School of Computing, Engineering, and the Built Environment
Edinburgh Napier University

PHD STUDENT PROJECT

Application instructions:
Detailed instructions are available at :
https://www.napier.ac.uk/research-and-innovation/doctoral-college/how-to-apply

Prospective candidates are encouraged to contact the Director of Studies (see details below) to discuss the project and their suitability for it.

Project details

Supervisory Team:
- DIRECTOR OF STUDY: Dr Lina Khaddour (Email: l.khaddour@napier.ac.uk)
- 2ND SUPERVISOR: Prof. Bernadino D'Amico

Subject Group: Built Environment

Research Areas: Built Environment

Project Title: Digitalising Decarbonisation: Exploring the Role of Artificial Intelligence in Enhancing Energy Efficiency and Circularity of Building Materials

Project description:
The construction industry is essential to modern society, delivering critical infrastructure that underpins economic and social well-being. However, the industry's traditional practices are increasingly at odds with global sustainability goals, particularly concerning the significant carbon footprint and environmental impact associated with construction activities. The integration of digital technologies, such as Artificial Intelligence (AI), presents an opportunity to transform these practices, driving the industry towards more sustainable outcomes.

The circular economy (CE) has emerged as a key strategy for addressing this challenge, promoting the efficient use of resources and extending the lifecycle of materials to minimize environmental impact. The link between CE and decarbonisation is clear: by reducing waste and maximizing the reuse of materials, CE can significantly lower carbon emissions. However, the potential of AI to enhance CE practices and

contribute to the decarbonisation agenda within the construction industry remains underexplored. The built environment encompasses residential, commercial, and industrial buildings, as well as vital infrastructure such as roads, bridges, and airports. While these structures contribute to national productivity and quality of life, they also contribute to a large share of global greenhouse gas emissions, exacerbating climate change. The challenge of mitigating these emissions while continuing to develop and upgrade infrastructure is critical to achieving sustainability goals. There is limited research on AI application to the circularity performance of the built environment.

This PhD research aims to fill this knowledge gap by exploring the role of AI in improving the circularity and decarbonisation of building materials within the built environment. The research will analysis further highlights AI's potential to optimize material and energy use, enhance decision-making, and promote responsible production and consumption behaviors, all of which are crucial for improving CE performance and achieving decarbonisation targets.

In addition to its technical contributions, this PhD will have a broader impact by helping the Scottish construction industry understand the role of AI in improving the circularity performance of construction, thereby supporting the decarbonisation of the built environment. The research will offer recommendations to advance digitalising decarbonisation, underscoring how the adoption of innovative practices and techniques within energy systems can enhance circularity performance and facilitate successful decarbonisation. Through these contributions, the study will support the transition towards a more sustainable and digitally advanced construction industry.

References:

[1] Inderwildi, O., & Kraft, M. (Eds.). (2022). Intelligent Decarbonisation: Can Artificial Intelligence and Cyber-Physical Systems Help Achieve Climate Mitigation Targets? (Vol. 86). Springer Nature.

[2] elinek, Thorsten, Amit Bhave, Nicolas Buchoud, Michael Max Bühler, Patrick Glauner, Oliver Inderwildi, Markus Kraft et al. "Advancing AI for Climate Action: Global Collaboration on Intelligent Decarbonisation." (2023).

[3] Awuzie, B., Ngowi, A., & Aghimien, D. (2024). Towards built environment Decarbonisation: A review of the role of Artificial intelligence in improving energy and Materials' circularity performance. Energy and Buildings, 114491.

Candidate characteristics

Education:

A first-class honours degree, or a distinction at master level, or equivalent achievements in Built Environment subject i.e. Civil / Structural Engineering; Architecture; Construction management; Architectural Technology; Sustainable Built Environment or equivalent

Subject knowledge:

The candidate should have fundamental knowledge of sustainability, construction management, risk management, supply chain management, energy efficiency and sustainable built environment

Essential attributes:

- Experience of supply chain mapping
- Knowledge of sustainable building design and construction
- Capable of collecting and analyzing data sets and undertaking complex predictive modelling
- Competent communicator capable of engaging with industry and external stakeholders
- Good written and oral communication skills
- Strong motivation, with evidence of independent research skills relevant to the project
- Good time management