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

PHD STUDENT PROJECT

Funding and application details

Funding status: Self funded students only

Application instructions:
Detailed instructions are available at https://blogs.napier.ac.uk/scebe-research/available-phd-student-projects/

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: Dr. Bernardino D'Amico

Subject Group: Built environment

Research Areas: Architecture, Building & Planning

Project Title: Investigating the Economic and Environmental Sustainability of Using Nanoparticle-Reinforced Recycled Building Materials

Project description:

Purpose:

The construction industry is a major contributor to environmental problems such as greenhouse gas emissions, resource depletion, and waste generation. Construction delivery and operation accounts for 34% global final energy use and 37% energy-related carbon dioxide (CO2) emissions whilst extracting finite resources and destroying natural habitats. As a result, improved methods of construction delivery as well as the evolution of more sustainable building material need to be identified with an emphasis on recycled building material as

recommended by the Climate Change Committee and Environmental Audit Committee. To address these issues, there's a growing interest in the use of recycled building materials in construction. Nanoparticle reinforcement offers the potential to enhance the mechanical properties of recycled building materials, making them more suitable for construction applications. However, there's a need for a comprehensive assessment of the economic and environmental sustainability of using nanoparticle-reinforced recycled building materials in construction projects.

Research Objectives:

The study aim to evaluate the economic and environmental sustainability of using nanoparticle-reinforced recycled building materials in construction projects. The project objectives are:

- To evaluate the environmental implications of using nanoparticle-reinforced recycled building materials compared to conventional construction materials.
- To assess the economic feasibility of using nanoparticle-reinforced recycled building materials in construction projects.
- To identify the most promising applications of nanoparticle-reinforced recycled building materials in construction.
- To investigate the potential risks and challenges associated with using nanoparticle-reinforced recycled building materials in construction projects.

Methodology:

Building upon the findings of the extensive review undertaken, the research will use a mixed-methods approach. The research will conduct Life Cycle Assessments (LCAs) and Life Cycle Costing (LCC) of selected nanoparticle-reinforced recycled building materials compared to traditional construction materials. It will also conduct cost-benefit analyses of using nanoparticle-reinforced recycled building materials in selected construction projects. Furthermore, the research will carry out case studies of successful applications of nanoparticle-reinforced recycled building materials in construction.

Expected outcomes:

The outcomes from this will be utilised to inform future supply chain resilience strategies and identify where possible potential construction materials and systems capable of being manufactured from nanoparticle-reinforced recycled building materials for sustainable built environment delivery. This project will provide important insights into the economic and environmental sustainability of using nanoparticle-reinforced recycled building materials in construction projects. This project will develop a comprehensive assessment of the economic and environmental sustainability for nanoparticle-reinforced recycled building materials application in construction projects. This identification of the most promising applications of nanoparticle-reinforced recycled building materials in construction will promote the adoption of nanoparticle-reinforced recycled building materials in the construction industry. The findings will be useful to policymakers, construction professionals, and researchers working on sustainable construction materials and practices.

References:

[1] Climate Change Committee

[2] Environmental Audit Committee

[3] Zhang, P., Han, S., Golewski, G. L., & Wang, X. (2020). Nanoparticle-reinforced building materials with applications in civil engineering. Advances in Mechanical Engineering, 12(10), 1687814020965438.

[4] McNamara, A. (2023). Thermal Performance of Nanoparticle Reinforced Enzymatic Construction Materials: Photothermal Heating System Proposal (Doctoral dissertation, Worcester Polytechnic Institute).

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; construction management, Architectural Technology; Sustainable Built Environment or equivalent

Subject knowledge:

The candidate should have fundamental knowledge of sustainability, construction material and the built environment.

Essential attributes:

- Knowledge of building material properties and specification
- 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