MANCHESTER 1824
The University of Manchester

Department of Civil Engineering and Management

2026 PGR Conference





Schedule

Date: Friday, 27 November 2026

Venue: Ground floor lecture theatre (GA.056), Ground Floor Event Space, Nancy Rothwell Building

Time	Event	Venue
9:15-9:30	Registration & PGRs arranging display of their posters	GA.056
9:30-9:45	Welcome Address, Head of Department Conference Overview, including voting instructions	GA.056
9:45-11:00	3MT Competition	GA.056
11:00-11:15	Break, tea and coffee	Event Space GF
11:15-12:00	Entrepreneurship in Civil Engineering - Starting Your Own Firm	GA.056
12:15-13:00	First Panel session (Securing Your First Academic Job After a PhD)	GA.056
13:00-14:00	Lunch	Event Space GF
14:00-15:00	Poster Session	Event Space GF
15:00-15:45	Second Panel Session: Moving to industry after PhD	GA.056
15:45-16:15	Securing a Higher Education Academy (HEA) Fellowship	GA.056
16:30-17:00	Awards and Closing	GA.056

Poster Information

Number	Presenter	Research Group/Theme
1	Noura ElAgouz	Tyndall Centre
2	Hud Al-Saadi	Tyndall Centre
3	Amal Alenezi	Tyndall Centre
4	Yue Yu	Tyndall Centre
5	Qin Zhou	Engineering Management
6	Yusuf Almansoori	Engineering Management
7	Chengyuan Hao	OREEE
8	Ashani Fernando	Sustainable Construction Materials
9&10	Muhammad Hamza Khalid	Geotechnical Engineering

Presentation Schedule

Session	Presenter	Research Group/Theme
9:45-9:50	Aliyu Sadiq	Tyndall Centre
9:50-9:55	Wasundara Doradeniya walawwe	Tyndall Centre
9:55-10:00	Dominic Graham	Tyndall Centre
10:00-10:05	Ayesha Shafiq	Tyndall Centre
10:05-10:10	Matt Newbould	Tyndall Centre
10:10-10:15	Paolo Della Moglie	Tyndall Centre
10:15-10:20	Amal Alenezi	Tyndall Centre
10:20-10:25	Yue Yu	Tyndall Centre
10:25-10:30	Anas Alhaddad	Energy and Environmental Engineering
10:30-10:35	Peng Zou	Energy and Environmental Engineering
10:35-10:40	Raikhan Ospanova	Structural Safety and Resilience
10:40-10:45	Mas Iliani Rosli	Structural Safety and Resilience
10:45-10:50	Yusuf Almansoori	Engineering Management
10:50-10:55	Ashani Fernando	Sustainable Construction Materials

Poster

Abstracts

How sustainable are our medicines? Mapping 20 years of pharmaceutical life cycle assessment

Noura ElAgouz

Pharmaceuticals carry a large and growing environmental burden. Medicines account for a quarter of the NHS carbon footprint, and pharmaceutical chemicals can have up to 25 times the global warming impact of bulk chemicals. Life Cycle Assessment (LCA) can identify where these burdens arise. Life Cycle Sustainability Assessment (LCSA) goes further by adding economic and social dimensions. How widely either has been applied to medicines is still unclear. This systematic review followed PRISMA 2020 and searched Scopus, Web of Science and grey literature for studies published from 2006 to 2026. Of the 1,839 database records and 76 grey-literature records identified, 66 studies met the inclusion criteria. Each was coded against the ISO 14040/44 phases: goal and scope, inventory, impact assessment and interpretation.

The evidence is concentrated on active pharmaceutical ingredients (APIs) and tablets, which together make up two-thirds of the studies. Process-based modelling dominates (95%), and 62% of studies end at the factory gate, so distribution, use and disposal are rarely assessed. Every study assessed environmental impacts, but only 30% included an economic dimension, only four applied full life cycle costing, and none applied social LCA. No study conducted a complete LCSA. Inventories rely mainly on secondary data from Europe and North America. API synthesis was the most frequently reported GHG hotspot, identified in over half of both cradle-to-gate and cradle-to-grave studies. Within API manufacturing, solvents were the main driver (54%). No study assessed long-acting therapeutics. This review therefore sets the agenda for a cradle-to-grave LCSA of long-acting formulations using treatment-equivalent functional units.

Department of Civil Engineering & Management

Research Theme: AI & Circular Economy

Hud AL-Saadi, 14176275

Examining Artificial Intelligence to Implement Circular Economy Principles During the Early Phase of Construction Design

Abstract

Construction and demolition waste (CDW) is largely determined before a building is built. Decisions made at the early design stage shape most of a building's lifecycle impact, yet circular economy (CE) practice remains skewed towards end-of-life. This research examines how artificial intelligence (AI) can support CE principles during the early phase of construction design.

A systematic literature review following the PRISMA protocol screened 6,109 records from Scopus, Web of Science and ScienceDirect (2013–2025) and analysed 209 papers on AI-supported early-stage design, of which 83 studies with validated AI models were examined in depth.

The findings show AI's significant potential, but current applications concentrate on measurable optimisation. Reuse (74 mentions) and Reduce (43) dominate the R-strategy hierarchy, while Refuse (3) and Rethink (28) trail far behind, and the biological loop is nearly absent. Life cycle assessment (44 studies) is favoured over circularity indicators (10), and most AI frameworks optimise a single material rather than evaluating the whole design.

Data availability, governance frameworks and digital standardisation are fundamental barriers that must be overcome before advanced AI applications can be deployed effectively. Long-term strategies, such as extending AI to Refuse and Rethink, should be pursued alongside the socio-technical changes needed to accelerate circular construction.

