LEEDS BECKETT UNIVERSITY
SCHOOL OF BUILT ENVIRONMENT, ENGINEERING AND COMPUTING

INTERNATIONAL SUSTAINABLE ECOLOGICAL ENGINEERING DESIGN FOR SOCIETY (SEEDS)

CONFERENCE 2022 & 2023

ABSTRACTS

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2023

International SEEDS Conference 2023

(Sustainable Ecological Engineering and Design for Society)

University of Suffolk, Ipswich, UK

29th – 31st August 2023

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Decarbonise or Demise

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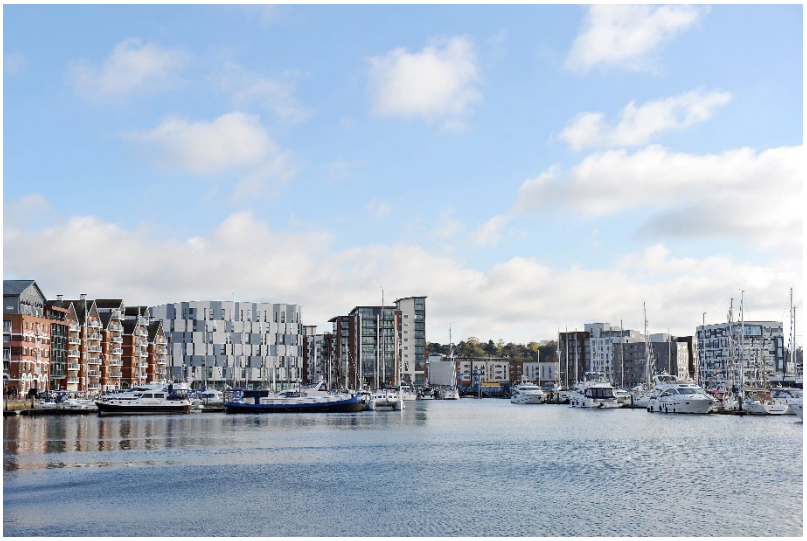
What must we do now to enable transformation towards carbon conscious communities; enabling a resilient carbon neutral future?

Welcome to Suffolk



Located in the heart of East Anglia, Suffolk boasts beautiful coastline, medieval villages, two Areas of Outstanding Natural Beauty and bustling market towns.

Historically known for its agriculture and importance during the wool trade, Suffolk is fast becoming a top tourist destination for people who want to enjoy local food and drink, culture and a range of outdoor activities.

Many people come to explore the natural beauty of Suffolk, much of it captured by two of the country's most famous artists Thomas Gainsborough and John Constable who painted many landscapes including, perhaps, one of the most famous of all, Constable's Haywain.

The county is also home to one of the world's most iconic horse breeds, the Suffolk Punch, an endangered species, and one third of Suffolk's celebrated Trinity of animals – the other two being the Red Poll Cow and the Suffolk Sheep.

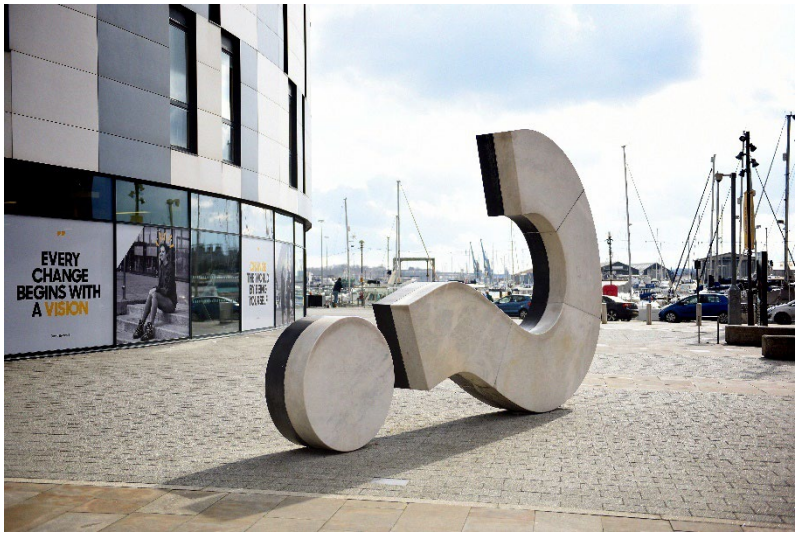
2023 marks the 550th anniversary of the birth of Ipswich's most famous son, Cardinal Wolsey, and the Wolsey 550 project in Ipswich is bringing his story to life through exhibitions and events and looking at how his story is relevant in today's society.

