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IDENTIFYING TRENDS IN CONSTRUCTION TECHNOLOGY THROUGH STUDENT INTERNSHIP EXPERIENCES

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ABSTRACT: Construction technology is a critical component of the construction industry, offering opportunities to enhance efficiency, productivity, and innovation. However, its implementation is often hindered by challenges, such as limited workforce capacity, high costs, and time constraints. These challenges are particularly significant for young professionals, who are still navigating the industry and may lack exposure to emerging technologies during their education or early career experiences. The overarching goals of this study are to identify the types of construction technologies currently being utilized and determine how they acquire their technological skills in professional settings. Through an extensive literature review, eight types of construction technologies and software were identified. A survey was then distributed to Construction Management students, ranging from sophomores to seniors, to assess their experience with these technologies during internships. The survey specifically asked whether students have utilized the technologies directly or observed their use in the workplace. The findings indicate that cloud-based systems, virtual meeting platforms, and monitoring devices are the most prevalent technologies among students. In contrast, advanced tools, such as unmanned aerial vehicles (UAVs), non-aerial robots, and augmented/virtual reality (AR/VR), exhibit limited utilization. Notably, most students indicated that their learning was informal, either through on-the-job training or self-teaching. By examining the integration of construction technologies in both educational and professional settings, this study establishes a baseline for understanding current technological adoption trends. These insights can guide companies and educational institutions in developing targeted strategies to better prepare the current and future workforce for successful technology implementation.

1. INTRODUCTION

The construction industry, valued at approximately $2.1 trillion in annual spending, is a critical driver of economic activity (U.S. Census Bureau 2025). However, it faces inherent uncertainties due to fluctuating demand, unpredictable weather, and resource availability, all of which impact productivity. Over the past three decades, technological advancements, such as cloud-based collaboration tools and advancements in building information modeling (BIM), have streamlined project workflows, enhanced safety, and boosted productivity (National Research Council 2009). Companies of all sizes are integrating emerging technologies, requiring on-site training to ensure effective adoption (Meng and Brown 2018). However, the training for a given technology can be just as demanding, despite its benefits in the long term (Zhou et. al 2013).

Education plays a vital role in bridging the gap between technological advancements and industry implementation, equipping future professionals with essential digital skills. This would also offer the potential for curricula to prepare students for the demands of the industry and act as a recruitment incentive for construction companies seeking tech-savvy professionals (Becerik-Gerber et. al 2011). The use of technology in construction can save time, improve site safety, and increase efficiency in construction, but it must be implemented and taught effectively. This study examines how construction students are exposed to and trained in emerging technologies during internships, providing insights for educational institutions and industry stakeholders to enhance workforce readiness.

2. LITERATURE REVIEW

The construction industry is increasingly integrating digital technologies to enhance efficiency, safety, and collaboration. Key advancements, such as BIM, augmented and virtual reality (AR/VR), drones, robotics, wearable sensing devices, and 3D laser scanning, are reshaping construction practices. Existing research has explored these technologies and examined the role of student internships in developing technological competencies.

Cloud-based computing and BIM adoption are becoming more prevalent, largely driven by regulatory requirements and industry demand. Moreno et al. (2019) conducted a survey to understand the use of BIM across different project phases and found that adoption is highest during the design, pre-construction, and construction phases but significantly lower in commissioning, operations, and decommissioning. Their survey of 1,256 Architecture, Engineering, and Construction (AEC) professionals highlighted BIM's benefits, such as reducing requests for information (RFIs), change orders, and material waste, while improving project timelines. Nassereddine et al. (2022) further analyzed BIM adoption by surveying five key stakeholder groups: owners, owner representatives, architects/engineers (A/E), construction managers/general contractors (CM/GC), and mechanical, electrical, and plumbing (MEP) trades. Their findings revealed that 72% of A/E, CM/GC, and MEP professionals utilize BIM, yet only 43% of owners mandate its use. This highlights a gap in owner-driven BIM requirements despite its widespread industry adoption.

