

# Integrating AI into Methodology: A Critical Review of a Research Methods Course in Postgraduate Interdisciplinary Built Environment Education

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**Abstract**—This study presents critical mapping and reflection on the convergence between conventional research methodologies in the built environment and the cutting-edge AI-driven tools and platforms in design education. AI has been instrumental in nurturing interdisciplinarity in students' methodological thinking in the built environment, as the research methods are not confined to disciplinary jargon but rather emphasise the nature of the analysis. Through evaluations of students' research proposals and questionnaires involving participants from three distinct programmes, the challenges to integrating AI-empowered tools and the potential of applying AI-enhanced research methodologies are identified. AI notably bridges the gap between architectural design and engineering in students' research outcomes; however, gaps persist in terms of applying AI-empowered computer vision to interdisciplinary research as well as incorporating AI-enhanced methods from outside the built environment into students' research.

**Keywords**—design education, AI-enhanced research methods, interdisciplinary learning, built environment

## I. INTRODUCTION

Presently, built-environment design education is being propelled forwards by artificial intelligence (AI): often operating at a visual level in the studio setting, AI is primarily used to generate visually inspiring images. However, this approach may not necessarily expedite or enhance the design process in the built environment, which typically relies on concrete data, pragmatic thinking, and contextual insights—essential components that mere aesthetic appeal cannot encompass. Significant experiments have been conducted on integrating AI into the design process in the built environment [1, 2]; however, there has been a noticeable lack of focus on AI-empowered research methodologies in the built environment, especially in postgraduate teaching, where methodological thinking is crucial and should be deeply ingrained.

In this paper, the pedagogical development was advanced through an interdisciplinary lens, with a focus on research methods in the built environment at the postgraduate level. The course introduced a dedicated session focusing on AI-empowered research tools, offering significant progress over

previous years' offerings. Our paper provides critical mapping and reflection on the convergence between conventional research methodologies in the built environment and the cutting-edge AI-driven tools and platforms in design education. It examines the various perspectives held by students across different programmes, assessing the extent to which AI-empowered tools are integrated into their research thinking. This analysis can guide the development of an interdisciplinary curriculum and pinpoints areas for further exploration of AI applications which are aligned with students' interests.

## II. RESEARCH METHODS

In the 2024-2025 academic year, a cohort of 32 students attended an interdisciplinary course in Architectural Design and Research Methods, which is collaboratively offered by three programmes: the M.Arch. in Architectural Design, the M.Sc. in International Professional Practice in Architecture, and the M.Sc. in Sustainable Construction. The diversity of the students' academic backgrounds is noteworthy: their undergraduate studies range from architectural design and landscape architecture to civil engineering, project management, and several other related disciplines. This study maps research methods, exploring the bridging of traditional and innovative approaches as a pivotal element in the evolution of the pedagogy. Utilising a collaborative platform, we equipped students with AI-empowered tools, platforms, and literature; students were encouraged to incorporate AI-empowered tools into the research methodology section of their final research proposals. Subsequently, we conducted a survey with 30 students from the three programmes, to investigate their viewpoints and obtain their insights. Through the evaluation of students' research proposals and the survey results, we assess their awareness and integration of AI-empowered tools and their application of AI-enhanced research methodologies.

## III. CONVENTIONAL RESEARCH METHODS IN BUILT ENVIRONMENT DESIGN EDUCATION AND THEIR AI-DRIVEN COUNTERPARTS

Although the module was titled "Architectural Design and Research Methods", it is evident that architectural design is transcending its traditional boundaries, becoming increasingly

interdisciplinary. For one thing, design decision-making has become more reliant on empirical data and sophisticated models for assessment; for another thing, it intersects with various disciplines in the built environment, such as civil engineering, construction management, and urban design. As a result, it is essential to chart the research methodologies across the spectrum from architecture specifically to the broader context of the built environment.