As a county with a rich and varied history, Suffolk also enjoys looking to the future to keep it firmly on the map and is always keen to welcome new businesses and ventures. The region benefits from international links through the Port of Felixstowe which is the UK's largest container port handling 48% of Britain's container trade. There is a burgeoning tech scene in the region which supports small businesses, start-ups and entrepreneurs.

The vibrant Ipswich Waterfront, home to the University of Suffolk's Ipswich campus, is a busy part of town with a mix of bars, restaurants, and cultural attractions for residents and visitors to enjoy.

University of Suffolk

The University of Suffolk believes in transforming individuals, the community, the region and beyond.



One of the newest Universities in the country, it was originally established as University Campus Suffolk in 2007, before being awarded independent University status in 2016. It then became the flagship Ipswich campus on Ipswich's Waterfront quickly becoming one of Suffolk's most recognisable buildings.

The University is proud of the introduction of its pioneering Block and Blend method of teaching, which is now used by the majority of its undergraduate programmes. This innovative way of delivering learning supports students as they complete one module at a time and lectures are recorded, enabling students to revisit content and follow up on learning.

The University is already on an upward trend across a number of table rankings, climbing 20 places in the most recent Complete University Guide League Table and 30 places in the Guardian University Guide. In 2021, the University made its first submission to the Research Excellence Framework (REF), receiving an outstanding outcome indicating world-leading and international research.

Honorary Graduates include international superstar, Ed Sheeran MBE, who lives in Suffolk, comedian Jo Brand and dancer Robin Windsor.

This year, the University was named Green Business of the Year at the 'Creating the Greenest County' awards when judges praised it as "an organisation that has really got to grips with its net zero ambition demonstrating a consistent vision for environmental excellence.

It is also proud to be number one out of nearly 120 universities in the country for showing the biggest decrease in its own carbon emissions.

The University is always looking forward and exploring new and innovative ways to work with partners and offer unique learning environments. In June 2023, the University's state-of-the-art £13million Health and Wellbeing Building was officially opened and features hospital wards, a midwifery unit, radiography and paramedic resources and lecture theatres.

Suffolk Sustainability Institute (SSI), based at the University of Suffolk, is committed to tackling climate change. Its mission is to contribute to, and lead on, quality research, training, and innovation towards effective action on climate change, sustainable use of resources and a healthy environment. SSI research is centred on three key themes that span a range of disciplines:

- Green Infrastructure
- Sustainable Healthy Communities

- Energy and Resource Management

In November 2022, the University of Suffolk, in conjunction with partners, opened the Smart House at its DigiTech Centre on BT's Adastral Park at Martlesham, near Ipswich.

This "living laboratory" house is used by academics and students to gather a range of data about the potential for sustainability and energy reduction in new build houses.

Looking to the future, the University will continue to grow and welcome more students from all over the world.

