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# PRESENT REALITIES AND FUTURE DIRECTIONS OF AI INTEGRATION WITHIN BUILT ENVIRONMENT HIGHER EDUCATION

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## *ABSTRACT*

*Technological advancements in the construction industry driven by Artificial Intelligence (AI), mandate a significant re-evaluation of Built Environment Higher Education (BEHE). While the imperative for AI integration within BEHE is acknowledged, it remains underexplored. This study aims to identify the potential for AI integration within BEHE and assess its capacity to enhance the readiness of HE learners, trainers and the institutions to cater to the evolving demands. Data was collected through a literature review and nine semi-structured interviews among academics and industry practitioners across HE, construction, information technology, and manufacturing sectors of UK to identify current status quo of AI applications within BEHE, and potential integration of best practices from other sectors. Data was thematically analysed using NVivo14. The results show that the effective adoption of AI technology yields efficient outcomes in student learning, teaching efficacy, administrative processes including mentoring, inclusivity, quality assurance, research and entrepreneurship. The findings demonstrate that BEHE has not fully attained the effective utilisation of AI integration in its curriculum, capacity development is needed in pedagogical approaches, learning methodologies, and policy formulation. A successful achievement of these goals necessitates proactive stakeholder engagement and robust top-down support, including substantial investment in IT infrastructure, training and comprehensive dedication at individual, institutional and national policy levels.*

***Keywords:*** *Artificial Intelligence; Built environment; Higher Education; Sustainability; UK.*

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# 1. INTRODUCTION

The evolving landscape of artificial intelligence (AI) is the most important technological development during the first half of the 21st century. The profound effects of AI on higher education cannot be overlooked (Holmes, 2023). Higher Education Institutions (HEIs) are increasingly recognizing and focusing on the pivotal role of AI as an innovative technology that continues to reshape the educational landscape. The benefits of AI applications in HE, such as cognitive scaffolding provided by Intelligent Tutoring Systems (Paladines & Ramirez, 2020), Self-Regulated Learning and Mentoring (Nguyen & Barbieri, 2025), Automated Grading including personalised feedback, online/remote learning (Chen et al, 2020), Lifelong Learning (Rawas, 2023) and administrative processes (Parycek et al, 2023) are extensive and diverse. However, majority of academics remain uncertain about its effective usability and, more critically, what its integration truly entails for their profession, student learning and teaching methodologies (Hinojo-Lucena et al., 2019). Although there has been an increasing interest into this field, much of the research surrounding AI in HE is focused on the broader education systems (Zawacki-Richter et al., 2019), with limited research explaining the potential of AI integration to enhance current Built Environment Higher Education (BEHE). Hence, this paper identifies the potential for AI integration within BEHE and assess its capacity to enhance the readiness of HE learners, trainers and the institutions.

# 2. RESEARCH METHODOLOGY

This research adopted a qualitative research design approach with a view to gaining an in-depth understanding of the problem highlighted in section 1. A review of literature and standard documents (policy papers, UKHE frameworks) was conducted. Semi-structured interviews were the empirical data collection technique as it allowed a structured yet flexible approach. Two interview guidelines were developed to target two categories namely BEHE staff and industry professionals with some AI experience. Both guidelines were tested for clarity, readability and timing. Ethical approval was obtained prior to the formal interviews. The sample included a mixture of BEHE professionals and industry practitioners. 89 BE staff profiles of 33 UK HEIs were reviewed to identify the academics for interviews. 18 academics with profiles indicating familiarity with AI adoption were invited and 7 agreed to do so. Similarly, 2 industry practitioners from construction and manufacturing sectors also contributed by way of interviews.

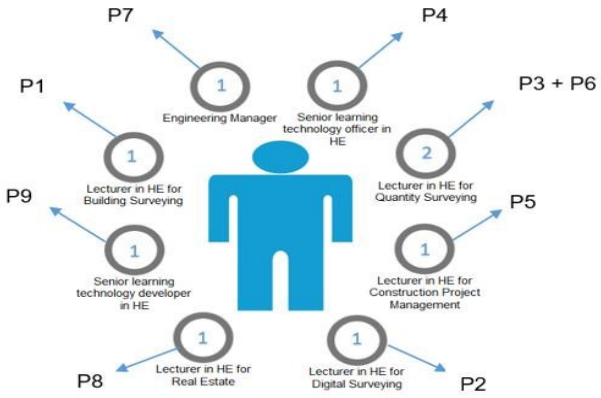


*Figure 1: Interviewees' profiles*

All interviews were conducted online via MS Teams, primarily for the convenience of remote participation and the advantage of automated transcription. Key themes and patterns were identified by scanning each transcript and were coded accordingly. Cross analysis was undertaken to address overlapping topics. Identified themes were further filtered into sub-themes to establish relationships and patterns.