An empirical study will be conducted in the UK to explore stakeholders' needs and perceptions and to investigate the practicality of AI in supporting CE principles during the early design of construction, informing an evidence-based, AI-driven framework.

Supervisors: Dr. Alejandro Gallego Schmid, Dr. Saeed Reza Mohandes

Tyndall Centre for Climate Change Research, The University of Manchester

Sustaining Disaster Waste Management Systems Operations under Prolonged Disruption: A Systematic Review

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Keywords: Resilience, Disruption, Waste management, Disasters, Armed conflict, Debris

Armed conflict generates large volumes of disaster waste that overwhelms the waste management system capacities to manage it. As of September 2025, the war in Ukraine has generated about 17.2 million tonnes of debris from damaged and destroyed buildings, with 11.7 million tonnes that still need to be removed, sorted and treated (UNDP, 2026). While existing literature often focuses on addressing mitigation actions, risk assessments and post-disaster recovery strategies for natural and human induced disasters, limited attention has been given to maintaining system functionality during armed conflict where prolonged operational disruptions challenge the assumption of a recovery period. As a result, the conventional disaster waste management system prepares and plan for disruptions that are followed by an assumed recovery period, and prolonged conflict removes the certainty of a recovery window. This study investigates the resilience of disaster waste management systems across disaster types, with armed conflict as the focal case. It focuses on the absorptive, adaptive and transformative mechanisms that help these systems to maintain functional continuity. This study is a systematic literature review using the PRISMA guidelines. The relevant studies were identified from two academic databases, Web of Science and Scopus from 2015 to 2026. Of the 111 studies included, 42 have been analysed using systems thinking, the Iceberg model (Maani & Cavana, 2007) and 3D Resilience framework (Béné et al., 2012). Preliminary findings identifies visible recurring patterns including difficulties segregating waste that is linked to underlying structure barriers such as lack of disaster waste guidelines, influenced by mental models treating disaster waste similar to construction and demolition waste. Across the 42 reviewed literature, 139 resilience mechanisms were identified. Of these mechanisms, 38 strategies were proposed or implemented post disaster across 6 reviewed armed conflict literature, all addressing waste management recovery following a disaster with none examining maintaining essential waste management system functions during prolonged continuous armed conflict disruptions. None of these studies address persistent disruptions, only one addresses power outages, two addresses restricted access, and two addresses limited funding. The findings provide the basis for a conceptual resilience framework to support functional continuity at each level of the waste management system under prolonged disruption and resource depletion, with armed conflict as the focal case.

References

[1] Béné, C., Wood, R. G., Newsham, A., & Davies, M. (2012). Resilience: New Utopia or New Tyranny? Reflection about the Potentials and Limits of the Concept of Resilience in Relation to Vulnerability Reduction Programmes. *IDS Working Papers*, *2012*(405), 1–61. https://doi.org/10.1111/j.2040-0209.2012.00405.x

[2] Maani, Kambiz., & Cavana, R. Y. . (2007). *Systems thinking, system dynamics : managing change and complexity*. Pearson Education New Zealand.

[3] UNDP. (2026). *Ukraine could recover up to 8.2 million tonnes of secondary raw materials from war-generated debris, UNDP study reveals*.

Photovoltaic electricity, product retention and glazing for office HVAC: reducing life cycle impacts or shifting burdens?

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Abstract

Heating, cooling and ventilation impose burdens through electricity and repeatedly replaced equipment, yet electricity supply, product retention and glazing are rarely assessed together or beyond carbon. Coupling dynamic energy simulation with life cycle assessment, we evaluated them across 18 impact categories in a Manchester office. Full photovoltaic supply, a limiting case, cut global warming potential (GWP) by 58.8% but shifted burdens, slightly raising aquatic ecotoxicity and mineral resource scarcity. Longer product lives cut mineral resource scarcity over twice as much as GWP, mainly through fewer chiller replacements, which carbon-only rankings undervalue. Glazing changed glass inputs and electricity: lower total solar energy transmittance saved net electricity, whereas a third pane added glass and cooling demand. Combined, compatible measures lowered every category more than any single measure; longer lives, aided by glazing, reversed the burden shift. In similar offices, as electricity becomes cleaner, reducing impacts will depend increasingly on lower material inputs.

Keywords: Life cycle assessment, HVAC systems, Electricity decarbonisation, Product service life, Mineral resource scarcity, Circular economy

PGR CONFERENCE | POSTER ABSTRACT

How Do Green Offices Shape Behaviour?

Studying employees and project teams through virtual reality

Qin Zhou | Supervisor: Dr Kun Wang

Department of Civil Engineering & Management, The University of Manchester

Abstract

An office's environmental performance depends partly on how people use its lighting, equipment and recycling facilities. This proposed study asks how office design shapes energy-saving and recycling behaviour when people work together in temporary project teams. Teams of three will complete the same task in a virtual office, allowing researchers to compare team actions across different office designs under controlled conditions. The study will combine records of what participants do during the task with questionnaire responses about their experience. The findings could help designers and project teams identify features that make saving energy and reducing waste easier in everyday work.

Public Participation and Project Portfolio Management: The Case of Bahrain

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Keywords: Public Participation, Project Portfolio Management, Bahrain Case Study

Although public participation (PP) is becoming increasingly important to governments, its relationship with public-sector project portfolio management (PPM) remains underexplored [1, 2]. This research adopts a qualitative single embedded case-study design to examine how outputs from three Bahraini PP initiatives (Tawasul, Fikra and Sharekna) relate to the PPM lifecycle. Published findings indicate substantial participation, including 37,514 Tawasul suggestions, seven Fikra editions generating multiple ideas, and varied public input through Sharekna [3]. However, their influence on PPM decisions requires further investigation. The study will empirically assess and validate the proposed 6ISP conceptual evaluation framework (Figure 1). The research is expected to advance understanding of PP–PPM relationships and offer government organisations a potential tool to evaluate how public input informs portfolio decisions.

