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Implementation of circular economy in the built environment

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European Cooperation in Science and Technology

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BIRMINGHAM

CircularB Implementation of Circular Economy in the Built Environment

Dr Sakdirat Kaewunruen and Professor Charalampos Baniotopoulos School of Engineering, University of Birmingham

Sustainable Infrastructures Research Group

Lifecycle Infrastructure Sustainable & **Reliability and** performance & engineering & smart materials risks forensics resilience Noise and Systems thinking Al and Data Net Zero Energy Vibration for greener Sciences Buildings infrastructure mitigations

Research Team: 24 PhD students, 1 visiting scholars and over 20 MEng/MSc/BEng students



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Implementation of Circular Economy in the Built Environment" (CircularB)

The main aim of the Action is to define the methodology to develop a common circularity framework for inclusive application and assessment in new and existing buildings to support decision-making for all value chain stakeholders and appraise the implementation level of the European Circular Economy Action Plan (ECEAP).



Implementation of Circular Economy in the Built Environment" (CircularB)

- By developing a benchmark database based on each country/region conditions, culture and traditions – the direct use of the tool is enabled, supporting both designers in developing more sustainable buildings and national/local governments in assessing and promoting their CE targets.
- Construction, assembly, adaptability, deconstruction and business model guidelines will be identified for new and existing buildings to enhance CE in buildings and promote stakeholder knowledge.
- The rating tool will also be integrated into the Open BIM workflow for better-informed design decisions, automated assessment, efficient value chain management, and circular feedback using central BIM models



Implementation of Circular Economy in the Built Environment" (CircularB)

The action embraces inclusive and multi- & interdisciplinary approach

Areas of Expertise:

- Civil engineering: Sustainable engineering, adaptation to long-term environmental changes
- Civil engineering: Architecture engineering
- Other engineering and technologies: Sustainability for other engineering and technologies



https://www.cost.eu/actions/CA21103/



Implementation of Circular Economy in the Built Environment" (CircularB)

CircularB COST Action involves 61 organisations from 28 different COST countries, including Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Finland, Germany, Greece, Ireland, Italy, Latvia, Malta, Montenegro, Netherlands, North Macedonia, Norway, Poland, Portugal, Romania, Serbia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

University of Birmingham is a UK hub. Please participate in various networking events to be sponsored by the Action.

https://www.cost.eu/actions/CA21103/



COST Action CA21103 Implementation of Circular Economy in the

Built Environment" (CircularB)

CircularB COST Action brings together a network of stakeholders with a significant impact on different life cycle stages of buildings. Actors from multidisciplinary fields will be able to communicate to enhance circularity implementation in buildings constantly.

- Academia from different European universities with distinct expertise (Architecture, Construction Materials, Economics, Engineering, Management, Urban Planning, ...);
- Research institutes currently working on CE topics, as assessment methods, efficient management of CDW, materials recycling and reuse, and design strategies, among others;
- Practitioners, including building design offices, contractors, consultants, material producers and supplier companies, waste management companies, and international environmental consultancy...;
- National and local authorities and policymakers, including European municipalities;
- National associations, including building and construction institutes, material producer representatives, professional associations, civil society, NGOs, etc.

https://www.cost.eu/actions/CA21103/

COST Action CA21103 Implementation of Circular Economy in the Built Environment" (CircularB)

The CircularB COST Action aims at delivering a holistic approach to circular buildings including all technical, technological, social, legal, economic and environmental aspects. In order to cover all of the proposed aspects, the research will be divided into 4 WGs:

WG1: Circularity strategies and best practices

WG2: Circular value chain and stakeholder engagement

WG3: Circular KPIs framework

WG4: Dissemination and results communication

Start date - 27/10/2022 End date - 26/10/2026

https://www.cost.eu/actions/CA21103/







TRANSPORT CO₂

UK greenhouse gas emissions

Domestic emissions from all sectors: 2015*



495.7 million tonnes of CO₂ equivalent (MtCO₂e)



is the total net domestic emissions from all sources.

24%



of UK domestic greenhouse gas emissions were from transport, up from 15% in 1990.

93%



of total domestic transport greenhouse gas emissions were from road transport.

TRANSPORT CO₂



Kaewunruen et al. (2016) Frontiers in Transportation and Transit Systems; UIC (2016)

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Digital Twins for Smart City



Systems-based strategy to achieve carbon-efficiency



- Extensive monitoring and measurements of railway construction management practices (>> 60 real projects) were rigorously conducted.
- Life cycle carbon emission from plain-line railway renewal activities are assessed.
- Field data suggests the carbon footprint due to <u>ballasted track</u> construction and maintenance is less than that of ballastless tracks over the lifespan.

Krezo et al. (2016) Transportation Research Part D: Transport & Environment

Systems-based strategy to achieve carbon-efficiency



Travel Mode Carbon Emissions (CO2)

■ Work Mode Carbon Emissions (CO2)

 By adopting the right combination of work equipment, carbon efficiency can be optimised through appropriate use of resurfacing machines (by using 6D BIM = 3D + Schedule + LCC + CO₂e).

Resurfacing machine TJ061 and TJ091 (single head) are the most efficient tampers. It is found that although the dual head tamper (TJ096) is more productive, it is not carbon-efficient.



Kaewunruen and Liang (2019) Cleaner Production

Systems-based strategy to achieve carbon-efficiency



The comparative results showed a 31% reduction in CO₂ emissions by using this parallel construction strategy and should be considered by construction and rail transport managers to help reduce CO₂ emissions from future special trackwork reconstruction projects.





Develop a machine learning model forecasting electricity consumption to eliminate CO_2 in a public building



Hierarchical approach





Al models – SVR, LSTM, XGBoost



Ideas to Impact



- Action TU1404 TOWARDS THE NEXT GENERATION OF STANDARDS FOR SERVICE LIFE OF CEMENT-BASED MATERIALS AND STRUCTURES
- Action CA15125 Designs for Noise Reducing Materials and Structures (DENORMS)
- Action CA15202 Self-healing As preventative Repair of Concrete Structures (SACOS)





an Open Access Journal by MDPI

Advances in Circular Economy in the Built Environments

Guest Editors

Dr. Sakdirat Kaewunruen, Dr. Yunlong Guo, Prof. Dr. Charalampos Baniotopoulos, Dr. Chayut Ngamkhanong

Deadline

31 March 2023



mdpi.com/si/140097

- Action CA20109 Modular Energy Islands for Sustainability and Resilience (2021-2024) <u>www.modenerlands.eu</u>
- Vice-chair Prof C Baniotopoulos

Ideas to Impact



Our research contributes to



- British Standard Committee (BSI) and Rail Safety and Standard Board Committee (RSSB) for Railway Sleepers and Bearers
- ISO Standard Working Group (269/1) for Plastic and Composite Sleepers
- ISO Standard Working Group (269/4) for Recycling of Rolling Stocks

Conclusions

Summary

- This presentation will highlight collaborative research into Big Data, Digital Twins, and AI applications for improving sustainability and carbon footprint in transportation and transit systems in urban environments.
- The collaborative research are aligned with **United Nation's Sustainable Development Goals.**
- With proven research insights and open data science, 6D BIM can be used to enhance sustainability in railway industry.





European Commission





Thank you very much for your kind attention



European Cooperation in Science and Technology

