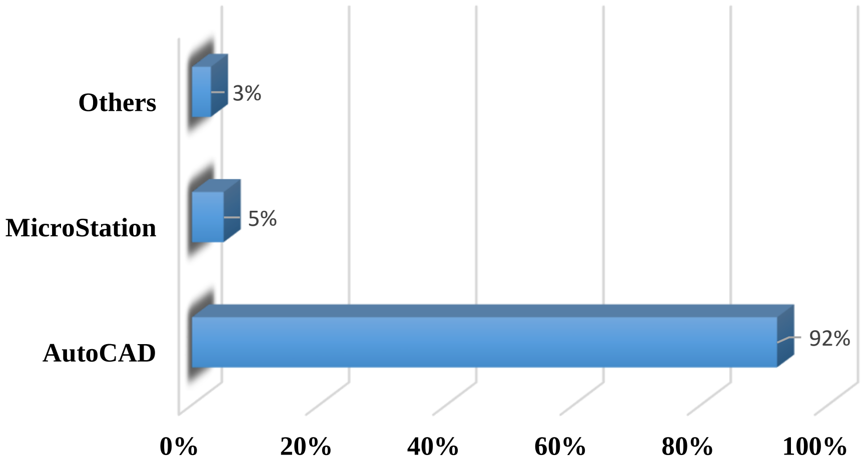

Figure 2: Distribution of Students by Preferred CAD Software

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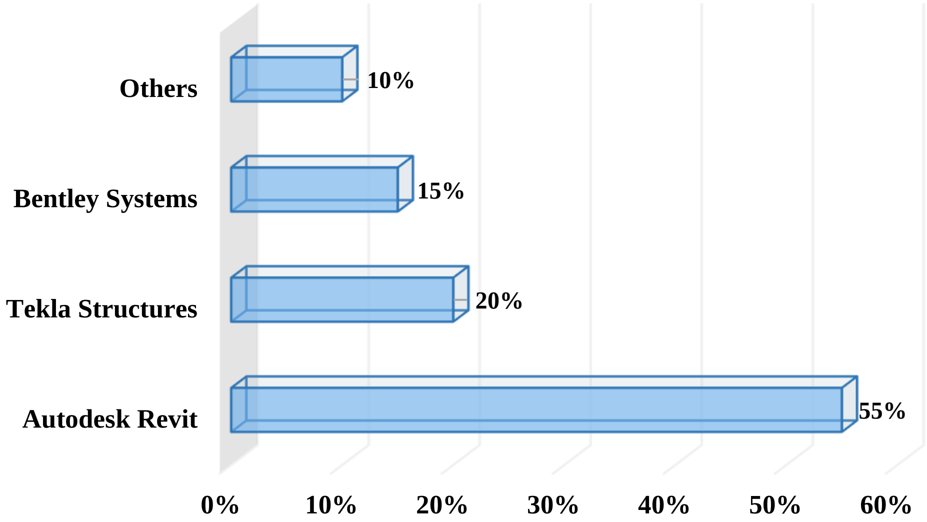

Figure 3: Distribution of Students by Preferred BIM Software

Factors Influencing Software Choices

Multiple linear regression analysis identified several factors influencing students' software choices as in Table 2. The strongest predictors of BIM software preference were curriculum integration ($\beta = .32$, $p < .001$) and industry demand ($\beta = .28$, $p < .01$). Other significant factors included perceived ease of use ($\beta = .22$, $p < .05$) and perceived usefulness ($\beta = .18$, $p < .05$). Familiarity with CAD software emerged as a negative predictor of BIM preference ($\beta = -.25$, $p < .01$).

Table 2: Multiple Linear Regression Analysis of Factors Influencing UiTM Civil Engineering Students' Software Choices

Predictor	Standardized Beta (β)	p-value
Curriculum Integration	0.32	< .001
Industry Demand	0.28	< .01
Perceived Ease of Use	0.22	< .05
Perceived Usefulness	0.18	< .05
Familiarity with CAD	-0.25	< .01

Note: A negative beta coefficient for "Familiarity with CAD" indicates that increased familiarity with CAD software is associated with a decreased preference for BIM software.

Perceived Benefits and Barriers to BIM Adoption

Students perceived several benefits of BIM, including improved collaboration (80%), enhanced visualization (75%), reduced errors (70%), increased efficiency (65%), and better cost estimation (60%) (Figure 4). However, several barriers to BIM adoption were also identified, with limited access to software (70%) and inadequate training (65%) being the most significant. Other barriers included the steep learning curve (55%) and concerns about industry resistance (45%) (Figure 5).