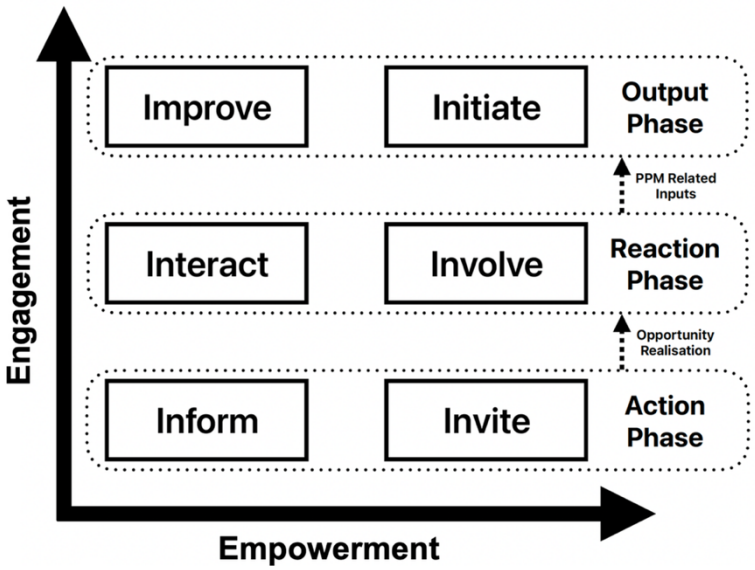

Figure 1: The Six I's of Stakeholder Participation (6ISP) Conceptual Evaluation Framework.

References:

[1] Roberts, P. and Hamilton Edwards, L. (2023) 'Portfolio management: A new direction in public sector strategic management research and practice', Public Administration Review, 83(4), pp. 947–959.

[2] Derakhshan, R., Turner, R. and Mancini, M. (2019) 'Project governance and stakeholders: A literature review', International Journal of Project Management, 37(1), pp. 98–116.

[3] Almansoori, Y., Alkhaja, Z., Alkhaldi, M. and Mohamed, F. (2026) 'Project Portfolio Management in Public Service Provision: The Case of Bahrain Government', Systems, 14(4), 370.

Fast Prediction of Fully Nonlinear Regular Waves Using MLPs

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Abstract

Offshore renewable devices have to be designed for steep waves. Such waves are not sinusoidal: their crests are sharper and their troughs flatter than linear theory predicts, and the fluid velocities beneath the crest can be considerably larger. A fully nonlinear regular wave consists of a free wave and a series of bound harmonics, and the steeper the wave and/or the shallower the water, the more harmonics are needed. The pseudo-spectral solver SSGW [2] computes these waves accurately, but a single near-breaking wave can take up to 5 seconds, which is too slow for a design study that needs millions of waves.

We replace the iterative solver with a neural-network surrogate that maps the relative depth kh and the steepness $\varepsilon = kH/2$ to the Fourier coefficients of the surface elevation η and the surface horizontal (u) and vertical (w) velocities. The steepness is first rescaled by the local breaking limit, $\varepsilon/\varepsilon_{\max}(kh)$ [1], so that the training datacovers shallow to deep water and near-linear to near-breaking waves. The (kh, ε) plane is divided into four sub-areas with overlaps, each with its own multilayer perceptron (MLP) for one physical quantity at the free surface, and each network predicts only as many log-scaled harmonics as it needs (3 to 100), so no network is asked to learn coefficients that are effectively zero. Neighbouring networks are blended smoothly across their overlap(s), which keeps the predictions continuous at the overlapping boundaries. The complete model has 13 MLPs (65,760 weights) and was trained on 3,000 SSGW waves in 1.6 hours on a laptop CPU.

The model was tested on 10,000 waves outside the training set against a 16,384-mode SSGW reference. With an ensemble of ten networks trained from different random initialisations, the crest value is within 1 % of the reference for η, u and w over 99 % of the test waves, and the median relative L_2 error over one wavelength are all around 0.015 %, which is half of the error of predictions from a single set of networks. The waves with errors above 1 % lie close to the breaking limit, mostly in shallow water, apart from a narrow band of very small waves for u.

Below the surface, the H and H_2 operators [3] reconstruct the full velocity field from the predicted η and surface u, with w obtained as the harmonic conjugate of u. For a wave at $kh = 0.75$ (shallow water) and 99 % of the breaking limit, the velocity is within 0.85 % everywhere; for near-breaking waves in deep water the higher harmonics have to be truncated for the operators to converge, and the error at the crest rises due to the removal of higher harmonics.

Once trained, the surrogate makes each additional wave almost free. For a batch with the steepness mix of the test set it is at least 60 times faster than the original code in a mixed group of waves with 30 % of near-breaking waves. However, the model applies to regular surface gravity waves on a flat bed within the training range of kh and ε, and it is less reliable outside that range. The next step is to extend this idea to irregular waves, which we will first look at focussed waves based on NewWave theory [4].

Keywords: nonlinear water waves; bound harmonics; neural networks; surrogate model; offshore renewable energy

References

[1] Fenton, J. D. Nonlinear wave theories. *The Sea*, vol. 9, Wiley, 1990.

[2] Clamond, D. & Dutykh, D. Accurate fast computation of steady two-dimensional surface gravity waves in arbitrary depth. *J. Fluid Mech.* 844, 2018.

[3] Bateman, W. J. D., Swan, C. & Taylor, P. H. *J. Comput. Phys.* 186, 70–92, 2003.

