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STAKEHOLDERS' PERSPECTIVES ON THE INTEGRATION OF DIGITAL TECHNOLOGIES IN CONSTRUCTION TRAINING WITHIN INDUSTRIAL TECHNOLOGY EDUCATION FOR SUSTAINABLE DEVELOPMENT

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Abstract
The increasing digitalization of the construction industry has created a need for training programmes that equip learners with relevant digital competencies. This study explored stakeholders' perspectives on the integration of digital technologies in construction training within Industrial Technology Education for sustainable development in Nigeria. A qualitative research design was adopted to gain in-depth insights from key stakeholders involved in construction education and practice. Purposive sampling was used to select fifteen participants comprising instructors, industry professionals, and institutional administrators. Data were collected through semi-structured interviews and analysed using thematic analysis supported by NVivo qualitative data analysis software. The findings revealed that stakeholders demonstrate a growing awareness of digital technologies such as Building Information Modelling (BIM), simulation tools, and digital construction software, although the level of integration within training programmes remains moderate. Participants reported that digital technologies enhance students' visualization of construction processes, improve practical skill development, and better prepare graduates for industry demands. However, several challenges were identified, including inadequate digital infrastructure, limited institutional funding, insufficient instructor training, and weak collaboration between educational institutions and industry. Stakeholders emphasized the need for improved digital infrastructure, curriculum modernization, professional development for instructors, and stronger industry–academia partnerships to support effective technology integration. The study concludes that strengthening digital capacity and institutional support is essential for enhancing the integration of digital technologies in construction training. Such efforts can improve the quality of Industrial Technology Education and help develop a workforce capable of supporting sustainable development in the construction sector.

Keywords: *Digital technologies, construction training, Industrial Technology Education, stakeholder perspectives, sustainable development.*

Introduction

The construction industry plays a significant role in national development by providing infrastructure, employment opportunities, and economic growth. As construction projects become increasingly complex, the industry requires a workforce equipped with modern technical competencies and digital skills. Educational institutions responsible for training construction professionals therefore face increasing pressure to adopt innovative teaching approaches that reflect emerging technological trends within the construction sector (Sampaio, 2022; Onatere-Ubrurhe et al., 2025). In recent years, digital transformation has reshaped the construction industry worldwide. Technologies such as Building Information

Modelling (BIM), Virtual Reality (VR), Augmented Reality (AR), drones, and Internet of Things (IoT) systems have improved the efficiency, coordination, and visualization of construction processes. These technologies enable professionals to simulate building designs, detect potential construction errors, and enhance project planning before actual construction begins. As a result, digital technologies have become essential tools in modern construction practice (Abouelkhier et al., 2024; Onatere-Ubrurhe et al., 2024).

The increasing adoption of digital technologies in the construction industry has significant implications for education and training. Construction education programmes are expected to equip students with competencies that align with industry demands. Digital tools such as BIM and VR can enhance construction training by providing interactive and immersive learning experiences that allow students to visualize construction processes, explore building systems, and understand complex project relationships. These technologies also support experiential learning by enabling learners to interact with simulated construction environments without the risks associated with real construction sites (Sampaio, 2022; Abouelkhier et al., 2024; Onatere-Ubrurhe et al., 2025).

Within Technical Vocational Education and Training (TVET)/Industrial Technology Education programmes, the integration of digital technologies is particularly important. TVET programmes are designed to develop practical skills that prepare learners for employment in various industries, including the construction sector. As the construction industry becomes increasingly digitized, TVET institutions must adapt their training approaches to ensure that graduates possess the digital competencies required in modern workplaces. The integration of digital technologies into construction training can therefore improve the quality of skill development and enhance the employability of graduates (Onatere-Ubrurhe et al., 2025; UNESCO, 2025).

Furthermore, digital technologies have the potential to support sustainable development within the construction sector. Sustainable construction requires efficient use of resources, improved planning processes, and reduced environmental impact. Digital technologies such as BIM allow construction professionals to analyze building performance, optimize material usage, and minimize waste during the design and construction stages. Consequently, integrating digital technologies into construction education can help prepare future professionals to adopt sustainable construction practices (Sampaio, 2022; Abouelkhier et al., 2024).