# 3. AI APPLICATIONS IN HIGHER EDUCATION

The UKHE landscape is evolving due to several external factors such as the resistant to embrace innovative technologies, changing student demographics and significant demand for student support. The Higher Education Students Statistics Agency (2024) declares 16.5% of differently abled learners (i.e., 484,000) in UKHE sectors where demand for additional support is highly required. Hence innovative mechanisms need to be adopted to cater to such demands. Literature acknowledges the ability of AI to improve HE (Luckin et al., 2016), whilst offering benefits for HE stakeholders, including learners, trainers, supportive staff, HEIs, funding, policy and professional bodies through system innovation. Intelligent Tutoring Systems (ITS) is a common theme in AI research in HE, falling under the umbrella of knowledge-based systems. ITS can be defined as, computer programs that provide instructions adapted to the needs of individual learners (Paladines & Ramirez, 2020). ITS outperformed traditional classroom instruction, reading printed text, computer assisted instruction, and laboratory or homework assignments (Steenbergen-Hu & Cooper, 2014). However, ITS is still not widely adopted in HEIs (Weitekamp et al., 2020). Apart from that, there are several AI adoptions in administrative processes such as student selection and enrolment, monitor dropout rates, timetabling, student support and analyse group behaviour trends. These programmes use data to forecast trends and modify instruction for next pupils (Bates et al., 2020). Applications of AI in HE has been categorised into several categories (Chen et al., 2020; Popenici & Kerr, 2017; Zawacki-Ritcher et al., 2019).

*Table 1: Applications of AI within higher education*
*Adapted from: (Zawacki-Ritcher et al., 2019)*

| Category | Application |
|---|---|
| Profiling and prediction | Admission decision and course scheduling |
| | Student models and academic achievement |
| | Drop-out and retention |
| Assessment and evaluation | Automated grading |
| | Feedback |
| | Evaluation of student understanding, engagement, and academic integrity |
| Adaptive systems and personalisation | Evaluation of teaching |
| | Teaching course content |
| | Recommending/providing personalised content |
| | Supporting teachers in learning and teaching design |
| | Using academic data to monitor and guide students |
| Intelligent Tutoring Systems | Teaching course content |
| | Diagnosing strengths or gaps in student knowledge |
| | Curating learning materials based on student needs |

Even though the potential applications of AI in HE is commended, the limited discussions in placed in relation to the risks and ethical ramifications of using AI in education (Zawacki-Ritcher et al., 2019). Hence without addressing this element it is somewhat challenging to integrate AI into HE.

The Institute for Ethical AI in Education's Ethical Framework for AI in Education (2021) noted that the laying the responsibility of AI education solely on staff members would be unreasonable. Rather, the institution must take the lead to facilitate this learning. Hence, it is essential for institutions to engage in discussions with HE stakeholders regarding the implication of AI on administrative, teaching and learning practices (Bearman et al., 2022). Furthermore, before fully implementing AI throughout the organisation, an ethical governance framework must be established to ensure responsible AI use and avoid unintended consequence (Défense Innovation Board, 2019). Additionally, classes and training programs should be implemented to equip staff with the skills and knowledge necessary in the future (Luckin et al., 2022).

The collaboration between HEIs, policy makers and funding agencies are required, in terms of support, funding and governance. Department of Science, Innovation and Technology (2019) explains that National AI strategy (2022) will focus on investment, support, and governance, emphasizing the government's commitment to facilitating AI integration within HE.

### 3.1 BUILT ENVIRONMENT HIGHER EDUCATION AND AI STATUS-QUO

Built Environment HE is typically an inter/multi-disciplinary field of study that aims to recognise design, procurement, construction and in-use of human-made spaces and systems effectively. Study programs generally follow a holistic and integrated approach and consider the entire lifecycle and interconnectedness of products and processes, often incorporating complex social, economic, and environmental considerations alongside technical ones.