[4] Tromans PS, Anaturk AR, Hagemeijer P. A new model for the kinematics of large ocean waves: application as a design wave. In: *1st international offshore and polar engineering conference*, Edinburgh, UK, 11–16 August 1991, vol 3, pp. 64–71. Cupertino, California: International Society of Offshore and Polar Engineers.

Why Does High Rice Husk Ash Replacement Weaken Cement?

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Keywords: Rice Husk Ash (RHA); High Cement Replacement; Calcium Silicate Hydrate (C-S-H); Microstructural Characterisation; Compressive Strength

There is a strong need for alternative supplementary cementitious material (SCM) options for cement replacement, as the availability of conventional SCMs is becoming increasingly constrained. Rice Husk Ash (RHA), a silica-rich agricultural waste, has strong potential as an additional SCM. Yet replacement is generally limited to around 20% because strength decreases at higher levels. This research investigates why, focusing on calcium silicate hydrate (C-S-H), the main binder. The study compares C-S-H formed from conventional cement hydration, C-S-$H_{(CEM\ I)}$, with secondary C-S-H produced through the pozzolanic reaction between RHA and calcium hydroxide, C-S-$H_{(RHA)}$. The amount and nature of C-S-H are investigated using quantitative X-ray diffraction (QXRD), Fourier transform infrared spectroscopy (FTIR), and scanning electron microscopy with energy dispersive X-ray spectroscopy (SEM-EDS). Results show that the amount of C-S-H formed in the RHA system at 28 days is comparable to that formed in the cement system**.** However, despite producing similar quantities of C-S-H, the RHA system exhibits approximately one-seventh of the compressive strength of the cement system. Further characterisation indicates that C-S-$H_{(RHA)}$ is structurally different, being more silica-rich and predominantly tobermorite-like, while cement derived C-S-H becomes more jennite-rich. These findings suggest that strength loss is governed not only by the amount of C-S-H formed, but also by its structure and microstructural organisation. Current work therefore investigates whether improving silica availability during hydration, enhancing RHA particle dispersion, and introducing nucleation sites can favourably modify the nature and microstructure of C-S-H, ultimately enabling up to 40% cement replacement with RHA while achieving compressive strength comparable to or higher than that of conventional concrete.

3MT

Abstracts

Assessment of Artificial Intelligence-Driven E-Waste in Sub-Saharan Africa and Potential Circular Economy Implications

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Keywords: **AI e-waste, Circular Economy, Sub-Saharan Africa**

The rapid expansion of generative artificial intelligence (AI) is expected to increase global electronic waste (e-waste), yet existing studies report widely varying estimates due to differences in system boundaries and modelling assumptions. Studies estimating AI-related e-waste from data centre servers and storage alone project quantities ranging from 200 tonnes to 4.2 million tonnes by 2030 [1] [2]. However, the Basel Action Network (BAN) has introduced the concept of AI contagion waste, arguing that these estimates may overlook additional e-waste generated by AI-driven user device replacement and telecommunications infrastructure upgrades [3]. These indirect waste flows remain poorly understood and are not explicitly captured as AI-related e-waste in existing monitoring frameworks, including the Global E-waste Monitor. Their potential scale and implications for Sub-Saharan Africa are particularly underexplored.

This PhD research addresses this gap by estimating AI-related e-waste arising from user device replacement and telecommunications infrastructure upgrades across Sub-Saharan Africa under business-as-usual and circular economy scenarios. Dynamic material flow analysis (dMFA) will be used to model future e-waste generation, while sensitivity analysis will assess uncertainty in key assumptions. Circular economy scenarios will examine the extent to which interventions, including repair, reuse, refurbishment, extended product lifetimes and improved recycling, could prevent or delay e-waste generation. In addition, semi-structured interviews will explore the opportunities and implementation barriers associated with these interventions across the region. The research will provide evidence to inform policies and strategies for managing AI-related e-waste and mitigating its potential environmental and social impacts in Sub-Saharan Africa.

References

[1] P. Wang, L. Y. Zhang, A. Tzachor, and W. Q. Chen, "E-waste challenges of generative artificial intelligence," *Nat Comput Sci,* vol. 4, no. 11, pp. 818–823, Nov 2024, doi: 10.1038/s43588-024-00712-6.

[2] A. de Vries-Gao, "Recalibrating global artificial intelligence e-waste estimates," *Resources, Conservation and Recycling,* vol. 229, 2026, doi: 10.1016/j.resconrec.2026.108872.

[3] J. Puckett, "The Coming AI Waste Wave," Basel Action Network, 2026. [Online]. Available: https://wiki.ban.org/images/1/16/AI_Waste_Wave_Part_1.pdf

Helping cities turn climate plans into action!

Doradeniya, Wasundara. Tyndall Centre for Climate Change Research

Local councils have established ambitious climate targets, yet businesses control many of the emissions and resources central to achieving them. This research examines how collaboration between local councils and businesses can translate climate plans into action, using Greater Manchester as the primary case study alongside international examples.

Through an embedded role within the Greater Manchester Combined Authority's Environment Team, this research combines ethnographic observations of collaborative practice with interviews and document analysis. The study examines factors that encourage business participation, barriers to involvement, and the role of local government in supporting sustained commitment. International examples enable exploration of alternative approaches and identification of lessons for Greater Manchester.

Preliminary findings from Greater Manchester suggest that a lack of clarity concerning the benefits of collaboration can weaken business commitment, particularly where organisations face constraints on staff time and resources. When the value of participation is unclear, businesses may struggle to justify involvement alongside competing priorities. These findings indicate the importance of clearly communicating both the benefits of collaboration and expectations regarding business contributions. The findings remain specific to Greater Manchester at this stage; ongoing research will examine how other collaborations address comparable challenges. The research aims to inform the development of more effective local government–business collaborations that sustain participation and support the delivery of local climate action.