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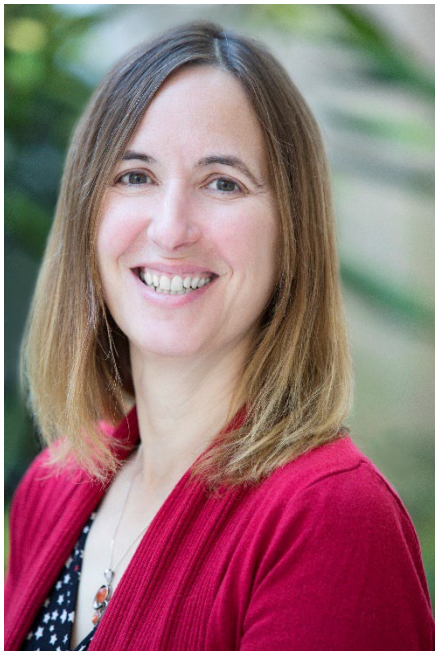
Dr Aboagye-Nimo Emmanuel	Birmingham City University

Keynote Speaker Biographies



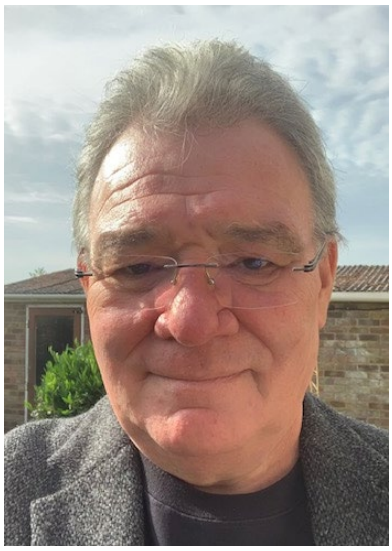
Rosemary Horry is a Senior Lecturer at the University of Derby. She has taught environmental management in higher education settings for about twenty years. A Fellow of the Insitute of Environmental Management and Assessment, she has been Chair of the Midlands Region of IEMA for around 13 years. Recognition of her standing in this field has resulted in her being made an Honorary Fellow of the Environmental Association of Universities and Colleges (EAUC). Her research interests focus chiefly on how businesses can make a positive contribution to the environment, particularly through the use of ISO 14001. Over the last six years she has implemented an Environmental Management System at the University of Derby and has chaired the University's Fairtrade Group, leading them to gain a one-star award and has pushed for Responsible Futures to be adopted on campus. In the last couple of years much of her work focus has been on helping SMEs in the Derbyshire and Nottinghamshire regions to Decarbonise their practices. This work was recognised in the EAUC Green Gown Awards 2022 when the DE-carbonise project was a finalist. She firmly believes that companies can have significant positive impacts in protecting the environment and contributing to society.

Rosemary's keynote talk is entitled: One step beyond, it would be madness not to engage with sustainability.

Grazyna Wiejak-Roy is a Senior Lecturer in Urban Economics and Real Estate in the in the School of Architecture and Environment at the at the University of the West of England, Bristol. Her teaching centres around real estate finance, investment, and strategy. Her research is on investment strategies, transaction risk, the changing nature of the retail real estate market and land management. She carries nearly 20 years of experience in real estate consultancy gained at EY, PwC, and KPMG in the UK, Europe and Australia. She is a Fellow of the Royal Institution of Chartered Surveyors, Chartered Valuation Surveyor, RICS assessor, past member of RICS governing bodies in Poland and Australia, and a Senior Fellow of the Higher Education Academy. She holds MA in Economics, MSc in Property Appraisal and Management and PGCert in Academic Practice. Grazyna is a co-founder of LINK –

Land International Network for Knowledge (https://landinternational.network/) – a platform for research, education, and practice exchange on land management issues. More details on Grazyna's experience and research can be found here: Mrs Grazyna Wiejak-Roy – UWE Bristol and (1) Grazyna (Wiejak) Wiejak-Roy, FRICS | LinkedIn

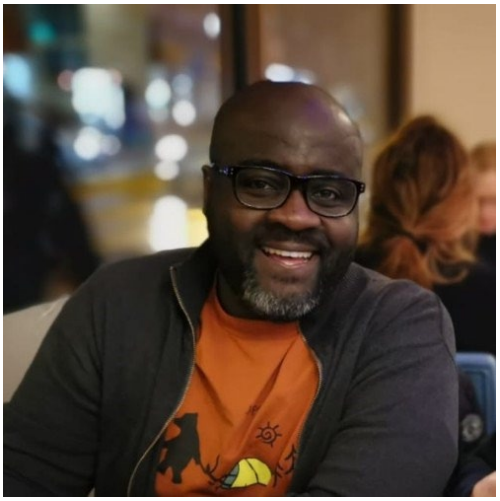
Grazyna's keynote talk is entitled: Allotment gardens in Warsaw, Poland – from fruit and veg to designed huts.