TABLE I. CONVENTIONAL RESEARCH METHODS IN BUILT ENVIRONMENT DESIGN EDUCATION AND THEIR AI-DRIVEN COUNTERPARTS

| Conventional Methods                                     | Key Issues                                                                             | AI-driven Tools' Type                                                                       |
|----------------------------------------------------------|----------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|
| <b>Typological Analysis</b>                              | To study the internal spatial organization and arrangement of spaces within a building | AI-assisted design pattern analysis                                                         |
| <b>Morphological Analysis</b>                            | To study the physical form of cities structured in different elements of urban form    | AI-assisted urban data analysis                                                             |
| <b>Simulation</b>                                        | To model specific aspects of a building                                                | AI-enhanced simulation and optimization (structural analysis, environmental assessment)     |
| <b>Ethnographic Research - Observation and Immersion</b> | To study human behavior and culture in natural settings                                | AI-assisted social media analysis as a complementary method                                 |
| <b>Environmental Psychology Related Research Methods</b> | To study how we perceive the built environment and how it can affect us                | AI-assisted computer vision for image analysis of field data                                |
| <b>Interpretive-Historical Research</b>                  | To conduct fact-finding and interpretation of historical facts                         | AI-empowered literature review and image analysis for historical fact interpretation        |
| <b>Drawing and Diagrams</b>                              | To study essential issues involving form, understood in its broadest sense             | AI-powered computer vision for in-depth understanding of rationale in drawings and diagrams |
| <b>Interviews and Questionnaires</b>                     | To measure attitudes, opinions, and behaviors that include people's perspectives       | AI-assisted sentiment analysis and textual analysis                                         |
| <b>Literature-based research</b>                         | To delve into existing literature for insights                                         | AI-assisted literature review                                                               |

We initially introduced the conventional methods to the students without immediately integrating new approaches, with the aim of teaching these methods in conjunction with their foundational theories so as to explain how they were developed. Once students gained a solid understanding of the conventional methods, we introduce new AI-empowered tools and platforms. During the teaching process, we designated a separate section for AI-empowered literature reviews, complete with a specific lecture on various platforms and their respective strengths and weaknesses in conducting literature reviews. We further identified the types of AI-driven tools in the built environment, such as AI-assisted urban data analysis, AI-enhanced simulation and optimisation, AI-assisted social media analysis, and AI-powered computer vision for image analysis. In establishing this mapping (Table 1), we encouraged our students to contemplate

the ways in which AI-powered tools can augment and refine traditional approaches across various disciplines. These AI-driven tools are not labeled as discipline-specific; instead, they directly address key issues to be resolved without being limited by disciplinary jargon.

The platform Miro was used for sharing technical workflows and selected papers as reference materials. Various platforms and tools were categorised under the "Data Collection" and "Data Analysis" sections on the Miro page. With respect to web data collection, platforms such as Octoparse, Gooseeker, and InstalloadGram were utilised, as well as APIs within self-coded Python scripts or GitHub repositories. For AI models, we incorporated GLM from Zhipu and ERNIE Bot from Baidu for multiplatform data collection, and stable diffusion for semantic segmentation. Students could easily follow the workflows associated with each platform or tool, and with a simple click they could access the recommended papers as references for their actual research projects in the built environment (Fig. 1).

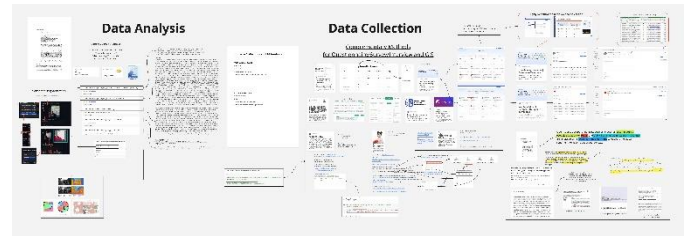


Fig. 1. The Miro page: a user-friendly interface for an AI-empowered research toolkit in teaching and learning.