Visualization plays a crucial role in construction, and AR/VR technologies help bridge physical distances by providing immersive site experiences. Noghabaei et al. (2020) conducted industry surveys in 2017 and 2018 to assess AR/VR adoption trends. Their results indicated that familiarity with these technologies is increasing, with 70% of respondents predicting widespread adoption within five years. Further research by Rubio (2023) examined AR/VR use across firms of different sizes, assessing its impact on stakeholder collaboration and project performance. Over a three-year period, survey data confirmed a steady increase in AR/VR adoption, with industry professionals recognizing its value in training, visualization, and design communication. Also, 3D laser scanning is gaining traction over traditional surveying due to its precision and efficiency. Almukhtar et al. (2021) highlighted its growing adoption for asset documentation, particularly in historical building restoration. Tysiac et al. (2023) demonstrated how laser scanning is used to create virtual models of museums, historic sites, and infrastructure projects, offering unmatched accuracy with an error margin below 2 millimeters. This technology significantly reduces surveyor error and enhances digital documentation.

Drones and unmanned aerial vehicles (UAVs) have become essential tools in construction, particularly for mapping, inspection, and site monitoring in hazardous environments. Mahajan (2021) conducted a comprehensive review of drone adoption, identifying benefits such as enhanced land surveying, progress tracking, and material volume estimation. Choi et al. (2023) further examined drone applications and found that their top three uses include assisting emergency response teams in rescue operations, site monitoring, and earthwork/grading assessments, highlighting their increasing role in construction safety and efficiency. Similarly, robotics and remote-controlled machinery are emerging as transformative solutions in construction. Carra et al. (2018) surveyed industry professionals and identified maintenance inspection, construction installation, and design support as the three areas with the highest potential for robotics integration. Expanding on these findings, Xiao et al. (2022) conducted a qualitative study to explore future applications of robotics in construction, outlining four key areas for advancement: (1) deeper integration of BIM and robotics, (2) near-site robotic fabrication, (3) AI-driven adaptability for dynamic environments, and (4) enhanced robot-to-robot collaboration.

Complementing these advancements, real-time monitoring devices, including sensors and wearable sensing devices (WSDs), play a crucial role in construction safety, efficiency, and project management. Guo et al. (2017) conducted a study utilizing physical data collected through wearable monitoring devices to examine the correlation between workers' psychological and physical conditions. Their findings revealed that negative emotions were negatively correlated with calorie and heart rate levels, while stress states showed a positive correlation with calorie expenditure and heart rate fluctuations. These insights underscore the potential of monitoring devices in assessing worker well-being and mitigating safety risks. However, despite their benefits, adoption barriers persist. Fugate and Alzraiee (2023) found that 46% of field workers were unwilling to use biometric WSDs, while 59% resisted location-tracking devices, citing concerns over privacy and adaptability.

Internships play a vital role in preparing construction students for industry demands. Lucas (2016) surveyed juniors and seniors with internship experience to assess their exposure to construction technologies. Among 77 analyzed responses 22% had experience with BIM software (Navisworks, Revit, BIM 360), 35% used mobile technology (Bluebeam, PlanGrid, BIM 360), and 28% worked with cloud-based document management systems (Procore, CMiC, Prolog). A later qualitative study by Plugge (2023) reinforced these findings, highlighting that student interns frequently used technology for project management tasks, such as scheduling, estimating, and document control. Luk and Chan (2021) further explored the competencies gained through internships and conducting interviews with engineering students. They identified key skills, such as adaptability, interpersonal communication, planning, and problem-solving, in addition to technical proficiency with construction software. Beyond skill development, internships also enhance job prospects. Wandahl et al. (2022) analyzed academic literature and surveyed 100 graduates and their supervisors. Their results confirmed that industry experience through internships directly correlates with faster job placement and higher employability.

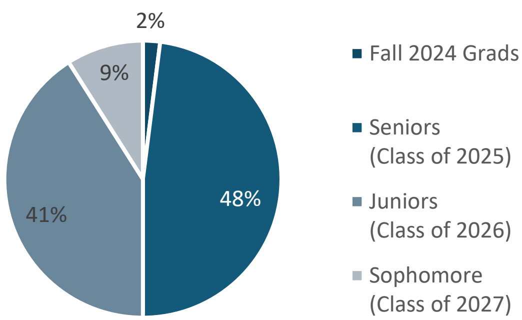
While the adoption of digital technologies, such as BIM, AR/VR, drones, robotics, and monitoring devices, continues to transform the construction industry, a critical gap remains in understanding how emerging professionals engage with these tools. Student internships serve as a bridge between academic learning and industry practice, providing firsthand exposure to construction technologies. However, while existing research primarily focuses on industry-wide adoption, technological benefits, and implementation challenges, limited attention has been given to how students and early-career professionals develop proficiency in these technologies. Moreover, the extent to which interns actively use or merely observe these tools, as well as how they acquire their technological skills remains underexplored. Addressing this gap, the overarching goals of this study are to identify the types of construction technologies currently being utilized and examine how students develop their technological competencies in professional settings. The findings will help inform educational strategies and industry practices, ensuring that the next generation of construction professionals is better prepared for technology-driven workplaces.

