Futureproofing Built Environment Students through Responsible AI Integration

Research report

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Executive summary

The integration of Artificial Intelligence (AI) into higher education within the built environment (BE) is rapidly transforming the pedagogy and practice. Recent studies highlight the potential of AI to enhance creativity, efficiency, and sustainability in design processes. However, as such there are limited studies to understand the adoption of AI within BE higher education around the world and challenges and opportunities for the educators. Therefore, this project aimed at carrying out a detailed comprehensive review on the adoption of AI within BE higher education around the world and analysing the challenges, opportunities, best AI tools for the BE context.

In this project, the primary data was collected through: i) Survey questionnaire (n=32, involving 23 UK academic institutions) and ii) Online workshop (n=19, involving 13 UK academic institutions). The survey findings revealed that AI adoption remains limited, with only 47% of educators currently using AI in teaching, while 53% face barriers such as skills gaps, lack of institutional guidance, concerns over accuracy, and academic integrity issues. Around 75% of educators highlighted the need for targeted support, including training, clear policies, and access to appropriate AI tools. Online workshop insights further emphasise that AI should function as an augmentation tool rather than a replacement for human creativity, with a strong focus on ethical use, prompt engineering, and maintaining critical thinking. Participants also highlighted the importance of evolving assessment methods, including transparent AI use and process-based evaluation. Overall, the findings indicate that while AI offers significant potential to enhance BE higher education, its effective adoption depends on addressing institutional, pedagogical, and ethical challenges through structured support and human-centred approaches.

1.0 Introduction

The BE encompasses human-made spaces such as buildings, infrastructure, and urban systems. With the rapid advancement of AI, there is growing interest in leveraging AI to enhance higher education within this field. AI technologies, including machine learning and generative tools, offer capabilities such as pattern recognition, automation, and decision support. This project titled, ‘Futureproofing Built Environment Students through Responsible AI Integration’ explores how AI can be responsibly integrated into BE curricula to prepare students for future professional demands.

2.0 Research objectives

1. To compare the AI adoption in built environment higher education around the world.
2. To understand the opportunities and barriers for UK educators to AI adoption in BE higher education.
3. To identify best AI applications in teaching and assessment and build skills and support systems for the BE students in making responsible use of AI.

3.0 Comparison of AI adoption in BE higher education around the world

A case study at Tongji University (Jin et al., 2024) demonstrated that an AI-assisted architectural programming and design course positively influenced student learning, with AI technologies improving innovative capability and work efficiency. Similarly, an experimental course at MSA University, Egypt (Sadek & Mohamed, 2023) utilized AI tools to assist students in generating conceptual designs from textual narratives. The findings indicated that AI tools can significantly enhance creativity in the conceptual design phase. Moreover, the adoption of Generative AI tools has been shown to improve digital literacy and holistic competencies among BE students. These tools aid in conceptual creativity, time management, and stress reduction, thereby enhancing overall student performance. However, challenges persist, including the fragmented application of AI tools and the need

for a systematic approach to their integration into BE curricula. By embracing AI, future professionals can be equipped with the necessary skills to navigate and lead in an increasingly digital and sustainable built environment. The literature on AI in BE higher education (as illustrated in Table 1) reveals a clear distinction between the UK and international contexts in terms of focus, maturity, and pedagogical approach. UK-based studies, including reports by the UK Government and Royal Institution of Chartered Surveyors, primarily emphasise skills shortages, low AI awareness, and limited curriculum integration. Research in this context is policy-driven or survey-based, highlighting a sector that is still in transition, where AI is treated as a supporting tool within existing frameworks such as BIM and digital construction. Whereas the international literature from the US, Europe, and China highlights more advanced and experimental integration of AI into teaching. Studies by scholars such as Becerik-Gerber et al,. (2022) and Zhang et al., (2024) show that AI is increasingly embedded in design studios, urban analytics, and computational workflows, positioning it as a core driver of creativity and decision-making rather than merely a technical aid. Methodologically, UK research tends to rely on reports and perception studies, whereas International research adopts case studies, experimental teaching models, and interdisciplinary approaches. Despite these advances, a consistent gap across both contexts is the lack of robust pedagogical frameworks and empirical evaluation of learning outcomes. Overall, the literature suggests that while the UK is focused on closing the AI skills gap and aligning with industry needs, international approaches are pushing towards redefining how BE curriculum are taught through AI, highlighting an opportunity for future research to bridge these perspectives.