#### IV. THE IMPACT OF AI ON STUDENT PERCEPTIONS: INSIGHTS FROM THREE PROGRAMMES

Students in the M.Arch. Architectural Design programme predominantly hailed from an architectural backgrounds. The M.Sc. International Professional Practice in Architecture programme primarily aims to foster students' engagement in entrepreneurial activities and to enhance their understanding of contemporary international practice; the programme attracts a highly diverse cohort, with students' backgrounds ranging from business to construction management, landscape design, urban design, and architecture. Finally, the M.Sc. Sustainable Construction programme enrolls students from civil engineering, architectural engineering, and (for a select few) design-related fields; students who opt for this course typically have a general interest in design-related knowledge. In the course, students were granted the freedom to define their research topics or proposals based on their personal interests.

The built environment—which includes such fields as architectural design, construction, and construction management—has a long-standing tradition of adhering to well-defined disciplinary boundaries. Accordingly, the existing literature highlights key questions related to interdisciplinarity [3]—such as "Establishing connections with students' prior knowledge and experiences" and "Enhancing students' abilities to recognise, evaluate, and integrate multiple perspectives"—as pivotal components. Achieving integration demonstrates that the interdisciplinary learner successfully understands the commonalities among disciplines and exercises crucial cognitive skills [4]. This research's mapping between traditional

methods and AI-related tools aims to re-establish commonalities across the diverse fields in the built environment, thereby facilitating a more integrated approach to problem-solving in research projects. Examining the insights of students from the three programmes, we reflected on whether our teaching has sparked interest in AI and whether AI has fostered interdisciplinary learning, and we identified specific gaps in certain programmes that hold potential for future development.

When students were asked about their perception of the impact of AI—specifically, how AI technologies can empower research in their respective fields—the data indicates a general awareness of AI's potential benefits across all programmes. Students in the M.Arch. Architectural Design programme showed a relatively high perception of AI's impact, particularly in analysing large datasets (66.67%) and automating repetitive tasks (58.33%). However, these students' perceptions drop significantly when it comes to enabling simulations and modelling (25%); this suggests that while students in this programme recognise the benefits of AI in data handling, they may perceive less applicability to advanced modelling scenarios or may be less aware of the significance of advanced modelling in research projects from an architect's perspective. For their part, students in the M.Sc. International Professional Practice in Architecture programme exhibited the highest perceptions across all categories, especially in analysing large datasets (76.92%) and automation (53.85%); they also acknowledged the ability of AI to provide new tools for data visualisation (61.54%) and to enable simulations and modelling (46.15%), indicating a well-rounded appreciation of AI's capabilities in enhancing professional practices.

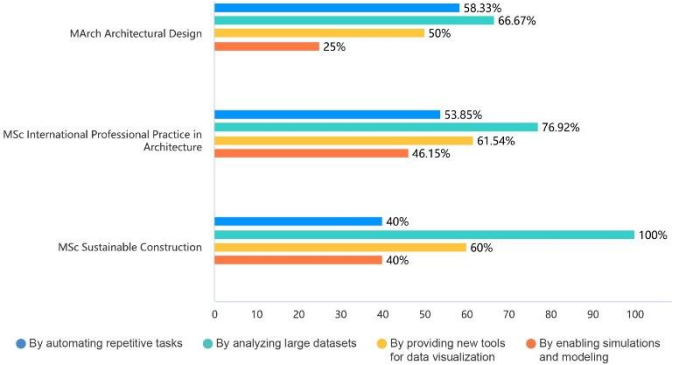


Fig. 2. Data showing students' thoughts on how AI can empower research in their respective fields.

The students in the M.Sc. Sustainable Construction programme had the lowest overall perceptions of AI's impact, with a notable disparity in their responses: while the students recognised AI's potential in analysing large datasets (100%), their responses for automation (40%) and simulations (40%) were significantly lower. This implies that students have a more cautious or critical stance towards the integration of AI in sustainable and construction practices. Students in this programme were inclined to utilise BIM in their research project; for example, one student's proposal for an industry building renovation research project suggested employing BIM to meticulously document the original condition of industrial buildings, to foster collaborative management, to mitigate risks during the renovation process, and to enhance sustainability by

evaluating and optimising building energy efficiency. However, the potential of AI for analysing large datasets and automating repetitive tasks through BIM was not explicitly addressed in the proposals of students from this group. A noticeable gap persisted between the specific applications of AI and conventional tools (such as BIM) in the design and construction practices.