3. RESEARCH METHODOLOGY

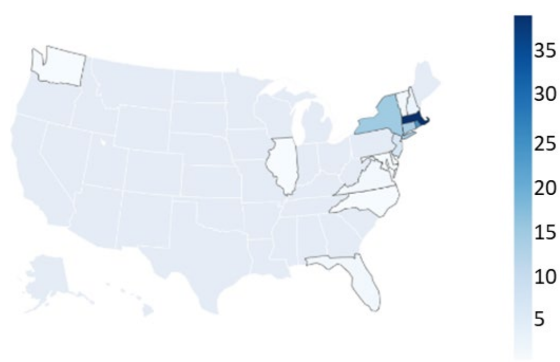
This study conducted a survey to examine the types of construction technologies students engage with during their internships and how they acquire technological skills in professional settings. The target population consisted of sophomore, junior, and senior Construction Management (CM) students at a four-year private university in the New England region. These students were selected because they were likely to have completed at least one summer internship, providing direct exposure to industry practices and technologies. To ensure a representative and targeted sample, the survey was distributed in core CM courses during the Fall 2024 semester. The study received institutional approval from the university's

Human Subject Review Board, as well as approval from course instructors before administration. Students were informed that their participation was anonymous and voluntary.

To maximize participation, the survey was administered in a paper format during class sessions over a two-week period, depending on instructor availability. Students were instructed to complete the survey based on their internship experience and to leave questions blank if they had no direct exposure to or knowledge of a particular technology. Upon collection, survey responses were digitized and organized in an Excel spreadsheet for further analysis. A total of 116 responses were collected; however, 16 responses were excluded as the students had not participated in an internship. Figure 1 presents an overview of the remaining 100 participants. The majority were seniors (Class of 2025) and juniors (Class of 2026), with smaller proportions of sophomores (Class of 2027) and students graduating in Fall 2024. Internship placements were concentrated in the Northeastern United States, particularly in Massachusetts, Rhode Island, and New York. One student reported an internship in Washington State, which aligned with their home state rather than broader geographic trends. The map visualization in Figure 1B highlights this regional distribution. Regarding project types, commercial projects (66%) accounted for the largest share of internships, followed by residential (18%), heavy civil (14%), and industrial (2%). Work environments varied among respondents. The majority worked in jobsite trailers or field offices (71%), while others were based in main offices (42%), hybrid settings (11%), or remote work arrangements (1%).



(A) Student Class Year Distribution



(B) Internship Location

Figure 1: Overview of the survey participation

The survey contained Likert scale questions and open-ended responses to assess students' exposure to various construction technologies, their frequency of use, and their mode of learning (e.g., formal training, mentorship, self-teaching). A survey was developed and distributed through an extensive literature review, and eight types of construction technologies and software were identified. These technologies included the following: monitoring devices, scanning devices, UAVs, non-aerial robots, E-Inspection, AR/VR, virtual meeting platforms, and cloud-based systems. Specifically, students indicated whether they used a given technology daily, weekly, or monthly. Open-ended responses provided students with an opportunity to elaborate on their experiences, perceptions, and suggestions regarding construction technology use in the workplace. Collected survey data was analyzed using descriptive statistics, relative importance index (RII), and heat mapping techniques. Additionally, responses to open-ended questions were examined through content analysis to identify recurring themes related to technology adoption and skill acquisition. The analysis was conducted using Excel and Python to process and visualize the data. Most students demonstrated enthusiasm and engagement in discussing construction technology, recognizing its importance in their careers. However, a few participants reported minimal exposure to emerging technologies, highlighting potential gaps in technology adoption at certain firms. Additionally, because the survey targeted students from one institution, findings may not be generalizable to all CM programs.