AI offers potentially ground-breaking methods (Popenici & Kerr, 2017). It is essential to stay current with technological developments as HEIs play a vital role in producing market-ready professional for the built environment (Akour & Alenezi, 2022). The growth of the construction industry faces challenges in relation to cost overruns, health and safety, productivity, and skilled labour. The industry is one of the least advanced digitally, making project management unnecessarily time-consuming and complicated (Abioye et al., 2021; Bello et al., 2021; Bughin et al., 2017). AI has vast capabilities yet is less commonly used in the construction industry compared to other industries. AI is particularly useful during the pre-construction phases of construction projects due to its ability to streamline complex processes by big data analytics, reducing time spent on routine tasks (Regona et al., 2022). The fragmentated nature of the industry, stakeholders impacts and influence on project objectives presents significant challenges in implementing such innovative applications.

AI integration within BEHE can be explored through the lenses of various stakeholders. In relation to learners', AI implementation can reward in several ways such as ITS to create personalized learning, and profiling and prediction to enhance student engagement (Zawacki-Richter et al., 2019). Trainers/Academics in HE need to be proficient enough in AI to teach their students exactly how to adopt this technology in their learning (Ng et al., 2023). However, the scarcity of educators with such knowledge and skills leads to a

substantial investment in time and money to upskill them (Ng et al., 2023). This will not be something that comes easy due to the common perception of AI being a threat to educators' jobs, causing a clear resistance to change (Humble & Mozelius, 2022). To address this, efforts must be made to raise awareness and educate HE staff about the potential benefits of AI in HE for themselves. University leaders have conveyed that AI will serve as a complement to human input rather than a replacement (Cremer & Kasparov, 2021). It's crucial to reiterate this message to the educators through adequate training and education.

The significance of training and educating AI in the context of BEHE is growing rapidly, especially as AI applications are expected to play a crucial role in construction education (Zawacki-Richter et al., 2019). Whilst AI applications in construction are currently in their infancy, it's inevitable that they will become a necessary tool to improve project cost, quality, and development time. As new technologies emerge, teaching construction will inevitably change, requiring staff members to revisit their teaching methodologies (Qureshi, 2020). It is essential to shift the focus on education towards teaching students how to apply and use information effectively, rather than just memorizing it. This shift prepares learners for a rapidly changing and technology-driven workforce, allowing them to become more adaptable and flexible in their approach to work (Brown, 2023). To bridge the gap between industry and academic institutions, it is crucial to acknowledge that education and training serve as long-term methods of disseminating new knowledge to the industry (Goh, 2006) and vice versa. This emphasises the importance of teaching graduates advanced technological skills and knowledge, such as AI, through education and training including work-based learning and off the job training. Lack of a clear roadmap or action plan impedes practical implementation of these improvements in BEHE.

# 4. KEY FINDINGS

This section discusses the results and the emerging discussion with regard to AI integration within BEHE.

## 4.1 CHALLENGES OF AI INTEGRATION WITHIN BEHE

Potential integration of AI into existing curriculum is one of the starting but challenging endeavours for HEIs as there is less flexibility in programs to adopt such changes immediately as significant program amendments take place in periodic program reviews. The interviewees agreed that they expect AI revolution in most of the elements of BEHE including teaching (course materials, delivery, marking and feedback, methodology etc), learning (assessment and feedback, engagement, support and mentoring, reflection, creativity, risk etc), institutional and national policies (new guidelines/legislations, dealing with fake news, transparency etc). For example, Interviewee P4 mentioned that "*you could train something to assess in a similar way that you are doing, and a huge benefit as well for that might be formative feedback so that machines might begin to help students with very fast feedback*."

The challenges of integrating AI into BEHE were frequently mentioned by the interview participants and are represented in Figure 2.