Dominic Graham

Robotic systems are increasingly being considered for inspection, maintenance and intervention activities in complex and hazardous environments. However, the sustainability implications of the robots themselves remain comparatively underexplored. Using quadruped robots as an initial case study, this research explores how life cycle assessment can be combined with circular economy principles such as durability, repairability, reuse, remanufacturing and design for disassembly. Particular attention is given to the data and methodological challenges associated with evaluating complex robotic systems where detailed bill-of-materials and supply-chain information may be unavailable. The developing framework also considers how environmental and circularity performance may interact with lifecycle economics, technical resilience and supply-chain dependencies. The research ultimately aims to support more comprehensive assessment and design of robotic systems, enabling their benefits to be considered alongside the lifecycle impacts and dependencies associated with their manufacture, use and end-of-life.

Article 6 Initial Reports: Gaps, Inconsistencies, and the Case for Standardized MRV Before CDR Integration

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Keywords: Article 6.2; Paris Agreement; international carbon markets; monitoring, reporting and verification; carbon dioxide removal; environmental integrity; transparency.

International carbon markets allow countries to cooperate in reducing greenhouse gas emissions by transferring emission reduction credits across borders. However, for these markets to deliver genuine climate benefits, countries must be able to demonstrate that the reductions are real, accurately measured and counted only once. Article 6.2 of the Paris Agreement establishes a framework for this cooperation, but questions remain about how effectively countries are implementing its requirements.

The paper examines transparency and accounting challenges emerging during the early implementation of Article 6.2. It analyses the initial reports submitted by Switzerland, Ghana, Thailand and Vanuatu, alongside the feedback provided by the United Nations Technical Expert Review Teams (TERT). These reports document how countries organise, monitor and account for emission reduction activities carried out through international cooperation. The analysis identifies 69 inconsistencies across 14 reporting elements, revealing significant differences in institutional arrangements, accounting practices and technical capacity.

The findings highlight three major challenges. First, countries do not consistently explain how decisions are made and which institutions are responsible for authorising international carbon credit transfers. Second, differences in digital infrastructure create difficulties in tracking credits across national systems, with some countries relying on manual processes rather than interconnected registries. Third, inconsistencies in accounting methods, project baselines and the treatment of emission reductions raise concerns about whether transferred credits genuinely represent additional climate benefits.

These challenges have implications beyond existing emission reduction projects. As countries increasingly consider Carbon Dioxide Removal (CDR) approaches, such as capturing carbon dioxide directly from the atmosphere or removing it through biological processes and storing it for the long term, the demands on monitoring and verification systems will become considerably greater. Unlike conventional emission reduction activities, CDR requires confidence that captured carbon remains stored over extended periods and that potential reversals are properly accounted for.

The paper argues that the weaknesses identified in the early implementation of Article 6.2 must be addressed before more complex carbon removal activities are integrated into international carbon markets. It highlights the need for more consistent reporting requirements, stronger digital infrastructure and standardised monitoring, reporting and verification (MRV) systems to safeguard the environmental integrity of future international climate cooperation.

The Climate and Biodiversity Crises are inextricably linked and decisive, joined-up actions must be taken to solve them (CIEEM 2019; WWF 2024). In theoretical discourse around sustainability transformations, oncological shifts towards relationality have lead to a spotlight on the 'more-than-human' as agents with affect in world systems (Blanco-Wells 2021; Barua 2021), while social and material infrastructures are reconceptualised as conjoined and in varying states of (dis)repair (Ramakrishnan et al. 2021). Urban areas are unique zones of high metabolism of resources and high human population with lower biodiversity, and the city of Manchester in particular has a green and blue infrastructure strategy that makes it unique as a socio-ecological study site, coming to its end (Cui et al. 2019; Manchester City Council 2022). This PhD aims to use mixed-methods approaches to investigate the role of the 'more-than-human' in systems of care, repair and maintenance for social and built infrastructure, by examining the urban socio-ecology of Manchester across its infrastructural networks. By doing so, the PhD will further improve the ways in which joint adaptation action on the climate and biodiversity crises can be taken through planning and development processes accounting for the uncovered relationships. The conceptual framework of a multispecies mending matrix could aid in resolving the dysconnectivity by using a single consistent plane to draw the concepts together on (Kershaw 2023). To demonstrate how this would work practically, I have devised a mixed-methods approach using documentary and ecological data analysis, participant observation and walking interviews with a clear timeline of when this research will be carried out over the next year.

CIV conference: 3-minutes thesis abstract

Paolo Della Moglie

November 2026

The long way around: sailing more, burning less.

International shipping accounts for approximately 3% of global greenhouse gas emissions. Limited policy robustness, high development costs and scalability challenges associated with low-carbon technologies have constrained the sector's decarbonisation progress. Consequently, current emissions trajectories suggest that international shipping is at risk of missing its 2030 emissions reduction targets. Against this background, short-term low-carbon measures are gaining momentum. These measures aim to deliver immediate emissions reductions through solutions that are (i) readily scalable, (ii) widely deployable and (iii) cost-effective.

Among these, arrival optimisation represents a potentially high-impact and scalable solution for maritime decarbonisation. It seeks to challenge the conventional *Sail Fast Then Wait* behaviour, whereby vessels race towards their destinations to secure higher priority in berthing queues, only to experience prolonged waiting times due to port congestion. This behaviour is environmentally suboptimal, as additional fuel is consumed both during high-speed sailing and while maintaining onboard operations at anchorage. Arrival optimisation addresses this inefficiency by synchronising vessel arrivals with port availability, encouraging vessels to reduce their en-route speed.