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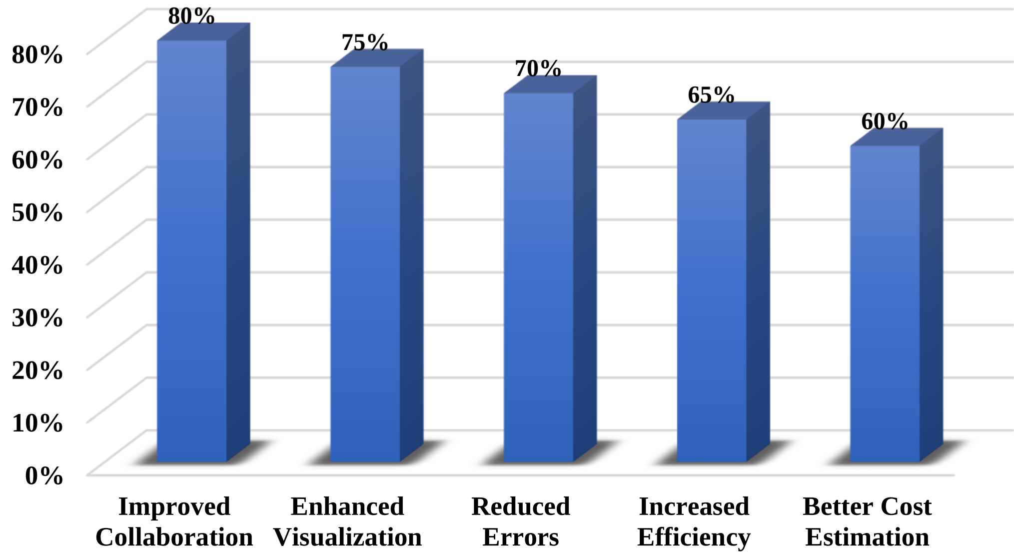

Figure 4: Perceived Benefits of BIM Software by UiTM Civil Engineering Students

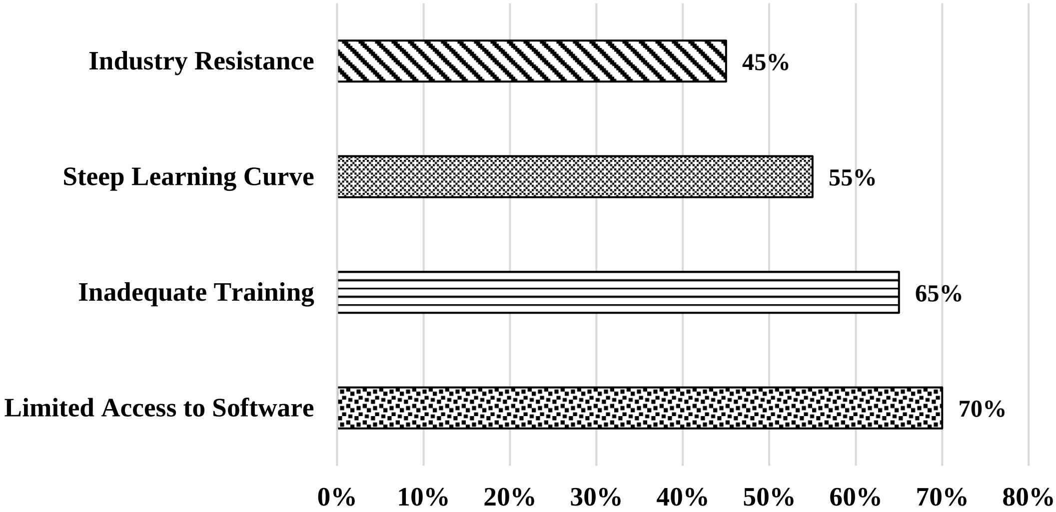

Figure 5: Perceived Barriers to BIM Adoption by UiTM Civil Engineering Students

Qualitative Findings

Thematic analysis of the qualitative data revealed several key themes:

- **Ease of Use and Familiarity:** Students overwhelmingly favored CAD software due to its user-friendly interface and their prior exposure to it during their studies and internships. BIM software was perceived as complex and requiring a steep learning curve.
- **Curriculum Integration:** Students expressed a desire for more comprehensive BIM education that went beyond theoretical concepts. They emphasized the importance of hands-on experience, project-based learning, and integration of BIM throughout the curriculum, not just as a standalone elective.
- **Industry Relevance:** Students stressed the need for BIM education to be aligned with industry demands and practices. They sought opportunities to apply BIM to real-world scenarios and gain practical experience that would be relevant to their future careers.

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- **Perceived Barriers:** Students echoed the quantitative findings regarding the barriers to BIM adoption, particularly limited access to software and inadequate training. They also expressed concerns about the cost of BIM software and the lack of industry-wide adoption in Malaysia.

Discussion

The findings of this study illuminate the multifaceted landscape of software preferences among UiTM civil engineering students, revealing a strong preference for CAD software, particularly AutoCAD, due to its familiarity, ease of use, and prior exposure. This preference persists despite a growing recognition of BIM's potential benefits in enhancing collaboration, visualization, and error reduction. These findings align with previous research on BIM adoption in academic settings, which highlights the challenges of transitioning from familiar CAD workflows to the complexities of BIM (Abanda et al., 2018; El-Gohary, 2019).