Despite the growing importance of digital technologies in the construction industry, their integration into construction training programmes remains limited in many educational institutions, particularly in developing countries such as Nigeria. In Nigeria, construction education programmes often rely on traditional teaching methods that focus mainly on theoretical instruction with limited exposure to modern digital construction tools. This situation has contributed to a skills gap between the competencies acquired by graduates and those required by employers in the construction industry (Onatere-Ubrurhe et al., 2025). Several factors have been identified as barriers to the effective integration of digital technologies in construction education. These include inadequate technological infrastructure, limited access to digital tools, insufficient training for instructors, and weak collaboration between educational institutions and industry stakeholders. Without addressing these challenges, many institutions may struggle to prepare students for the digital transformation currently occurring within the construction sector.

Another important factor influencing the integration of digital technologies in education is the role of stakeholders. Stakeholders such as educators, students, institutional administrators, and industry professionals play a crucial role in shaping the adoption and implementation of new technologies in training programmes. Their perceptions, experiences, and expectations can influence how digital technologies are integrated into construction training. Understanding stakeholders' perspectives is therefore essential for identifying both

the opportunities and the challenges associated with technology integration in construction education (Onatere-Ubrurhe et al., 2025).

Although several studies have examined the application of digital technologies in construction practice, limited research has focused on stakeholders' perspectives regarding the integration of these technologies within construction training programmes, particularly in the context of Industrial Technology Education. Exploring these perspectives can provide valuable insights into the current state of technology integration, the challenges faced by institutions, and possible strategies for improving digital construction training. Therefore, this study explores stakeholders' perspectives on the integration of digital technologies in construction training within Industrial Technology Education for sustainable development. The study seeks to examine stakeholders' understanding of digital technologies used in construction training, identify the perceived benefits and challenges associated with technology integration, and explore possible strategies for enhancing the adoption of digital technologies in construction education; with specific objectives to: (1) Examine stakeholders' understanding of digital technologies used in construction training within Industrial Technology Education; (2) Explore the current level of integration of digital technologies in construction training programmes; (3) Identify stakeholders' perceptions of the benefits of integrating digital technologies into construction training; (4) Investigate the challenges affecting the integration of digital technologies in construction training; and (5) Explore stakeholders' suggestions for improving the integration of digital technologies in construction training to support sustainable development.

Literature Review

Concept of Industrial Technology Education

Industrial Technology Education focuses on developing learners' technical knowledge, practical competencies, and technological skills required for industrial occupations. The discipline emphasizes the application of scientific principles and technological tools in solving practical problems within industrial and technological environments. It prepares learners for careers in sectors such as manufacturing, construction, electronics, and other technology-driven industries (Onatere-Ubrurhe et al., 2025).

Industrial Technology Education is a Technical Vocational Education and Training (TVET) program, which aims to equip learners with employable skills and competencies needed in the labour market. TVET programmes integrate theoretical instruction with hands-on training to prepare individuals for productive participation in the workforce. Through this combination of theory and practice, learners develop problem-solving abilities, technical expertise, and workplace readiness (Okolie et al., 2020; Onatere-Ubrurhe et al., 2025).

Globally, the role of Industrial Technology Education has expanded significantly due to rapid technological advancement and the growing demand for skilled workers capable of operating modern technologies. Industries are increasingly adopting digital technologies to improve efficiency and productivity, which requires workers who possess both technical knowledge and digital competencies. Consequently, educational institutions are expected to modernize their curricula and training approaches to reflect emerging technological developments (Onatere-Ubrurhe et al., 2025; UNESCO, 2025).

In addition, Industrial Technology Education contributes to national economic development by producing skilled professionals capable of supporting industrial growth. In developing countries such as Nigeria, the sector plays a crucial role in addressing unemployment and skills shortages by equipping learners with practical competencies required for industry participation. However, to remain relevant in the era of digital transformation, Industrial Technology Education programmes must integrate modern technological tools into teaching and learning processes (Okolie et al., 2020; Onatere-Ubrurhe et al., 2025).