Author and Year	Context (UK / Int'l)	Study focus	Methodology	AI application in BE teaching	Key findings	Remarks
Boland et al. (2021)	UK	AI awareness in construction education	Survey of students and professionals	Introductory AI literacy, BIM-linked tools	Low AI awareness; limited curriculum integration	Highlights skills gap in UK education
UK Government (2021)	UK	AI readiness in education sectors	Policy report and data analysis	General AI adoption in higher education	Built environment disciplines lag behind computing fields	Shows policy-level gap affecting curriculum
Pan & Zhang (2023)	International (China-focused)	AI integration in construction training	Case study + curriculum analysis	Smart construction, automation, robotics	Strong integration of AI in technical modules	Demonstrates state-driven curriculum innovation
Abioye et al. (2021)	UK	Digital twin and AI in construction	Systematic literature review	Digital twins, predictive analytics in teaching	AI improves decision-making understanding	Limited discussion of pedagogy → teaching gap
Becerik-Gerber et al. (2022)	International (US-focused)	AI in built environment curricula	Mixed-method (curriculum + interviews)	Machine learning, data-driven design	Need for interdisciplinary AI education	Suggests integration across design + computing
Liu et al. (2022)	International	Smart city education using AI	Case studies (universities)	Urban analytics, simulation tools	AI enhances systems thinking in planning	Weak link to construction practice

Sacks et al. (2020)	International	Construction 4.0 and education	Conceptual framework	AI + BIM + IoT integration	Calls for curriculum transformation	Lacks empirical validation in classrooms
Royal Institution of Chartered Surveyors (2023)	UK	Skills for future built environment workforce	Industry report	AI in valuation, risk, project analytics	Urgent need for AI upskilling	Confirms industry–education mismatch
Eastman et al. (2018)	International	BIM education evolution	Foundational academic text	Early AI-linked BIM workflows	BIM dominates teaching; AI still secondary	Shows historical lag before AI adoption
Koutamanis (2020)	International (EU-focused)	AI in architectural education	Theoretical + studio-based analysis	Generative design, computational creativity	AI reshapes design thinking	Limited adoption in UK studios
Zhang et al. (2024)	International	Generative AI in design studios	Experimental teaching study	GANs, parametric AI tools	Enhances creativity but risks over-reliance	Raises pedagogical and ethical concerns
World Economic Forum (2023)	International	Skills transformation due to AI	International labour market analysis	AI-related competencies in education	Demand for hybrid AI + domain skills	Supports curriculum redesign argument

Table 1. Comparison of AI adoption in BE higher education around the world.

4.0 Primary data collection and analysis

The project comprised two main activities: i) Survey questionnaire and ii) Workshop. The survey data was collected among participants for the workshop aimed at understanding the positionality of participants and panellists.

4.1 Survey questionnaire

Participants were asked the following questions:

- University/organisation name
- Academic/organisational position
- Which course/programme in BE do they teach? (Architecture/Building Surveying/Quantity Surveying/Real Estate/Construction/Other)
- If they have used AI in teaching and assessment
- If the teaching and assessment for on campus, online, degree apprentice, etc..
- If AI has helped in their teaching and assessment
- If they can specify two things learned from their experience with AI
- If they can suggest how BE students can effectively and responsibly use AI
- What support do staffs and students need to use AI effectively and responsibly.

Survey data results show that out of a total 32 participants (comprising 23 academic institutions):

- Institutional participations: highest participation from Leeds Beckett University (7 responses), followed by Northumbria University (4 responses), University of the West of England (3 responses), and Ulster University/ Glasgow Caledonian University/ Liverpool John Moores University (2 responses).
- AI adoption: 15 (47%) are using AI in their teaching and assessment, while 17 (53%) have not yet adopted.
- Needing additional support: 24 (75%) provided specific feedback or suggestions regarding the support students and staff need to use AI effectively.
- Facing adoption barriers: 17 (53%) have not yet used AI in their teaching and assessment, indicating significant barriers to entry or implementation.
- Barriers for adoption of AI in BE education:
  - ✓ *Skills and Knowledge Gaps*: Many staffs lack confidence in using AI tools. There is limited training, unclear best practices, and uncertainty about how to integrate AI meaningfully into curriculum of BE.

  - ✓ *Trust, Accuracy, and Reliability:* AI outputs can be inconsistent or incorrect, which is a major concern in disciplines where precision matters (e.g., design calculations, compliance, safety). This leads to hesitation and the need for constant verification.

- ✓ *Academic Integrity Concerns:* Fears about plagiarism, over-reliance, and reduced critical thinking are significant. Educators worry students may use AI to bypass learning rather than support it.
  - Institutional and Policy Barriers:
  - Lack of clear guidelines or frameworks for AI use
  - Slow curriculum updates
  - Uncertainty about assessment methods in an AI-enabled environment

- ✓ *Time and workload pressures:* Learning and integrating AI requires time that staff often don't have. Adapting teaching materials and assessments adds to already heavy workloads.