This research investigates whether the fuel-saving potential of arrival optimisation can be further enhanced through its integration with ship weather routing. By reducing sailing speeds, arrival optimisation increases vessels' time at sea, potentially creating opportunities to exploit more favourable environmental conditions along their routes. We assess the combined benefits of these two operational measures through a global analysis of more than 1,200 voyages. Results demonstrate that arrival optimisation and weather routing are compatible and that their integration can increase fuel savings by at least a factor of two compared with arrival optimisation alone. These findings highlight the potential of combining operational measures to accelerate shipping decarbonisation through readily deployable, scalable and cost-effective solutions.

Sustaining Disaster Waste Management Systems Operations under Prolonged Disruption: A Systematic Review

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Keywords: Resilience, Disruption, Waste management, Disasters, Armed conflict, Debris

Armed conflict generates large volumes of disaster waste that overwhelms the waste management system capacities to manage it. As of September 2025, the war in Ukraine has generated about 17.2 million tonnes of debris from damaged and destroyed buildings, with 11.7 million tonnes that still need to be removed, sorted and treated (UNDP, 2026). While existing literature often focuses on addressing mitigation actions, risk assessments and post-disaster recovery strategies for natural and human induced disasters, limited attention has been given to maintaining system functionality during armed conflict where prolonged operational disruptions challenge the assumption of a recovery period. As a result, the conventional disaster waste management system prepares and plan for disruptions that are followed by an assumed recovery period, and prolonged conflict removes the certainty of a recovery window. This study investigates the resilience of disaster waste management systems across disaster types, with armed conflict as the focal case. It focuses on the absorptive, adaptive and transformative mechanisms that help these systems to maintain functional continuity. This study is a systematic literature review using the PRISMA guidelines. The relevant studies were identified from two academic databases, Web of Science and Scopus from 2015 to 2026. Of the 111 studies included, 42 have been analysed using systems thinking, the Iceberg model (Maani & Cavana, 2007) and 3D Resilience framework (Béné et al., 2012). Preliminary findings identifies visible recurring patterns including difficulties segregating waste that is linked to underlying structure barriers such as lack of disaster waste guidelines, influenced by mental models treating disaster waste similar to construction and demolition waste. Across the 42 reviewed literature, 139 resilience mechanisms were identified. Of these mechanisms, 38 strategies were proposed or implemented post disaster across 6 reviewed armed conflict literature, all addressing waste management recovery following a disaster with none examining maintaining essential waste management system functions during prolonged continuous armed conflict disruptions. None of these studies address persistent disruptions, only one addresses power outages, two addresses restricted access, and two addresses limited funding. The findings provide the basis for a conceptual resilience framework to support functional continuity at each level of the waste management system under prolonged disruption and resource depletion, with armed conflict as the focal case.

References

[1] Béné, C., Wood, R. G., Newsham, A., & Davies, M. (2012). Resilience: New Utopia or New Tyranny? Reflection about the Potentials and Limits of the Concept of Resilience in Relation to Vulnerability Reduction Programmes. *IDS Working Papers*, *2012*(405), 1–61. https://doi.org/10.1111/j.2040-0209.2012.00405.x

[2] Maani, Kambiz., & Cavana, R. Y. . (2007). *Systems thinking, system dynamics : managing change and complexity*. Pearson Education New Zealand.

[3] UNDP. (2026). *Ukraine could recover up to 8.2 million tonnes of secondary raw materials from war-generated debris, UNDP study reveals*.

Cutting office carbon without shifting the burden

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Abstract

Offices need heating, cooling and ventilation every day. These systems use electricity and need new equipment, such as chillers, several times over a building's life. Studies of these systems often count carbon only. I asked what happens to other environmental impacts, such as toxic effects in rivers and seas and the use of scarce minerals.

I linked a computer model of energy use in a Manchester office with life cycle assessment, a method that tracks a product's impacts from raw materials to disposal. I calculated 18 types of impact and tested three changes: solar electricity, longer-lasting equipment and different window glass.

In an extreme case where all electricity came from solar farms, the carbon footprint fell by more than half, but toxic effects in water and mineral use rose slightly. Longer-lasting equipment cut mineral use by more than twice as much as carbon, mainly because the chillers needed replacing less often. Adding the other two changes to that extreme solar case cut carbon by two-thirds and lowered all 18 impacts.

For owners of similar air-conditioned offices, the results suggest pairing solar electricity with longer-lasting equipment, so that lower carbon does not come with higher impacts elsewhere.

Evidencing Energy Justice Beyond ESG Reporting: Jackdaw Field Development

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The energy transition is reshaping the legal and regulatory regimes through which energy projects are consented, disclosed, and held to account. This abstract examines whether sustainability disclosure regimes including ISSB's IFRS S1 [1] and S2 [2], the EU's CSRD [3] and ESRS [4], together with environmental impact assessment (EIA), produce the record needed to evidence energy justice claims. Its central thesis is that compliance with these regimes does not, by itself, establish that such claims are adequately evidenced [5].

The work builds on the Energy Justice Milestone Reports (EJMR) proposal [6] by specifying the evidence needed to validate the claims those reports contain. Its contribution is to connect distributive, procedural, recognition, restorative and cosmopolitan justice [7, 8, 9] to identifiable evidence requirements and examine whether existing reporting processes meet them. It assesses if materiality assessments can filter justice concerns before reports are prepared, while disclosures of impacts and engagement do not necessarily establish who bears burdens, whose participation influences decisions, or who is responsible for remedy.

The purpose is to clarify the evidentiary conditions under which energy justice, the evidence a justice claim would need to be documented, traced and reviewed within existing governance and reporting processes. The method combines a conceptual structured narrative review of the energy justice, ESG and materiality literatures with analysis of reporting standards and regulatory documents. Evaluative questions and evidence requirements are

derived for each justice dimension and mapped against the environmental, social and governance pillars of ESG. These requirements are then used to examine the public legal record of the Jackdaw Field Development from 2021 to 2026, including its judicial review [10].