Construction Training in Industrial Technology Education

Construction training is an essential component of Industrial Technology Education because

the construction sector requires skilled professionals who possess both technical knowledge and practical competencies. Construction training programmes typically cover areas such as building materials, construction methods, structural systems, project management, and construction safety.

Traditionally, construction education has relied heavily on classroom lectures, drawings, and theoretical explanations. While these approaches provide fundamental knowledge, they may not adequately capture the complexity of real construction processes. Construction projects involve dynamic interactions among multiple stakeholders, complex workflows, and detailed coordination of activities. Students trained primarily through theoretical instruction may therefore struggle to fully understand practical construction processes (Abouelkhier et al., 2024; Onatere-Ubrurhe et al., 2025). To address this limitation, many educational institutions have begun adopting experiential learning approaches in construction education. Experiential learning involves providing learners with opportunities to engage directly with practical activities, simulations, and real-world scenarios. Such approaches allow students to develop a deeper understanding of construction processes and improve their problem-solving abilities (Kolb, 2015; Onatere-Ubrurhe et al., 2025).

Additionally, industry collaboration plays a crucial role in improving construction training. Partnerships between educational institutions and construction companies can facilitate work-integrated learning opportunities, internships, and practical training experiences for students. These collaborations help ensure that training programmes reflect current industry practices and technological developments (Onatere-Ubrurhe et al., 2025).

However, in some developing countries such as Nigeria, construction training programmes still face challenges such as limited access to modern construction equipment, inadequate laboratory facilities, and insufficient industry collaboration. These challenges highlight the need for innovative teaching methods, including the integration of digital technologies, to enhance construction training and improve students' practical competencies (Onatere-Ubrurhe et al., 2025).

Digital Technologies in Construction Training

Digital technologies have transformed the construction industry by improving project visualization, coordination, and decision-making processes. As a result, these technologies are increasingly being integrated into construction training programmes to enhance learning experiences (Onatere-Ubrurhe et al., 2025). One of the most widely adopted digital technologies in construction is Building Information Modelling (BIM). BIM is a digital representation of the physical and functional characteristics of a building, enabling professionals to visualize and manage building information throughout the project lifecycle. BIM facilitates collaboration among architects, engineers, contractors, and other stakeholders by integrating project information into a shared digital model (Sampaio, 2022; Onatere-Ubrurhe et al., 2025). Within construction education, BIM helps students understand complex building systems, construction sequencing, and project coordination. By interacting with digital building models, learners can explore different construction scenarios and identify potential design conflicts before construction begins (Sacks et al., 2018; Sampaio, 2022; Onatere-Ubrurhe et al., 2025).Virtual Reality (VR) and Augmented Reality (AR) are also gaining increasing attention in construction training. VR technology enables users to immerse themselves in simulated construction environments where they can explore building structures and construction processes. Research has shown that VR-based learning environments can improve students' spatial understanding and comprehension of construction operations.

Similarly, AR overlays digital information onto real-world environments, enabling learners to visualize building components and construction activities in real time. AR technologies are particularly useful in construction training because they allow students to interact with both physical and digital elements simultaneously (Abouelkhier et al., 2024;

Onatere-Ubrurhe et al., 2025). Other emerging technologies used in construction training include drones, digital twins, and Internet of Things (IoT) systems. These technologies enable real-time monitoring of construction activities, data-driven decision-making, and improved project management. Integrating such technologies into construction education helps prepare students for the increasingly digital nature of the construction industry (Onatere-Ubrurhe et al., 2024).

Integration of Digital Technologies in Technical Vocational Education and Training (TVET)

The integration of digital technologies into TVET has become a global priority due to the digital transformation occurring across industries. Modern workplaces increasingly require workers who possess digital competencies alongside traditional technical skills (Onatere-Ubrurhe et al., 2025). Digital technologies provide several benefits for vocational education. They support interactive learning environments, simulation-based training, and collaborative learning experiences. Simulation tools allow learners to practice complex tasks in controlled environments without the risks associated with real-world situations (Schwab, 2017; Onatere-Ubrurhe et al., 2025).

In construction-related TVET programmes, digital technologies enable students to visualize construction processes, explore building models, and simulate project activities. These technologies enhance experiential learning by allowing learners to experiment with different construction scenarios and observe the outcomes of their decisions (Chegu Badrinath et al., 2016; Sampaio, 2022; Onatere-Ubrurhe et al., 2025).