4. FINDINGS

This study examined the prevalence and usage of construction technologies among students during their internships, as well as how they acquired technological skills in professional settings. The findings indicate clear trends in the utilization, observation, and learning methods of various construction technologies.

4.1 Usage of Construction Technologies during Internships

Figure 2 presents the extent to which interns utilized or observed various construction technologies during their internships. Cloud-based systems and virtual meeting platforms had the highest utilization rates, suggesting that these technologies are well-integrated into internship programs and are essential for modern construction workflows. This reflects the increasing reliance on digital collaboration tools within the construction industry, likely accelerated by trends such as remote work and real-time data sharing. In contrast, more advanced technologies, such as AR/VR, drones, and non-aerial robots, exhibited significantly lower utilization and observation rates, suggesting that either companies are not fully integrating them into their workflows, or interns are not given the opportunity to engage with them directly. Additionally, some technologies, such as E-Inspection and scanning devices, saw moderate levels of utilization but were still not as prevalent as foundational digital tools like cloud-based systems.

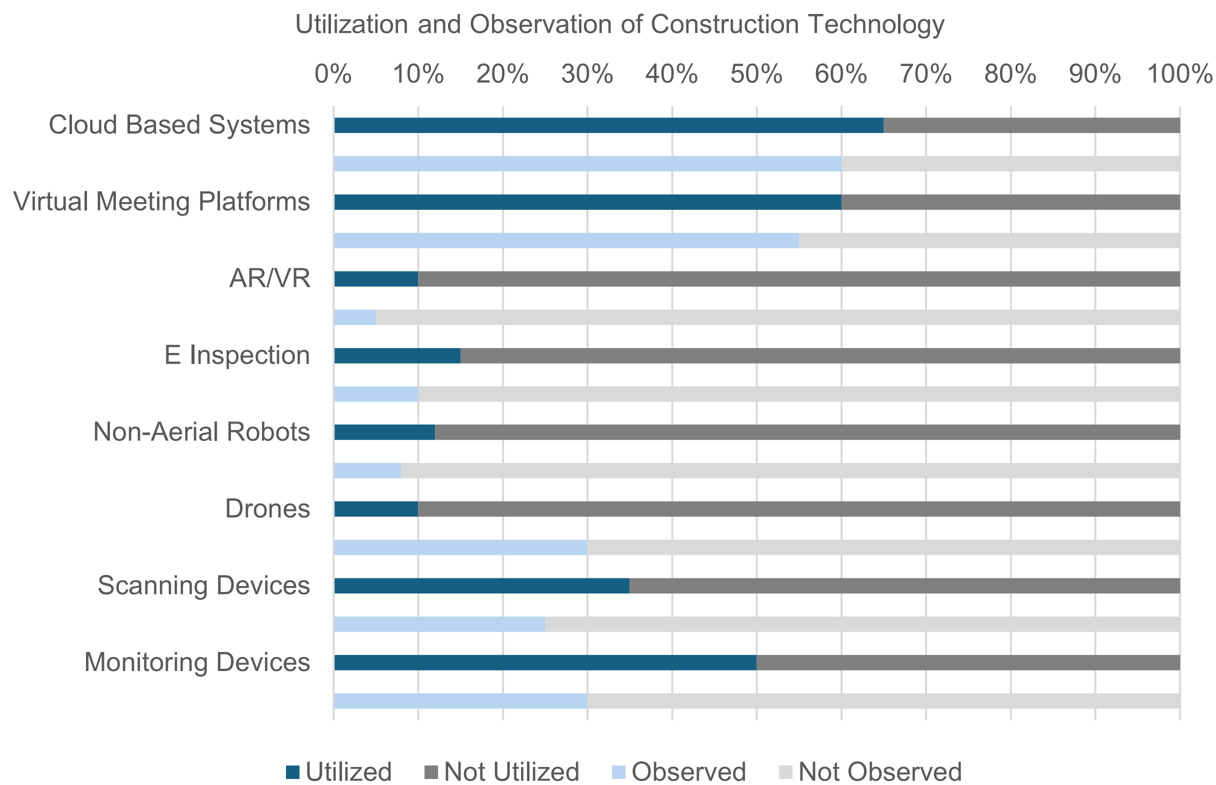


Figure 2: Comparison of Utilized and Observed Construction Technologies Among Students

To assess the relative importance of each technology, we further analyzed responses from interns who reported utilizing or observing a given technology. The survey measured the frequency of use with three response options: monthly, weekly, and daily. The relative importance index (RII) is calculated as follows (Eq. 1):

[1] $Relative\ Importance\ Index\ (RII) = \frac{\sum W}{(A \times N)} = \frac{3n_3+2n_2+1n_1}{3N}$

Where *W* represents the weighting assigned to each response, with 1 for Monthly, 2 for Weekly, and 3 for Daily usage. n_1, n_2, and n_3 represent the number of respondents selecting Monthly, Weekly, and Daily usage, respectively. *A* is the highest possible weighting (3 in this study). *N* is the total number of respondents.