Jackdaw provides an illustrative record of evidence produced by existing consent and disclosure processes. The paper does not apply an EJMR toolkit, produce milestone reports or assess whether the project is just. The case illustrates gaps between documented impacts and the evidence required to establish distribution, influence, recognition, remedial responsibility and cross-border obligations. By distinguishing reporting compliance from the substantiation of justice claims, the paper contributes to debates on legal accountability in the energy transition and identifies evidence requirements that could inform future EJMR development and empirical testing.

Basic References

[1] International Sustainability Standards Board (ISSB). IFRS S1 General Requirements for Disclosure of Sustainability-related Financial Information. IFRS Foundation, 2023. https://www.ifrs.org/issued-standards/ifrs-sustainability-standards-navigator/ifrs-s1-general-requirements/

[2] International Sustainability Standards Board (ISSB). IFRS S2 Climate-related Disclosures. IFRS Foundation, 2023. https://www.ifrs.org/issued-standards/ifrs-sustainability-standards-navigator/ifrs-s2-climate-related-disclosures/

[3] European Parliament and Council of the European Union. Directive (EU) 2022/2464 of 14 December 2022 as regards corporate sustainability reporting. Official Journal of the European Union, L 322, 16 December 2022, pp. 15–80. https://eur-lex.europa.eu/eli/dir/2022/2464/oj/eng

[4] European Commission. Commission Delegated Regulation (EU) 2023/2772 of 31 July 2023 as regards sustainability reporting standards (ESRS), Annexes I and II. Official Journal of the European Union, 22 December 2023. https://eur-lex.europa.eu/eli/reg_del/2023/2772/oj/eng

[5] A. M. Foley, R. J. Heffron, D. Al Kez, D. D. Furszyfer Del Rio, C. McInerney, and A. Welfle, “Restoring trust in ESG investing through the adoption of just transition ethics,” *Renewable and Sustainable Energy Reviews*, vol. 199, Art. no. 114557, 2024, doi: 10.1016/j.rser.2024.114557.

[6] R. J. Heffron, A. Foley, and D. D. Furszyfer Del Rio, “The role of justice is set to shift accountability and responsibility in the energy sector,” *Nature Energy*, 9(8): p. 910-912, 2024, doi: 10.1016/j.rser.2024.114557.

[7] B. K. Sovacool, M. Burke, L. Baker, C. K. Kotikalapudi, and H. Wlokas, “New frontiers and conceptual frameworks for energy justice,” Energy Policy, vol. 105, p. 677-691, 2017, doi: 10.1016/j.enpol.2017.03.005.

[8] K. Jenkins, D. McCauley, R. Heffron, H. Stephan, and R. Rehner, “Energy justive, A conceptual review,” *Energy Research & Social Science*, vol. 11: p. 174-182, 2016, doi: 10.1016/j.erss.2015.10.004.

[9] R. J. Heffron and M. M. Sokołowski, “Resolving energy policy failure: Introducing energy justice as the solution to achieve a just transition,” *Energy Policy*, vol. 187, Art. no. 114042, 2024, doi: 10.1016/j.enpol.2024.114042.

[10] *Greenpeace Ltd. and Uplift v. Secretary of State for Energy Security and Net Zero*, [2025] CSOH 10, Court of Session (Outer House), 2025.

Coordinating irrigation water conservation and river regulation enables financial, energy and environmental gains in Central Asia

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Abstract

Global irrigation expansion and modernization may require up to US$70 billion in annual public investment through 2050. In emerging market and developing economies, high public debt, about 70% of GDP in 2024, constrains public investment. Planning irrigation-efficiency upgrades independently of river regulation may overestimate the capital needed to satisfy irrigation demands. In transboundary basins, limited information sharing and competing national interests can further fragment the planning on irrigation investment and reservoir releases. Here we find that synergies between irrigation water conservation and transboundary river regulation can reduce capital requirements and help reconcile competing water demands. Synergistic planning selects irrigation investment portfolios at basin-scale, assessing basin-wide benefits and informing river regulation aimed at multilateral and multisectoral gains. Synergistic planning in Central Asia's Syr Darya basin delivers about five times the 10th-percentile annual additional benefit per dollar of national irrigation-efficiency targets across future climates. Synergistic planning can also increase upstream winter hydropower and dry years' annual flows towards the Northern Aral Sea. These findings can inform irrigation financing and transboundary river negotiations for agreements acceptable to each country.

Shear strength performance of concrete brick and mortar masonry incorporating eggshell powder as cement replacement

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Keywords: Cement, Concrete, Mortar, Eggshell Powder (ESP), Shear strength, masonry

Cement production has a substantial environmental impact, creating a need for alternative materials that reduce cement consumption while maintaining adequate structural performance. This study explores the use of eggshell powder (ESP), a waste product high in calcium carbonate, as a partial cement substitute in concrete masonry. Before examining masonry shear behaviour using triplet tests, the mechanical performance of concrete and mortar made from cement incorporating 15% and 30% ESP was examined. Compressive strength decreased as ESP content increased; 15% ESP offered a better balance between mechanical performance and cement reduction than 30% ESP. The average shear strength of the control specimens in the masonry tests was 0.15 MPa, while that of the ESP modified specimens was 0.08 MPa. Debonding at the brick-mortar interface was the primary cause of failure, suggesting that the bond with the smooth brick surface had a significant impact on shear performance. Overall, 15% ESP demonstrated the most promise as a workable partial cement replacement in masonry products.