Despite these benefits, the integration of digital technologies in TVET institutions often faces several challenges. These include limited technological infrastructure, lack of trained instructors, high cost of digital tools, and resistance to technological change within educational institutions. Addressing these challenges requires coordinated efforts from governments, educational institutions, and industry stakeholders. Investments in technological infrastructure, instructor training, and curriculum development are necessary to ensure that TVET programmes can effectively incorporate digital technologies into their training processes (Onatere-Ubrurhe et al., 2025; UNESCO, 2025).

Sustainable Development and Technology-Based Skills Development

Sustainable development has become an important global priority as societies seek to balance economic growth with environmental protection and social well-being. The construction industry plays a crucial role in achieving sustainable development because construction activities significantly influence resource consumption, energy use, and environmental impact. Digital technologies can contribute to sustainable construction by improving design accuracy, optimizing material usage, and reducing construction waste. For example, BIM enables construction professionals to simulate building performance, analyze energy consumption, and evaluate environmental impacts during the design stage (Sacks et al., 2018; Sampaio, 2022; Onatere-Ubrurhe et al., 2025).

In addition, digital simulation technologies allow construction professionals to test alternative design solutions and select the most environmentally sustainable options. These capabilities help reduce resource wastage and improve project efficiency. Integrating digital technologies into construction training can therefore help prepare future professionals to adopt sustainable construction practices. Students who are trained using digital tools gain a better understanding of resource management, environmental considerations, and efficient construction processes (Sacks et al., 2018; Sampaio, 2022; Onatere-Ubrurhe et al., 2025). Educational institutions play an important role in promoting sustainable development by equipping learners with the knowledge and skills required to address environmental challenges. Incorporating digital technologies into construction education can therefore contribute to developing a workforce capable of supporting sustainable development in the built environment (Sacks et al., 2018; Sampaio, 2022; Onatere-Ubrurhe et al., 2025).

Empirical Studies on Digital Technology Integration in Technical Education

Several empirical studies have examined the integration of digital technologies in construction education and technical training programmes. Abouelkhier et al. (2024) investigated the use of a 4D BIM-based Virtual Reality simulation in construction management education. The study found that students who used VR-based simulations demonstrated improved understanding of construction sequencing and were better able to identify errors compared to students who relied on traditional learning methods.

Similarly, Chegu Badrinath et al. (2016) examined the integration of BIM into construction engineering education and found that BIM-based learning significantly improved students' comprehension of building systems and project coordination. Another study by Sacks and Pikas (2013) emphasized the importance of incorporating BIM into construction education curricula. The authors argued that BIM-based training can enhance students' ability to collaborate, visualize building systems, and understand project workflows. Research has also shown that immersive technologies such as VR can improve student engagement and learning outcomes. These technologies provide safe environments where students can explore construction activities and practice decision-making without real-world risks (Onatere-Ubrurhe et al., 2025).

Overall, empirical evidence indicates that integrating digital technologies into construction education can enhance teaching effectiveness, improve student learning experiences, and better prepare graduates for modern construction practices.

Research Gap

The research gap highlighted in this study centers on the limited exploration of how digital technologies are integrated into construction training within Industrial Technology Education, particularly from the perspective of key stakeholders such as instructors, administrators, and industry professionals. While existing literature has largely focused on the application of digital tools like BIM, VR, and AR in construction practice, there is a lack of research examining how these technologies are perceived and adopted in training programmes. Furthermore, most studies emphasize advanced economies, leaving a significant gap in understanding the unique challenges faced by developing countries such as Nigeria, where issues like inadequate infrastructure, limited funding, and weak industry–academia collaboration hinder effective integration.

Another gap lies in the specific context of Industrial Technology Education and TVET, which play a crucial role in workforce development but remain underexplored in terms of digital adoption. Finally, although digital technologies are widely recognized for their potential to support sustainable construction, few studies explicitly connect their integration in training with sustainable development outcomes, thereby underscoring the need for research that bridges digital competency development with sustainability goals.