The RII values range from 0 to 1, with higher values indicating greater frequency of use or observation. This metric provides insight into how integrated each technology is in internship experiences and, by extension, its relative importance in current industry practices. The RII, presented in Table 1, reinforces the observed trends in technology utilization and observation. Technologies with high utilization rates, such as cloud-based systems and virtual meeting platforms, also ranked highest in terms of observation, indicating their widespread industry adoption. An interesting exception to this trend is drones, which, despite being less utilized, were more frequently observed. This discrepancy may stem from regulatory requirements that limit direct hands-on use. Yahya et al. (2021) highlighted that obtaining a private pilot license for drone operation presents a barrier to accessibility. This potentially restricts students from actively using this technology during internships. Despite these regulatory challenges, drones have proven to be valuable educational tools in construction and engineering. Nwaogu et al. (2023) emphasized that drones are increasingly integrated into training programs, enabling virtual field trips and fostering essential skills, such as spatial visualization, innovative thinking, and problem-solving. However, in professional settings, the requirement for formal certification and specialized training often confines student interns to observe drone operations rather than actively participate in their deployment.

Table 1: Relative Importance Index of Utilized and Observed Construction Technologies

Rank	Technology Utilized	RII	Technology Observed	RII
1	Cloud Based Systems	0.670	Cloud Based Systems	0.623
2	Virtual Meeting Platforms	0.573	Virtual Meeting Platforms	0.583
3	Monitoring Devices	0.423	Monitoring Devices	0.530
4	Scanning Devices	0.223	Scanning Devices	0.347
5	E Inspection	0.107	Drones	0.150
6	AR/VR	0.077	E Inspection	0.117
7	Drones	0.067	Non-Aerial Robots	0.110
8	Non-Aerial Robots	0.050	AR/VR	0.060

Similarly, an intriguing insight from the RII analysis is the positioning of AR/VR technology, which ranks sixth in utilization but only ninth in observation among interns. This suggests that while interns actively engage with AR/VR tools, they rarely witness other professionals using them in the workplace. This disparity may indicate that AR/VR adoption remains in its early stages within many construction firms, with limited industry-wide implementation at the senior level. Additionally, the findings may highlight a generational shift in technology adoption. As younger professionals enter the workforce with greater familiarity and comfort with AR/VR, firms may need to expand its integration to align with evolving industry expectations and workforce capabilities. This trend aligns with Noghabaei et al. (2020), who reported that the AEC industry has been relatively slow in adopting AR/VR technologies, partly due to a lack of feasibility studies evaluating the cost-benefit ratio of implementation. However, the study noted a significant increase in AR/VR utilization between 2017 and 2018, with industry experts anticipating continued growth over the next 5 to 10 years.

4.2 Training Methods

Figure 3 illustrates how interns acquired their knowledge of construction technologies. Cloud-based systems and virtual meeting platforms showed the highest engagement across all training methods, including formal training, informal training by mentors, self-teaching, and learning in school. The dominance of informal training and self-teaching methods suggests that these technologies are relatively intuitive and may not require extensive formal instruction. For instance, monitoring devices and scanning devices were primarily learned through informal training, highlighting the reliance on hands-on, on-the-job learning rather than structured educational programs. This reliance on informal learning highlights the hands-on nature of these technologies and suggests that companies may not have formalized training programs in place for these tools. In contrast, drones, AR/VR, and E-Inspection technologies exhibited low engagement across all learning methods, aligning with their lower utilization and observation rates. The lack of exposure to these emerging technologies may point to structural barriers, such as high costs, limited training opportunities, or restricted access due to safety and regulatory concerns. This limited exposure may indicate that students require more structured educational opportunities or industry-driven initiatives to gain proficiency in these emerging technologies.