Numerical Modelling of Timber at Elevated Temperature

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Keywords: Finite element modelling, fire, Hashin damage, timber, UMAT

Advancements in engineered timber have expanded its use in mid-rise and tall buildings, however, fire performance of timber remains a key design concern. Although elevated temperature tests are proven to provide valuable data, they are costly and the results may vary due to natural variability of timber. Numerical modelling offers a cost-effective alternative to experimental tests, but timber's orthotropic properties and load-dependent failure mechanism complicate accurate prediction. This study presents a finite element modelling approach for timber at ambient and elevated temperature using a user-defined material (UMAT) subroutine implemented in Abaqus software. The aim of the study is to capture failure behaviour of timber under different loading and temperature conditions. The timber material model integrates orthotropic elasticity, 3D Hashin damage initiation criteria, continuum damage mechanics (CDM) for damage evolution and temperature-dependent reduction factors for mechanical properties. Comparison of the model predictions against corresponding ambient and elevated temperature experiments show the model is capable of capturing key behaviour with an acceptable level of accuracy.

Public Participation and Project Portfolio Management: The Case of Bahrain

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Keywords: Public Participation, Project Portfolio Management, Bahrain Case Study

Although public participation (PP) is becoming increasingly important to governments, its relationship with public-sector project portfolio management (PPM) remains underexplored [1, 2]. This research adopts a single embedded case-study design to examine how outputs from three Bahraini PP initiatives (Tawasul, Fikra, and Sharekna) relate to PPM. Published findings indicate substantial participation, including 37,514 Tawasul suggestions, seven Fikra editions generating multiple ideas, and varied public input through Sharekna [3]. However, their influence on PPM decisions requires further investigation. The study will empirically assess and validate the proposed 6ISP conceptual evaluation framework (Figure 1). The research is expected to advance understanding of PP–PPM relationships and offer government organisations a potential tool to evaluate how public input informs portfolio decisions.

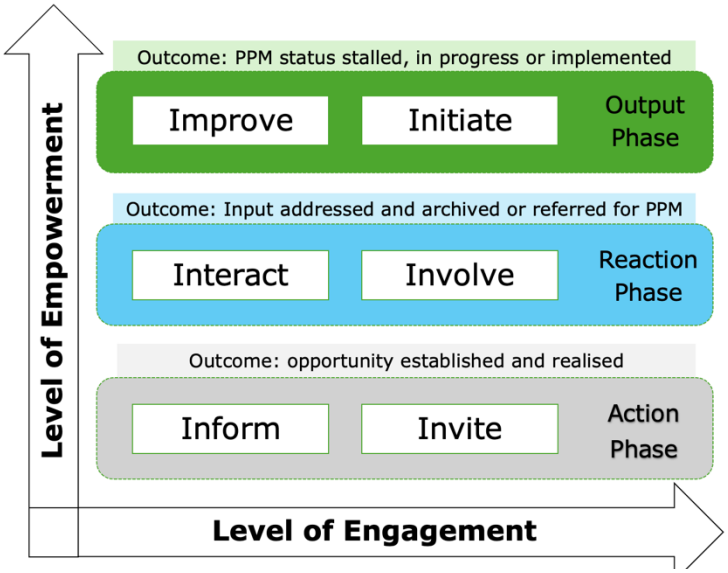

Figure 1: The Six I's of Stakeholder Participation (6ISP) Conceptual Evaluation Framework.

References:

[1] Roberts, P. and Hamilton Edwards, L. (2023) 'Portfolio management: A new direction in public sector strategic management research and practice', Public Administration Review, 83(4), pp. 947–959.

[2] Derakhshan, R., Turner, R. and Mancini, M. (2019) 'Project governance and stakeholders: A literature review', International Journal of Project Management, 37(1), pp. 98–116.

[3] Almansoori, Y., Alkhaja, Z., Alkhaldi, M. and Mohamed, F. (2026) 'Project Portfolio Management in Public Service Provision: The Case of Bahrain Government', Systems, 14(4), 370.

Why Does High Rice Husk Ash Replacement Weaken Cement?

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Keywords: Rice Husk Ash (RHA); High Cement Replacement; Calcium Silicate Hydrate (C-S-H); Microstructural Characterisation; Compressive Strength

There is a strong need for alternative supplementary cementitious material (SCM) options for cement replacement, as the availability of conventional SCMs is becoming increasingly constrained. Rice Husk Ash (RHA), a silica-rich agricultural waste, has strong potential as an additional SCM. Yet replacement is generally limited to around 20% because strength decreases at higher levels. This research investigates why, focusing on calcium silicate hydrate (C-S-H), the main binder. The study compares C-S-H formed from conventional cement hydration, C-S-$H_{(CEM\ I)}$, with secondary C-S-H produced through the pozzolanic reaction between RHA and calcium hydroxide, C-S-$H_{(RHA)}$. The amount and nature of C-S-H are investigated using quantitative X-ray diffraction (QXRD), Fourier transform infrared spectroscopy (FTIR), and scanning electron microscopy with energy dispersive X-ray spectroscopy (SEM-EDS). Results show that the amount of C-S-H formed in the RHA system at 28 days is comparable to that formed in the cement system**.** However, despite producing similar quantities of C-S-H, the RHA system exhibits approximately one-seventh of the compressive strength of the cement system. Further characterisation indicates that C-S-$H_{(RHA)}$ is structurally different, being more silica-rich and predominantly tobermorite-like, while cement derived C-S-H becomes more jennite-rich. These findings suggest that strength loss is governed not only by the amount of C-S-H formed, but also by its structure and microstructural organisation. Current work therefore investigates whether improving silica availability during hydration, enhancing RHA particle dispersion, and introducing nucleation sites can favourably modify the nature and microstructure of C-S-H, ultimately enabling up to 40% cement replacement with RHA while achieving compressive strength comparable to or higher than that of conventional concrete.