Methodology

This study adopted a qualitative research design to explore stakeholders' perspectives on the integration of digital technologies in construction training within Industrial Technology Education. (Creswell & Poth, 2023). Participants were selected using purposive sampling. A total of 15 participants were involved in the study, comprising five instructors, five industry professionals, and five institutional administrators involved in construction training and Industrial Technology Education (Patton, 2014). Data were collected through semi-structured interviews using an interview guide designed to capture participants' views on digital technology integration, perceived benefits, challenges, and strategies for improvement. Interviews were conducted through virtual platform (Miles et al., 2014). The collected data were analysed using thematic analysis following the procedures outlined by Braun and Clarke (2006). Interview transcripts were coded and organised using NVivo qualitative data analysis software to identify key themes and patterns related to stakeholders' perspectives on

digital technologies in construction training. Ethical principles were observed throughout the study. Participants were informed about the purpose of the research and their participation was voluntary. Informed consent was obtained before conducting the interviews, and participants were assured that their responses would be treated confidentially. To protect participants' anonymity, identification codes (P1–P15) were used instead of real names in the reporting of the findings (Creswell & Poth, 2023).

Table 1. Participants' profile

Participant Code	Participant Role	Organisation	Years of Experience
P1	Instructor	University	12
P2	Instructor	University	15
P3	Instructor	Polytechnic	9
P4	Instructor	University	11
P5	Instructor	College of Education Technical	8
P6	Industry Professional	Construction Firm	10
P7	Industry Professional	Construction Firm	14
P8	Industry Professional	Construction Firm	18
P9	Industry Professional	Construction Firm	9
P10	Industry Professional	Construction Firm	7
P11	Administrator	University	16
P12	Administrator	Polytechnic	13
P13	Administrator	University	20
P14	Administrator	College of Education Technical	17
P15	Administrator	Polytechnic	12

Results

The findings are presented in table 2 according to the major themes and sub-themes and supported with direct quotations from participants. Participants were identified using codes (P1–P15) to ensure anonymity.

Table 2. Summary of Themes, Sub-themes and Participant Quotes

S/N	THEME	SUB-THEME	PARTICIPANTS' QUOTE
1.	Awareness and Understanding of Digital Technologies (Objective 1)	Knowledge of emerging construction technologies	"I am familiar with technologies such a Building Information Modelling and some construction management software that can help students understand project planning." (Instructor, P2)
		Awareness of industry digital transformation	"The construction industry is becoming more digital, especially with the use of BIM and digital project monitoring tools." (Industry Professional, P7

2.	Current Level of Digital Technology Integration	Use of digital tools in teaching	"We sometimes use digital design software and online videos to demonstrate construction processes during lectures." (Instructor, P4)
	(Objective 2)	Institutional adoption of digital technologies	"Our institution has started encouraging departments to integrate digital tools into teaching, but the implementation is still limited." (Administrator, P12)
3.	Benefits of Digital Technologies for Construction Education	Improved visualization of construction processes "Digital technologies help students visualize building structures and construction stages more clearly than traditional drawings." (Instructor, P1)	"Digital technologies help students visualize building structures and construction stages more clearly than traditional drawings." (Instructor, P1)
	(Objective 3)	Development of industry-relevant skills	"Students who are exposed to digital construction tools are usually better prepared for the demands of the industry." (Industry Professional, P8)
4.	Digital Competencies Required in the Construction Industry	BIM and digital design skills	"Students need to understand BIM because many companies now use it for planning and project coordination." (Industry Professional, P6)
	(Objectives 3 and 5)	Construction software proficiency	"Graduates should be able to use digital project management and design software effectively." (Industry Professional, P9)
5.	Challenges Affecting Technology Integration	Inadequate infrastructure	"One of the major challenges is the lack of adequate digital equipment and reliable internet connectivity in some institutions." (Instructor, P3)
	(Objective 4)	Limited funding for technology adoption	"Budget constraints make it difficult for institutions to acquire modern digital technologies for construction training." (Administrator, P13)
6.	Capacity Building and Professional Development Needs	Training for instructors	"Many instructors need training on how to effectively use digital technologies in construction