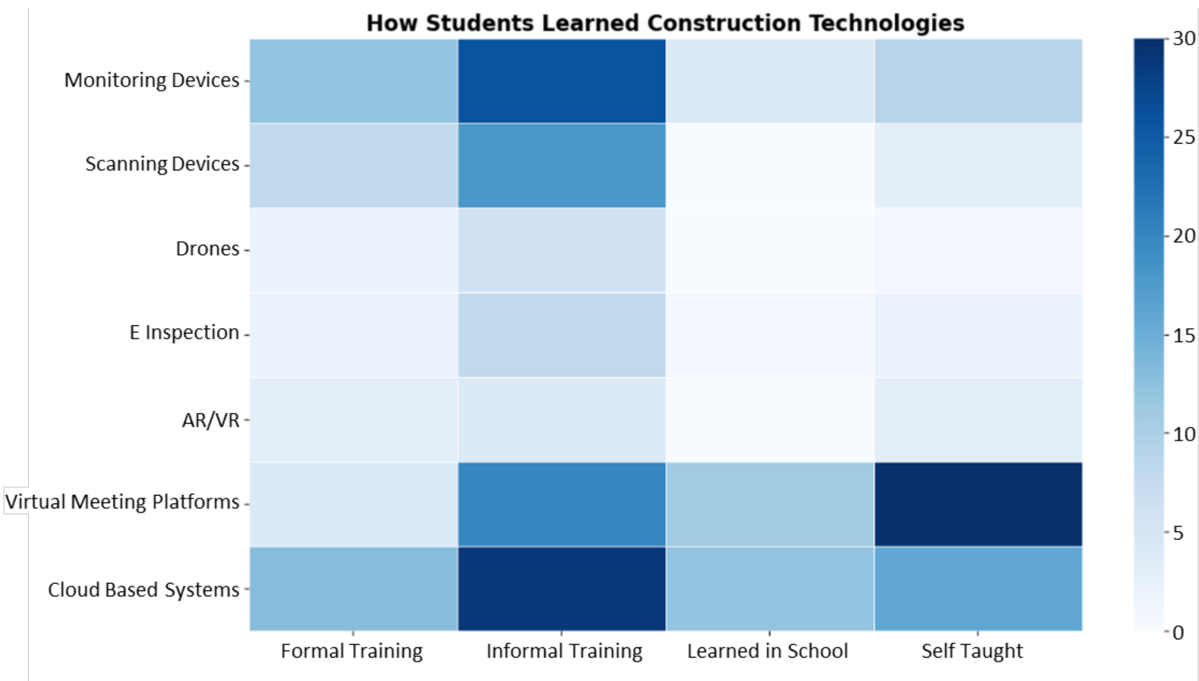


Figure 3: Heatmap of Construction Technology Training Methods

The survey responses, particularly those related to training methods and open-ended feedback, found a consistent reliance on informal, on-the-job learning for emerging technologies. Students frequently encountered tools, such as BIM 360, Trimble survey systems, and cloud-based platforms, during internships, despite having limited or no prior exposure through academic coursework. This indicates a persistent gap between formal education and evolving technological practices in the construction industry. The prevalence of self-teaching and mentorship-driven learning suggests that many firms assume new hires will adapt to the field rather than arrive fully prepared. While academic programs generally provide foundational skills, these findings highlight the need for greater responsiveness to industry advancements.

4.3 Change in Student Interest

The survey assessed how students' interest in construction technologies changed after their internships. As shown in Figure 4, approximately 67% of respondents reported an increase in interest, either slightly or significantly, indicating that real-world exposure to technology positively influenced their perceptions. However, 31% of students reported no change in their interest, suggesting that while construction technologies were present in their internships, they may not have been a central focus or did not significantly impact their career outlook. Notably, only 2% of respondents experienced a decrease in interest.

