
***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. Robert Hairstans

**Subject Group:** Built Environment

**Research Areas:** Built Environment

**Project Title:** Evaluating the Efficiency and Sustainability of Modern Methods of Construction Timber-based

**Project description:**
The building and construction sector is a significant contributor to climate change, responsible for nearly 40% of global CO2 emissions. Of these emissions, 28% are from building operations, while 11% stem from construction activities, including the production of building materials. Scotland's construction industry is currently experiencing a transformation with the adoption of Modern Methods of Construction (MMC), which includes off-site manufacturing, robotics, and automation. The growing shortage of resources available in the construction sector and of qualified workforce in particular puts growing pressure on improving construction efficiency in Scotland. There is a need to constantly monitor and quantify the production and completion processes in construction. Quantifying efficiency reveals the possibilities of implementing more efficient, cleaner, and more sustainable technological MMC. While MMC presents opportunities for diversifying the construction demand, its potential to foster sustainable performance toward 2030 Net Zero target—remains underexplored.

This PhD research, grounded in the environmental, economic and social of MMC, will critically examine the role of MMC in addressing sustainability triple bottom line. It will involve semi-structured interviews with underrepresented groups in construction to understand their working needs. Collaborating closely with construction firms, the research will co-develop scenarios for MMC that are tailored to the needs of Scotland construction sector. Additionally, this work will be in partnership with the Housing, Construction & Infrastructure (HCI) Skills Gateway to support inclusive career pathways in construction across Scotland.

The research has four primary objectives:

1. to develop multi-criteria in the context of efficiency and sustainability of MMC across key building archetypes in Scotland.
2. to conduct parametric analysis- identifying MMC environmental impact.
3. to evaluate the socio-economic impact of MMC on different construction stakeholders' groups including contractors, workers and occupants.
4. to optimize AI driven decision-making model that combines energy signatures and building energy simulations within an archetype framework.

The expected outcomes of this research will provide a systematic analysis of the environmental, economic and social impacts of MMC. This work will be of significant value to construction stakeholders aiming to minimize environmental impacts through design and procurement, thereby reducing lifecycle greenhouse gas emissions and informing the selection of materials, specifications, and suppliers that contribute most effectively to sustainability goals. Furthermore, by integrating energy signatures with building energy simulation tools, the research will produce reliable simulations that will benefit the wider UK construction industry.

In addition to its technical contributions, this PhD will have a broader impact by helping the Scottish construction industry understand the needs of different stakeholder groups; including the historically excluded workers and occupants. The research will offer recommendations to support the MMC, contributing to its sustainability performance by addressing the environmental, economic and social impact within the context of rapid modernization.

**References:**

[1] Sánchez-Garrido, A. J., Navarro, I. J., & Yepes, V. (2022). Multi-criteria decision-making applied to the sustainability of building structures based on Modern Methods of Construction. Journal of Cleaner Production, 330, 129724.

[2] Švajlenka, J., & Kozlovská, M. (2020). Evaluation of the efficiency and sustainability of timber-based construction. Journal of Cleaner Production, 259, 120835.

[3] Climate Change Committee

[4] Environmental Audit Committee

[5] British Standards Institution. (2014). BS EN 16449-2014: Wood and wood-based products – Calculation of the biogenic carbon content of wood and conversion to carbon dioxide 8.

[6] Grubb, M., Wieners, C., & Yang, P. (2021). Modeling myths: On DICE and dynamic realism in integrated assessment models of climate change mitigation.

[7] Wiley Interdisciplinary Reviews: Climate Change, 12(3), e698.
https://www.wri.org/insights/mass-timber-wood-construction-climate-change

## 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, timber in construction and the built environment.

**Essential attributes:**

- Knowledge of timber as a material
- Capable of collecting and analysing 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

**Desirable attributes:**

- Supply chain management
- Risk management
- Building performance