			education." (Administrator, P11)
	(Objective 5)	Continuous professional development	"Regular workshops and training programmes would help instructors stay updated with emerging construction technologies." (Instructor, P5)
7.	Industry–Academia Collaboration	Industry involvement in curriculum development	"If industry professionals are involved in curriculum design, students will learn the technologies that are actually used on construction sites." (Industry Professional, P10)
	(Objective 5)	Internship and work integrated learning	"Students should be exposed to real construction projects through internships where they can see digital tools in action." (Industry Professional, P7)
8.	Institutional Strategies for Technology Integration	Investment in digital infrastructure	"Institutions need to invest more in digital laboratories and construction simulation technologies." (Administrator, P14)
	(Objective 5)	Curriculum modernization	"Updating the curriculum to include digital construction technologies is essential for sustainable development in the sector." (Administrator, P15)

Interpretation of Findings

The findings reveal that stakeholders demonstrate a growing awareness of digital technologies relevant to construction training, particularly tools such as Building Information Modelling (BIM) and construction management software. Participants acknowledged that the construction industry is undergoing significant digital transformation, which requires training programmes to incorporate modern digital tools.

However, the results indicate that the integration of these technologies in construction training remains limited and uneven across institutions in Nigeria. While some instructors reported using digital tools such as design software and instructional videos during teaching, institutional adoption of advanced digital technologies is still developing. Participants further emphasized the significant benefits of digital technologies for construction education, particularly in improving students' visualization of construction processes and enhancing their readiness for industry practice. Industry professionals highlighted the increasing importance of digital competencies, especially BIM skills and proficiency in construction management software, as essential requirements for modern construction professionals. Despite these benefits, several challenges affecting effective integration were identified, including inadequate technological infrastructure, limited funding for digital resources, and insufficient training opportunities for instructors. Participants also stressed the need for stronger collaboration between educational institutions and the construction industry to

ensure that training programmes align with current industry technological practices.

Overall, the findings suggest that although stakeholders recognize the importance of integrating digital technologies into construction training, successful implementation will require institutional investment in digital infrastructure, enhanced instructor capacity, and stronger industry–academia partnerships.

Discussion

The findings of this study indicate that stakeholders generally recognize the growing importance of digital technologies in construction training within Industrial Technology Education, particularly tools such as Building Information Modelling (BIM), virtual simulation tools, and other digital learning platforms. Participants reported moderate awareness and partial integration of these technologies in teaching and training activities, although their use remains limited in many institutions due to infrastructural and capacity constraints. This finding aligns with previous studies which emphasize that digital transformation is gradually influencing construction education but has not yet been fully institutionalized in some developing countries such as Nigeria.

For instance, Sampaio (2022) observed that although digital tools such as BIM and virtual modelling have the potential to transform construction education, their adoption in educational institutions often progresses slowly due to limited resources and insufficient instructor training. Similarly, Abouelkhier et al. (2024) reported that the construction industry increasingly relies on digital technologies for project visualization, planning, and coordination, which makes it essential for training programmes to incorporate such tools to prepare graduates for modern construction practice. The study also found that instructors and industry professionals believe digital technologies significantly improve students' practical understanding, visualization of construction processes, and problem-solving skills. This result agrees with Chegu Badrinath et al. (2016), who found that the use of BIM and visualization technologies enhances students' engineering communication skills and spatial understanding, thereby improving learning outcomes in construction-related education.

However, despite these benefits, participants identified several barriers to effective integration, including inadequate digital infrastructure, insufficient funding, lack of professional training for instructors, and weak collaboration between industry and educational institutions. These findings are consistent with the work of Miles et al. (2014), who noted that institutional and organizational constraints often limit the adoption of innovative technologies in educational environments. Likewise, Patton (2015) highlights that successful implementation of technological innovations in training systems requires institutional support, policy direction, and stakeholder collaboration. Some participants further emphasized the need for stronger industry–academia partnerships to ensure that construction training programmes reflect current industry practices. This perspective agrees with Creswell and Poth (2023), who argue that stakeholder engagement is essential for improving the relevance of professional training programmes.

Overall, the findings suggest that while stakeholders acknowledge the value of digital technologies in enhancing construction training for sustainable development, significant institutional, infrastructural, and capacity-related barriers must be addressed before their full potential can be realized.