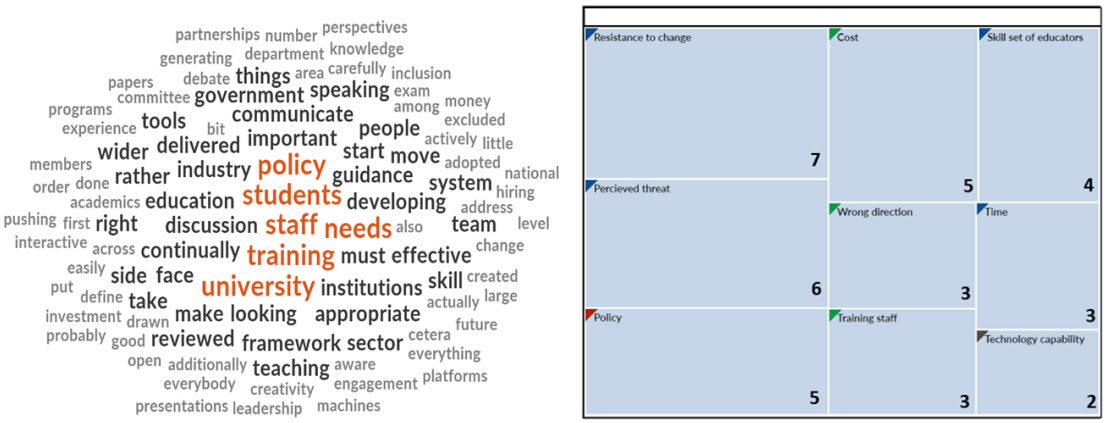


*Figure 2: Challenges of AI integration in BEHE*

Resistance to change by the staff, job security, lack of clear policies (institutional and national level) were highlighted. In some instances, institutional shifts in wrong directions by potentially deciding to restrict students from using AI instead of allowing them to use it effectively was also identified as a challenge. Also noted was the limited compatibility of existing IT infrastructure to adopt such technologies, an indication that AI technology may not be mature enough to be readily integrated into HE.

The identified challenges were further clustered into different tiers. For example, 'resistance to change', 'perceived threat' skills of educators and time requirements for implementation and training need to be addressed in individual level (learner, trainer); 'staff training', 'cost,' in institutional level (HEIs, organisations) and 'policy' (Authorities, Government).

## 4.2 BENEFITS OF AI INTEGRATION WITHIN BEHE

Similarly, benefits of AI integration also acknowledged, where P9 noted that "*AI can be used to create new forms of assessment that are more effective, making teaching easier, and promoting inclusivity within academic institutions"*. Also, faster feedback (P4, P6) and identifying design flaws early in project design (P1).

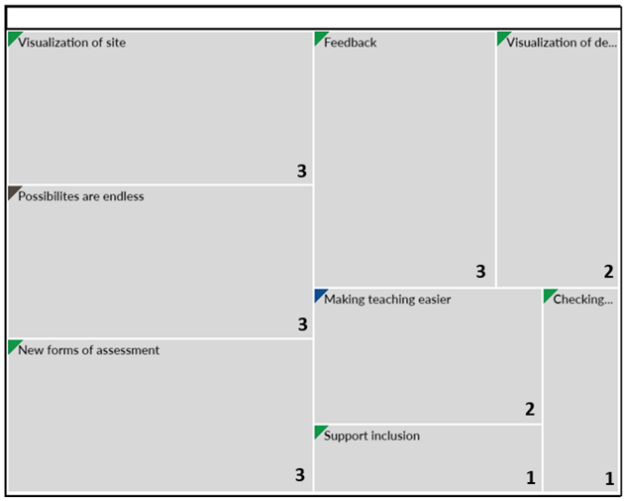


*Figure 3: Identified benefits of Artificial Intelligence in BEHE*

The results were further analysed in terms of the benefits of implementing AI within BEHE on various stakeholders (Fig 3), with a view to supporting the development of the necessary steps for full implementation and to reap the benefits of AI in BEHE.

### 4.3 KEY RECOMMENDATIONS

However, findings also show that next steps do require collaboration between all stakeholders, where P8, stated that "*there needs to be stronger partnerships between universities and the industry"* and supportively P4, noted that "a*ll institutions now must get on the wider debate about AI…and institutions need to start pushing students to think about it*." The importance of staff/trainers upgrading their skills to adapt to the evolving role of educating learners is required. It is crucial for all stakeholders to understand the ethical implications of using AI in BEHE before implementation.

## 5. DISCUSSION

The findings on AI experience among participants reveal varying levels of familiarity in different AI areas. The study notes limited AI application in BEHE, with only two areas directly related to its curriculum. Participants suggest a need for greater AI exposure in BEHE and identify it as a promising development for BEHE. This challenge aligns with Ng et al.'s (2023) observation of the scarcity of qualified educators with the necessary AI knowledge and skills. This indicates that AI is perceived as a useful tool to complement human input, aligning with the view of Cremer and Kasparov (2021).