The study's results resonate with the Technology Acceptance Model (TAM) and the Theory of Planned Behavior (TPB), confirming the influence of perceived ease of use and usefulness on software preferences (Davis, 1989). Additionally, the significant impact of familiarity with CAD software, subjective norms, and perceived behavioral control on students' BIM adoption intentions underscores the importance of addressing not only the technical aspects of BIM education but also the psychological and social factors that influence technology adoption (Ajzen, 1991).

Furthermore, the study identifies key barriers to BIM adoption, including limited access to software, inadequate training, and concerns about industry readiness. These challenges are particularly salient in the Malaysian context, where BIM adoption is still in its early stages and resources may be limited. Addressing these barriers necessitates a concerted effort from educational institutions, industry stakeholders, and the government to create a conducive environment for BIM education and adoption.

The emphasis on hands-on experience and industry relevance in the qualitative findings underscores the need for a paradigm shift in BIM education, transitioning from a predominantly theoretical approach to a more practical and industry-oriented one. This could involve incorporating BIM across the curriculum, providing access to industry-standard software, and creating opportunities for students to work on real-world BIM projects, thus aligning academic learning with industry demands and practices. Collaboration with industry partners can further enhance BIM education by providing students with exposure to BIM workflows, best practices, and the latest industry trends.

In essence, this study paints a complex picture of BIM adoption among UiTM civil engineering students, highlighting a tension between the familiarity and ease of use of CAD software and the recognized potential of BIM. The findings underscore the need for a multi-faceted approach to BIM education that addresses technical, psychological, and contextual factors to foster a BIM-ready workforce for the future of the Malaysian construction industry.

Implications for BIM Education

The findings of this study have significant implications for BIM education in Malaysia and other developing countries where BIM adoption is still in its early stages. To effectively prepare

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students for the digital age of construction, educational institutions need to adopt a multi-faceted approach that addresses the following aspects:

- **Curriculum Integration:** BIM should be integrated into all relevant courses in the civil engineering curriculum, not just as a standalone elective. This approach would ensure that students develop a comprehensive understanding of BIM and its applications throughout the project lifecycle. For instance, BIM can be integrated into courses on structural design, construction management, and project management. This would expose students to BIM in various contexts and help them understand its value in different phases of a project.
- **Hands-On Training:** Students should be provided with ample opportunities for hands-on training with industry-standard BIM software. This could involve workshops, tutorials, simulations, and project-based learning activities that mirror real-world BIM workflows. Hands-on training is crucial for students to develop practical skills and gain confidence in using BIM software. This could be facilitated by providing students with access to BIM software licenses, organizing workshops led by industry experts, and incorporating BIM projects into the curriculum.
- **Industry Collaboration:** Educational institutions should forge strong partnerships with industry stakeholders to provide students with exposure to BIM practices and real-world projects. This could include internships, guest lectures, site visits, and collaborative research projects. Such collaborations would bridge the gap between academia and industry, ensuring that students are equipped with the skills and knowledge that are in demand in the industry. Additionally, industry partnerships can provide students with access to the latest BIM software and technologies, as well as mentorship and guidance from experienced BIM professionals.
- **Faculty Development:** Faculty members should receive ongoing training on BIM concepts, software, and pedagogy. This would ensure that they are equipped to deliver effective BIM education and keep abreast of the latest industry developments. Faculty development programs could include workshops, seminars, conferences, and online courses. By investing in faculty development, universities can ensure that their teaching staff is knowledgeable and passionate about BIM, which can positively influence students' attitudes towards the technology.
- **Software Accessibility:** Educational institutions should provide students with access to BIM software outside of university labs. This could involve providing licenses for students to use on their personal computers or establishing virtual labs accessible from anywhere. Additionally, exploring open-source or affordable BIM software options could help alleviate cost barriers for students. Making BIM software more accessible to students would encourage them to experiment with the software, learn at their own pace, and apply their knowledge to personal projects.
- **Awareness and Advocacy:** Educational institutions should actively promote BIM awareness among students and faculty. This could involve organizing seminars, workshops, and conferences on BIM, showcasing successful BIM implementations, and inviting industry experts to share their experiences. By creating a culture of BIM awareness, universities can foster a positive attitude towards BIM and encourage its adoption among students. Additionally, advocating for the inclusion of BIM in accreditation standards for engineering programs can further incentivize universities to invest in BIM education.

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Conclusion

This comprehensive study provides valuable insights into the software preferences of UiTM civil engineering students and the factors influencing their choices. While CAD software remains the dominant choice due to its familiarity and ease of use, there is a growing recognition of the potential benefits of BIM. By addressing the perceived barriers and implementing the recommendations outlined in this study, educational institutions can empower students to embrace BIM and contribute to the digital transformation of the construction industry.

Furthermore, this study underscores the importance of aligning BIM education with industry demands and practices. By fostering collaboration between academia and industry, we can ensure that future civil engineers are equipped with the necessary skills and knowledge to thrive in the rapidly evolving digital landscape of the construction industry.

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