Conclusion

This study explored stakeholders' perspectives on the integration of digital technologies in construction training within Industrial Technology Education for sustainable development in Nigeria. The findings reveal that digital technologies are increasingly recognized as important tools for improving teaching, learning, and practical skill development in construction-related programmes. Stakeholders acknowledged that technologies such as digital modelling tools, simulation platforms, and other digital learning

resources have the potential to enhance students' understanding of construction processes, improve visualization of complex concepts, and better prepare graduates for the technologically evolving construction industry. However, the findings also indicate that the integration of digital technologies in construction training remains limited in many institutions due to several challenges, including inadequate digital infrastructure, limited access to relevant software and equipment, insufficient instructor training, and weak institutional support.

The study further highlights the importance of collaboration between educational institutions and the construction industry in promoting effective digital technology integration. Such partnerships can help ensure that construction training programmes remain aligned with current industry practices and technological developments.

Overall, the study concludes that strengthening digital capacity, improving instructor competencies, and promoting industry–academia collaboration are essential for enhancing the integration of digital technologies in construction training. Addressing these issues can improve the quality and relevance of Industrial Technology Education and contribute to the development of a skilled workforce capable of supporting sustainable development in the construction sector.

Implications of The Study

The practical implications of this study emphasize the urgent need for institutions to modernize construction training curricula by embedding digital technologies such as BIM, VR, and AR to strengthen students' visualization and problem-solving skills. It highlights the importance of instructor training and continuous professional development to ensure educators can effectively use these tools.

Furthermore, investment in digital infrastructure, including laboratories, simulation technologies, and reliable internet, is critical to overcoming barriers to adoption. Stronger industry–academia collaboration is also necessary to align training with real-world practices, provide internships, and expose students to digital tools used in construction firms. These measures collectively enhance workforce readiness and bridge the gap between graduate competencies and industry demands. The theoretical implications extend existing frameworks on technology integration in education by foregrounding stakeholder perspectives as a critical factor influencing adoption. The findings reinforce experiential learning theory, showing how immersive technologies enrich skill acquisition beyond traditional classroom methods. They also advance discussions on sustainable development by linking digital technology integration to environmentally responsible construction practices, demonstrating that training future professionals with digital tools fosters efficiency and waste reduction.

Finally, the study contributes to institutional theory by illustrating how organizational support, funding, and policy frameworks shape the extent of technology adoption in educational settings. Together, these insights enrich theoretical discourse on digital transformation in education and underscore the systemic nature of technology integration in construction training.

Recommendations

Based on the findings of this study, the following recommendations are proposed to enhance the effective integration of digital technologies in construction training within Industrial Technology Education.

1. **Provision of Digital Infrastructure:** Educational institutions offering construction-related programmes in Industrial Technology Education should invest in adequate digital infrastructure such as computers, specialized construction software, digital modelling tools, and reliable internet facilities to support the effective integration of digital technologies in construction training.
2. **Capacity Building for Instructors:** Institutions should organize regular training

workshops, seminars, and professional development programmes to improve instructors' competencies in the use of digital technologies relevant to construction education. This will enable instructors to effectively integrate these technologies into teaching and practical training activities.

3. **Curriculum Enhancement:** The curriculum of construction-related programmes should be periodically reviewed and updated to incorporate emerging digital technologies used in the construction industry. Integrating digital competencies into the curriculum will help ensure that students acquire skills that are relevant to modern construction practices.
4. **Strengthening Industry–Academia Collaboration:** Educational institutions should establish stronger partnerships with construction companies and industry professionals to facilitate knowledge sharing, access to modern digital tools, internships, and practical exposure for students. Such collaborations will help align construction training with current industry technological practices.
5. **Institutional and Policy Support:** Government agencies, educational authorities, and institutional administrators should develop supportive policies and funding mechanisms that encourage the integration of digital technologies in Industrial Technology Education programmes.
6. **Promotion of Sustainable Construction Practices:** Institutions should encourage the use of digital technologies that support sustainable construction practices, such as digital simulation and modelling tools that improve efficiency, reduce material waste, and enhance environmentally responsible construction processes.

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