The findings identify six potential avenues for integrating AI into BEHE. Participants believe that incorporating AI into existing courses would effectively prepare students for the evolving future of the construction industry. This finding is supported by P3 "*I think we (educators) need to be champions of this (AI)…in order to make our students relevant in the workplace*". P6 explained "*AI will keep you (students) relevant*". Previous studies have also supported the idea that it's crucial to keep up with technological advancements in order to produce future professionals for the construction industry (Akour & Alenezi, 2022). This emphasizes the need to integrate AI into existing curriculum to enable graduates to be well-prepared for the future of the industry, it's clear that participants are aware of this. Also, participants believe that new courses and programs should be designed with AI in mind to keep students relevant including assessment and grading. Participants see potential benefits in using AI-based tools to assess student performance and provide feedback. Benefits have also been identified in previous research (Zawacki-Ritcher et al., 2019). P5 stated "*it could play a critical role in assessing the quality of work that is being submitted.*" Whilst P4 noted "*you could train something to assess in a similar way that you're doing and a huge benefit as well for that might be formative feedback*". However, other participants remain sceptical due to the lack of trust in AI and the belief that human judgement is still essential, along with the opinion that the technology capability is not advanced enough. P2 stated "*I won't rely on them. I might use them as training or curiosity, but I won't rely on their final results. AI isn't ready*". Whist P7 also mentioned "*I think the future, definitely, but at the moment the technology is not mature enough.*"

Overall data suggests a positive interest integrating AI into BEHE, with potential benefits through multiple avenues. Barriers remain including lack of knowledge, skills, trust, and technology maturity. Findings have potential to enable institutions and educators to equip students with necessary skills to thrive in evolving construction industry. Results further

reveal insights into AI implementation within BEHE, highlighting it complexity and involvement of diverse stakeholders, with a strong emphasis on learners as primary beneficiaries. However, this also suggests other stakeholders may lack awareness of AI's broader benefits. Stakeholders must be informed of AI's full potential to make informed decisions about implementation. Past research identifies benefits (Luckin et al., 2016), yet stakeholder awareness appears incomplete. One of the key findings is that the majority of challenges relate to the staff/educator. This suggests that educators play a critical role in the successful implementation of AI in BEHE. Resistance to change and perceived threats were identified as the most common challenges facing educators. This finding is not surprising given that implementing new technologies, such as AI, can be disruptive and requires educators to learn new skills and adapt to new teaching methods (Ng et al., 2023).

Findings further highlight the importance of providing adequate training and support to educators to help them overcomes these challenges. Educators need to understand the benefits of AI and how it can enhance their teaching methods, rather than perceive it as a threat. Hence the need of institutional support and responsibility is noted. As per P5, "*I think universities have to take the first step; they need to open up the discussions wider among staff. There needs to be inclusion of those that will be using the AI interactive platforms, most academics should be drawn into the discussion.*" Whilst P9 also said "*speaking to staff to get their perspectives on it and to make sure that we can continually update and move with things as it as they move*". In addition, the study emphasizes the need for policymakers (government) and institutions to work together to address the challenges facing educators. Policymakers need to develop clear policies and guidelines that support the integration of AI in BEHE and address any concerns or issues that may arise. Institutions also need to develop strategies for funding and resource allocation to support AI implementation, as well as providing training and support to educators to help them integrate AI effectively.

## 5.1 IMPACT ON STAKEHOLDERS

The stakeholders were clustered into three main domains including individuals, Institutions, and the society. Each stakeholder is impacted significantly by the implementation of AI, as evidenced in the findings.

### 5.1.1 Individual Level (Learners and Trainers)

It is evident that students are most likely to be impacted positively by the implementation of AI in BEHE. In terms of preparedness findings suggest that the majority of participants believe that students are well-prepared to adopt AI in their university experience, primarily due to their existing technological skills. This belief is supported by the fact that the current generation has grown up in a world where technology is an integral part of their lives, which has made them more adaptable to technological advancements such as AI. Supportively, P2 said "*this generation's mindset is pretty much adaptable to the technology more than any other generation; so that's something making them understanding AI a bit easier.*" P1 also mentioned "*continuing along the line of technological skills.*" Additionally, the ongoing discussions about the ethical implications of AI would further ease the integration of AI into the curriculum. This can facilitate the seamless integration of AI tools into the curriculum while avoiding any negative ethical implications. P4 identified this "s*omebody must communicate to students to say when and where and how they can use these sorts of tools*." The findings suggest that the

implementation of AI in HE has significant impacts for the role of staff (academic and administrative). The most identified impact on the role of the academic staff in BEHE is upskilling, which indicates that educators must learn new skills and knowledge to be able to teach and support students effectively in the context of AI. Supportively, P2 explains *"I should be up to date, I should teach myself, then I should be able to teach the student."* This can impact the role of the educator either positively or negatively. On one hand, upskilling can provide educators with new tools and techniques to enhance their teaching and better prepare students for the evolving job market. However, on the other hand, upskilling can also be a significant challenge for educators, particularly to those less familiar with technology. There may be a steep learning curve associated with adopting AI, and educators may need to invest significant time and effort to learn how to use them effectively.