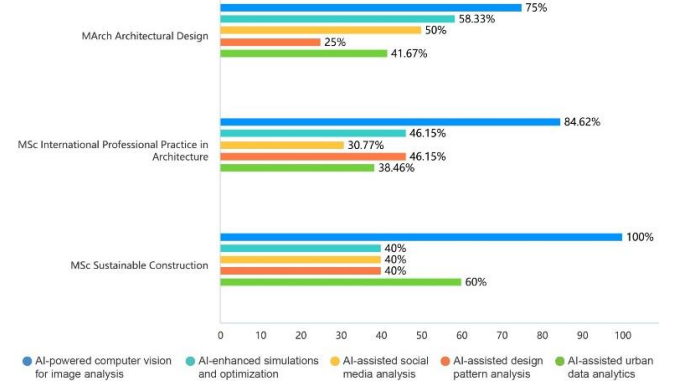


Fig. 3. Data showing students' respective engagement in various AI applications.

In a combination of the previous mapping of conventional research methods across various scenarios with the AI applications which students considered most beneficial to supporting research in the built environment, the data indicated AI-powered computer vision among all programmes, accompanied by varying degrees of interest in other applications (Fig. 3). M.Arch. Architectural Design students showed a strong inclination towards AI-powered computer vision for image analysis, with 75% of respondents favouring this application. M.Sc. International Professional Practice in Architecture students again had the highest percentage for AI-powered computer vision, at 84.62%; these students also showed a balanced interest in AI-enhanced simulations and optimisation, for which 46.15% of respondents expressed support, but their interest in AI-assisted social media analysis was notably low at 30.77%, indicating a potential area for reevaluation of relevance. Finally, M.Sc. Sustainable Construction students showed relatively lower engagement in AI applications, with their interests in AI-enhanced simulations and optimisation, AI-assisted social media analysis, and AI-assisted design pattern analysis falling between 40% and 60%.

Students from all programmes generally did not exhibit high interest in AI-assisted urban data analytics, indicating a gap in the teaching regarding how AI can be applied to urban data and integrated with architectural design and construction practices. AI-assisted social media analysis, previously not a common research method in the built environment, was introduced as a supplementary approach to complement traditional methods—especially as an alternative for gauging public opinion, which has typically been determined through semi-structured interviews and questionnaires. The general lack of interest in AI-assisted social media analysis indicates that students have not fully grasped the hybrid methodologies and are not confident in integrating conventional methods from the built environment with AI-enhanced cross-disciplinary techniques.

The common interest in AI-powered computer vision tools generally originates from students' undergraduate studies, which

emphasise visual aspects as the central focus, or from their personal preconceptions that design is primarily for aesthetic appeals. However, a minority of students selected image analysis as their research method in their final research proposals, and during tutorials, they expressed uncertainty about the role of AI-powered computer vision in their research projects, despite the general curiosity in this area. Consequently, considerable effort remains in bridging the gap between awareness of AI-assisted image analysis and its practical application in research thinking in the built environment. Several students, from both architectural and engineering backgrounds, chose to focus on AI for optimising building designs for energy efficiency, natural lighting, and ventilation in their research proposals. Such research proposals demonstrate an AI-integrated and -enhanced approach which bridges the knowledge gap between the domains of architecture and engineering in the built environment.

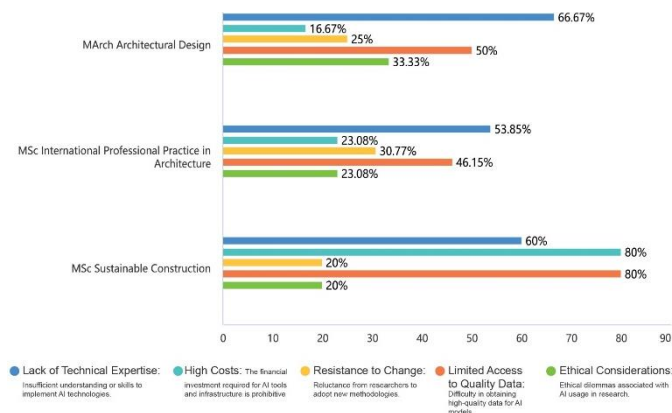


Fig. 4. Data showing students' perspectives on the primary barriers to adopting AI in research.