- ✓ *Technical and Resource Constraints:*
  - Unequal access to tools and infrastructure
  - Limited institutional support or funding
  - Concerns about data privacy and security

- ✓ *Relevance to BE Disciplines:* Some staffs struggle to see how AI applies directly to practical, site-based, or design-oriented teaching, especially where hands-on skills are central. Adoption is slowed not by resistance to innovation itself, but by a combination of capability gaps, trust issues, institutional inertia, and discipline-specific challenges. Overcoming these requires training, clear policies, and practical examples tailored to BE contexts.

4.2 Workshop

Workshop (online hosted by Northumbria University) titled, 'Futureproofing Built Environment Students through Responsible AI Integration' was conducted on 10th December, 2025. Objectives of the Workshop were to: i) identify best AI applications in teaching and assessment of BE, and ii) build skills and support systems for the BE students in making responsible use of AI. There were 19 participants, including presenters. From this figure, there were 11 UK institutions and 1 international institute. Main takeaways from presenters are as follows:

Dr. Kiran Kumar (Indian Institute of Technology, BHU) emphasized that while AI is a powerful tool for synthesis, it operates fundamentally differently from human creativity.

- Linear vs. Iterative Thinking: Engineering approaches are often linear (material selection via weight indices), whereas BE design is an iterative, non-linear process involving intuition and trial-and-error.

- The "Creative Quotient": Creativity requires both the logical/structured capabilities of the left brain and the imaginative/emotional capabilities of the right brain. Dr. Kumar argued that human traits like empathy and true imagination remain unique to human intelligence.
- AI as an Augmentation Tool: Students can use AI to refine "prompts" or keywords to visualize concepts (e.g., creating an interior space that feels "warm" or "safe"), but the core idea must still originate from the human mind.

Andrew Wilson (Senior TEL Analyst at Northumbria University) provided a framework for how higher education institutions can adopt AI responsibly

- Institutional Tools (Claude for Education): Northumbria has adopted an enterprise version of the Claude AI model to ensure data privacy. This prevents user data from being used to train public Large Language Models (LLMs) and ensures "equity of access" for all students.
- The "Expert in the Room": Wilson stressed that AI should enhance, not replace, the educator's expertise. Materials generated by AI must be vetted for pedagogical soundness.
- Environmental Impact: Users should consider the high carbon footprint of LLMs and avoid using AI for "trivial requests" that could be handled by a calculator or simple search engine.
- RAG Rating System: Mr. Wilson suggested a "Red-Amber-Green" system for assignments:
    - Red: No AI allowed.
    - Amber: AI allowed for assistive roles (e.g., brainstorming, structuring).
    - Green: AI is central to the assessment (e.g., critiquing AI outputs).
- Documentation and Transparency: Students are encouraged to use AI Declaration Forms and maintain reflective journals to document their thought process and how they interacted with the tool.
- Authentic Assessment: Shifting toward scenario-based and experiential learning makes it more difficult for students to rely solely on AI for answers.
- Prompt Craft/Engineering: Patrick Viney noted that "Prompt Craft" (giving AI a specific role and context) is a critical new professional skill that should be taught explicitly.
- Human-Centric Soft Skills: Industry still highly values transferable skills such as problem-solving, communication, and teamwork that AI cannot replicate.

5.0 Conclusions

The project revealed that AI integration in BE higher education presents both opportunities and challenges. AI enhances design capabilities, supports sustainable development, and improves efficiency through automation. However, it also raises concerns about academic integrity, over-reliance on technology, and the potential loss of critical thinking skills. Primary data from the survey questionnaire (n=32, involving 23 UK academic institutions) and workshop (n=19, involving 13 UK academic institutions) indicate that AI adoption in BE higher education is emerging but uneven, with less than half of educators currently integrating AI into teaching. Key barriers include limited skills and confidence, lack of clear institutional policies, concerns around accuracy and academic integrity, and time and resource constraints. There is strong demand for structured support, including training, guidance frameworks, and equitable access to tools. Workshop findings reinforce that AI should augment rather than replace human input, particularly in creative and design-oriented disciplines. Emphasis was placed on responsible and transparent AI use, the development of prompt engineering skills, and the need to redesign assessments toward authentic, process-based evaluation. Overall, the effective AI integration requires a balanced, human-centred approach supported by institutional frameworks, ethical guidelines, and targeted capacity building.

6.0 Recommendations for future work

- To develop assessment strategies that encourage reflective practice, transparency, and process-based learning.
- To conduct staff development and training programmes to improve confidence and competence in AI adoption.
- To establish industry–academia collaborations to align AI-related skills with professional practice and workforce expectations.
- To establish a collaborative national and international network focused on sharing resources, policies, case studies, and best practices for responsible AI integration.