Potential new ways of assessing students due to AI integration may mean that the traditional methods of evaluation may no longer be sufficient to measure students' success in the context of BEHE. This finding suggests that educators must explore new assessment methods that consider the skills and knowledge required for working with AI. Also, participants revealed the scary potential for AI to automate or replace their jobs. Many negative views were identified around this area. P1 stated *"I think in the early stages. I see it as a threat as an educator…because it's something that I can't use…I will see it as a hassle if I have to learn it."* This reinforces the previous point that educators need to understand the benefits of AI and how it can enhance their teaching methods, rather than perceive it as a threat.

Overall, the findings suggest that educators must be proactive in preparing themselves for the introduction of AI into the BEHE. They will be impacted significantly, and must make effort to upskill themselves, adopt new assessment methods, adapt to changing job requirements, and be open to new ways of teaching and operating in the classroom, in order to stay relevant and effective in their job.

### 5.1.2 Institutional Level (HEIs, Professional and Funding Bodies)

Integrating AI into BEHE presents significant requirements and demands for HEIs. Funding, guidance, and policy are critical to successful implementation, without which AI integration will be challenging. Identifying 'discussions' as the most crucial institutions step for sustainable AI integration in BEHE highlights the importance of stakeholder communication and collaboration. Success will require active participation from all relevant parties. Funding was also identified as a critical institutional next step, which suggests that HEIs will need to allocate appropriate resources to AI integration. This is particularly important given the high cost of implementing and maintaining AI technology in educational setting. The literature review highlights the importance of addressing ethical considerations before implementing AI in HEIs. Privacy and data sharing, as well as bias in data, are the most identified ethical issues, and HEIs must thoroughly understand these implications before integrating AI into BEHE programs.

The impact and role of the government for AI implementation in BEHE is significant. The participants acknowledged the involvement of the government in establishing frameworks and policies that facilitate universities in their ethical and accurate incorporation of AI. P4 identified that *"regulatory frameworks are needed to be created by governments around how this gets adopted."* Whilst P5 also said "*maybe there should be a national framework in the use of AI rather than the university."*

In summary, the findings provide critical insights into the impacts and requirements of AI integration in HEIs allowing them to develop effective strategies that consider all stakeholders.

# 6. CONCLUSIONS

This study aimed to investigate the potential for integrating AI technologies into Built Environment Higher Education (BEHE) and evaluate their impact on HE stakeholders. A qualitative analysis of stakeholder experiences and perspectives revealed that AI integration in BEHE offers extensive possibilities and substantial benefits for students including differently abled, institutions, educators, and the construction industry. Successful integration necessitates active involvement from all stakeholders, who operate within a defined hierarchy.

The government holds a vital role in establishing clear ethical frameworks and guidelines to ensure AI's successful adoption across institutions. This includes, addressing data security, finding the right mix of human - AI led education, promoting transparency and equity, and mitigating the risk of discrimination. HEIs are then responsible for communicating these frameworks to all staff and providing adequate training and guidance. Educators are arguably the most affected by AI implementation, as their job roles will significantly evolve. They must proactively develop new skills and maintain their knowledge of AI technology to remain effective and relevant. Students as the primary stakeholders and integrating AI into the BEHE curriculum is anticipated to profoundly enhance their readiness for the evolving construction industry. By equipping students with the necessary skills and tools to effectively utilize AI systems, the construction industry can overcome its current challenges. Fully assessing the impact of AI integration in BEHE is difficult without comprehensive implementation. Therefore, future research should focus on case studies where AI has been thoroughly tested or fully incorporated into BEHE, providing a more complete understanding of its benefits and limitations. The findings further recommended the need of organizational strategy and roadmap, along with ethical and legal frameworks, to govern the appropriate use of AI for successful implementation.

# 7. ACKNOWLEDGEMENTS

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