When students were asked about the barriers to adopting AI in research, the data revealed that there are common challenges across different programmes but the intensity of these concerns varies (Fig. 4). The M.Arch. Architectural Design students appear to have the highest levels of concern with respect to lack of technical expertise and resistance to change. This is partly because architects possess a robust professional identity grounded in their design skills. The potential of AI to revolutionize their role poses a challenge to their conventional identity. The M.Sc. Sustainable Construction students showed heightened awareness of high costs and data access issues; they also exhibited a heightened awareness of the potential role of AI in delivering real-time data on sustainability metrics, structural integrity, and energy efficiency. The MSc International Professional Practice in Architecture appears to have a more balanced perspective on these barriers but still faces notable challenges.

## V. DISCUSSION AND CONCLUSION

This study examined the potential of AI integration to reshape research methods in an interdisciplinary course on the

built environment. We observed that students incorporated concepts from various disciplines in the built environment into many of their research proposals, with AI acting as a catalyst for this interdisciplinary exploration.

Learning to cross disciplinary boundaries begins with the introduction of AI-empowered research methods, juxtaposed against traditional methods in the built environment. AI played a pivotal role in fostering interdisciplinarity, as the research methods were not confined to disciplinary jargon but instead emphasised the nature of analysis. However, this process hinges on a robust theoretical foundation during the beginning of the course, with conventional research methods in the fields introduced without the interference of AI platforms; students who lacked a solid grasp of these foundational methods tended to lag in the transition and showed diminished engagement with AI in later stages.

AI significantly bridged the gap between architectural design and engineering in students' research outcomes—a phenomenon observed in their proposals. However, gaps remain in terms of the application of AI-empowered computer vision in interdisciplinary research and in terms of integrating AI-enhanced methods from outside the built environment into research. Students from different programmes expressed varying concerns about using AI as a problem-solving tool, and addressing these barriers requires customised strategies for each programme's students so as to facilitate a smoother integration of AI technologies in a more interdisciplinary context. The findings of this study shed light on the potential of integrating AI into research methods courses, thereby paving the way for a more interdisciplinary approach in postgraduate teaching in the built environment.

## ACKNOWLEDGMENT

The Design School Teaching Innovation Fund (DES-20240722014, Empowering Research Methods by Integrating Digital Mindset in Postgraduate Education) supported the project at Xi'an Jiaotong-Liverpool University.

## REFERENCES

- [1] A. Akçay Kavakoglu, B. Almac, B. Eser, and S. Alacam, "AI Driven Creativity in Early Design Education - A pedagogical approach in the age of Industry 5.0," presented at the Proceedings of the 40th International Conference on Education and Research in Computer Aided Architectural Design in Europe (eCAADe) [Volume 1], 2022.
- [2] A. Agkathidis, Y. Song, and S. Ioanna, "AI-Assisted Design: Utilising artificial intelligence as a generative form-finding tool in architectural design studio teaching," presented at the Data-Driven Intelligence - Proceedings of the 42nd Conference on Education and Research in Computer Aided Architectural Design in Europe (eCAADe), Nicosia, 2024.
- [3] L. R. Lattuca, L. J. Voigt, and K. Q. Fath, "Does Interdisciplinarity Promote Learning? Theoretical Support and Researchable Questions," *Review of higher education*, vol. 28, no. 1, pp. 23-48, 2004, doi: 10.1353/rhe.2004.0028.
- [4] L. Park, "A Study of Integration: The Role of Sensus Communis in Integrating Disciplinary Knowledge," in *Interdisciplinary Pedagogy for STEM*, R. D. Lansiquot Ed.: Palgrave Macmillan, 2016, pp. 19-36