UCL: DAFNI contributing to the Circular Economy in Construction

Dr Evangelia Manola, Research Fellow in the UCL Department of Civil, Environmental & Geomatic Engineering

Introducing the research group

I am based in the Civil Engineering Department at UCL and working with Professor Liz Varga on eco design of mineral-based materials. The Research Group is called Interdisciplinary Circular Economy Centre for Mineral-Based Construction Materials ICEC ICM – funded by UKRI.

The ICEC ICM Centre is led by UCL and encompasses five other universities: Loughborough, Leeds, Lancaster, Sheffield, Imperial College London, and also the British Geological Survey. We have 15 post-doctoral researchers as well as associated PhDs, co-investigators, a management team and policy impact team. Each of our post-docs has a unique research project such as the economics of the Circular Economy, and the eco materials themselves - a lot of different aspects of research are happening across a variety of disciplines.

We have independent advisors from the Environment Agency, DSIT (Department for Science, Innovation and Technology) and DEFRA (Department for Environment, Food & Rural Affairs) and often invite them to centre meetings where they can see progress and outputs. The ICEC ICM Centre is frequently asked to give their research perspective regarding different decisions and strategies the agencies are formulating.

After my PhD on Composite Pavement numerical modelling and distress prediction, I did a secondment at DSIT as part of the ICEC ICM eco materials project, and I started a new secondment with National Highways in September 2023.

The Circular Economy

The idea of the Circular Economy is not that new but a lot of research being done now – more and more people are researching in different contexts and areas, such as food and metals.

Since February 2021, my focus has been on infrastructure products and the Circular Economy such as highways, roads, and transportation infrastructure projects. I'm researching ways to reduce waste and to generate minimal impact to the environment through decarbonisation of transportation modes and reducing carbon in general.

I work with Liz Varga, Professor of Complex Systems at UCL, on the eco design project and we have a PhD student who started recently who will look at combining digital tools in order to measure emissions in infrastructure projects.

With eco design we aim to look at the Circular Economy up front, during the design phase. This allows us to consider what positive steps can be taken for end of the life infrastructure early on, rather than only considering this at the conclusion of the infrastructure's lifespan or at the end of the project.

DAFNI Data & Analytics Facility for National Infrastructure

UCL: DAFNI contributing to the Circular Economy in Construction

The research is focusing on the UK to start with but there are no limitations. We're particularly interested in cement industries and the emissions, decarbonisations and imports and exports of those materials as well.

Digital twins in eco-design

One example of our research in the eco-design of technical characterisation of mineral-based construction materials with a focus on transport infrastructure projects is the Maritime Shipping Model we developed. In order to create it as a Digital Twin, we used the DAFNI platform and worked with the DAFNI team to hone in on what sort of programming languages to use and how to set up the model so that it can be adjusted to the DAFNI platform.

The model now runs 6 times a day on the DAFNI platform, it uses a specific API which draws data from a website into the DAFNI platform and the Maritime Shipping Model. Without the DAFNI platform we could not have set the model up as a Digital Twin and would not have got automatic runs and outputs.

Within the Digital Twin we can drill down into areas such as product usage, composition information, procurement data, health & safety information, facility information, and environmental data.

We're able to address big questions such as maritime decarbonisation, as well as to drill down into details such as how modifying the way waste materials are distributed could potentially reduce the number of truck journeys required, leading to less trucks on roads, less damage and maintenance required to roads, and ultimately less need for construction materials.

The impact of our research will be felt in areas such as changes to business practices, improved waste management of construction materials, and reduction in use of natural resources in construction projects.

The role of DAFNI

Our research also highlights the benefits of increased use of digital technology such as the DAFNI platform for the implementation of Digital Twins and as a platform for interdisciplinary research, and how the DAFNI platform can facilitate stakeholder collaboration for improved transparency and efficiency.

We've started to do more modelling involving Digital Twins – our next project is set to finish in September 2024 where we are researching an underground freight delivery system, and investigating how freight is moved underground rather than on roads - generating less carbon emissions in the environment, less traffic congestion, etc.

DAFNI Data & Analytics Facility for National Infrastructure