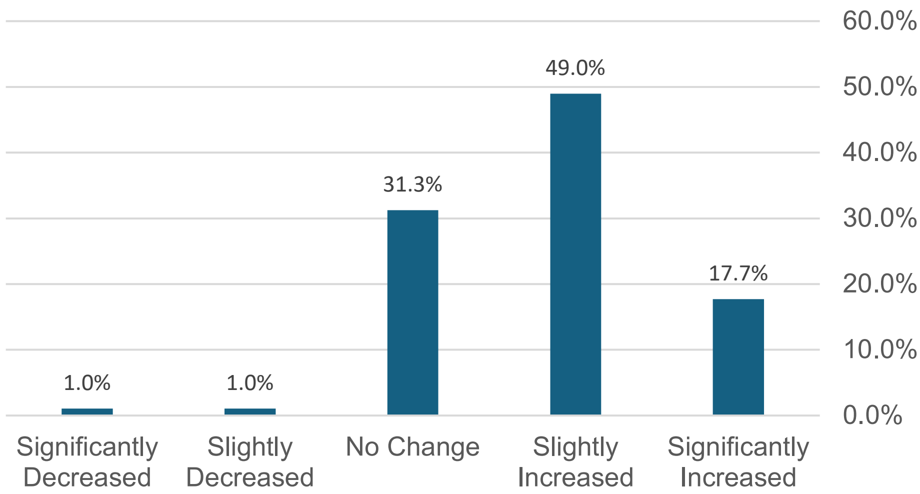


Figure 4: Changes in Interest in Construction Technologies After Internship

The open-ended responses further revealed key factors that contributed to these shifts. Many students emphasized that seeing technologies actively used on the job site played a crucial role in increasing their interest. Several expressed enthusiasm for hands-on engagement with software, scanning devices, monitoring tools, or AI-driven systems, finding direct interaction to be a motivating factor. Others recognized the efficiency and productivity benefits of construction technologies, noting how they streamline workflows, improve communication, and enhance overall project management. Industry relevance was another key influence, as students acknowledged that technological proficiency is becoming essential for career advancement. Exposure to experienced professionals using these tools also helped students understand their practical applications in the field. However, some students whose interests remained unchanged cited limited opportunities to engage with technology during their internships. These findings suggest that expanding structured, hands-on exposure to construction technologies both in academic settings and professional internships can better prepare students for the evolving demands of the industry.

4.4 Curriculum Development Implications

The findings point to several important implications for construction education. Widely used platforms, such as BIM 360 and Autodesk Construction Cloud, should be more explicitly integrated into construction management curricula. Embedding these tools into core courses through hands-on labs or project-based assignments would better prepare students to engage in collaborative digital workflows. As construction becomes increasingly interdisciplinary, curricula should also reflect the integration of construction, engineering, and architectural technologies. Encouraging cross-disciplinary collaboration in academic settings can mirror real-world project delivery and foster greater technological fluency.

Beyond curriculum adjustments, stronger collaboration between academic programs and industry partners is essential to expand hands-on learning opportunities. Institutions can work closely with industry advisors to keep course content current and anticipate emerging technology needs. Formalizing internship feedback loops and supporting faculty development are also critical to aligning educational preparation with industry expectations. Construction firms, software providers, and equipment manufacturers can play a valuable role by offering guest lectures, hosting workshops or site demonstrations, and providing students with access to specialized tools or simulation environments. These partnerships not only enhance student learning but also ensure that curricula evolve in step with technological advancements in the field.

5. CONCLUSIONS

The integration of construction technologies in student internship experiences provides critical insight into industry trends and the preparedness of the future workforce. This study revealed that cloud-based systems, virtual meeting platforms, and monitoring devices are the most commonly used technologies among interns, reflecting their widespread adoption and essential role in modern construction workflows. In contrast, emerging technologies such as UAVs, robotics, and AR/VR remain underutilized at the internship level, this can be due to a lack of structured training programs for these technologies. One of the most significant findings is that students primarily learn construction technologies informally, either through on-the-job training or self-directed learning, rather than structured academic instruction. This highlights the need for construction management programs to enhance their curricula by incorporating industry-relevant technologies, providing hands-on training, and fostering stronger collaboration with industry partners to bridge the gap between education and practice. Moreover, student interest in construction technologies evolved through their internships, with many reporting increased enthusiasm after direct exposure to these tools. This suggests that meaningful engagement with technology in professional settings can positively influence career aspirations and readiness for technology-driven roles in the industry.

By establishing a baseline understanding of technology adoption among interns, this study offers valuable guidance for educational institutions and construction firms in shaping their training strategies. Future research should explore the factors influencing the adoption of advanced construction technologies, investigate how companies can better facilitate technology transfer to new professionals, and assess the long-term impact of technological proficiency on career progression.

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