Professor Keith Jones is Professor of Facilities Management at Anglia Ruskin University, UK. His expertise covers a wide range built environment and management issues including: sustainability analyses of existing social, economic and technical systems within the built environment; performance based built asset management; impacts of climate change and earthquake events on the vulnerability, resilience and adaptive capacity of business organisations local communities; and occupant behaviour and carbon reduction in buildings. Professor Jones was previously Head of School of Engineering and the Built Environment and a member of both the REF2014 and REF2021 panels for Architecture, Built Environment and Planning. Prof Jones is currently a member of the EPSRC Peer Review College and the UKRI Future Leaders Fellowship programme, and of the ISO committee developing a new set of Facilities Management standards.

Professor Jones has published over 250 academic papers and for the past 6 years has been involved in 3 very large EU funded projects examining the role that construction and facilities managers can play in improving the resilience of the built environment to climate and geophysical related hazards.

Keith's keynote talk is entitled: Improving the resilience of the existing built environment to disaster events.



Dr Emmanuel Aboagye-Nimo is a Senior Lecturer in the Built Environment Department of Birmingham City University. He is a member of the Centre for Future Homes in Birmingham City University and an affiliate member of University of Brighton's Centre for Earth Observations Science. He has led multiple research projects and also led stakeholder engagement activities on numerous multi-disciplinary projects in the areas of sustainability, air quality and health & wellbeing. His research explores social aspects of Built Environment settings and organisations. His research often challenges 'broad-brush' depiction of practices in the construction sector as his philosophical position asserts that subtle nuances are

often overlooked. He has delivered research outputs of national and international significance. He has also worked on national policy documents in sustainable principles and wellbeing. His contribution to sustainability in the construction sector has seen him win four national and international awards.

Emmanuel's keynote talk is entitled: The complexity of sustainability in construction: Who knows what?

Dr Abdul-Majeed Mahamadu is an Associate Professor of Innovative and Industrialised Construction at the University College London (UCL) at the Bartlett School of Sustainable Construction, where he is also programme director for the MSci Construction Project Management. He is also a consultant in cost intelligence and digitalisation and a chartered construction manager with The Chartered Institute of Building (MCIOB). His research interests are broadly in the areas of Building Information Modelling (BIM), immersive technologies, cost intelligence, industrialised construction, and health and safety. He has led and participated in research and consultancy projects worldwide. He led an international partnership of institutions (from Spain, Germany and Poland) on the Safecrobot Erasmus+ project funded by EU Commission to explore the use of immersive Virtual Reality (VR) for improving robotics and automation safety training for construction. He has over 90 publications including papers in leading built environment and engineering journals with several well-cited articles in the areas of Building Information Modelling (BIM), construction health and safety and the application of immersive VR technology in construction. His projects, particularly on VR have won awards for innovative application of technology at the International Conference for Sustainable Ecological Engineering Design for Society, 2019 and 2020. He has construction industry experience as a project manager, quantity survey and digitalisation consultant.

Abdul's keynote talk is entitled: Immersive technologies and their application in the construction sector: a review of usefulness, opportunities, and challenges.

Justine Oakes has been an environmental professional for over 30 years; starting her career as a fast track graduate within the Ministry of Defence and later running her own environmental consultancy assisting blue chip companies, SME's and public sector organisations. Justine is currently the Head of Sustainability and Programmes at the University of Suffolk. AHer current focus is upon the strategic development and leadership delivery of a decarbonised estate by 2030, enhancing biodiversity and student and staff experience across the estate and collaborating with supply and service level partners to embed circular and responsible procurement. Justine places an emphasis on external partnerships, research collaboration and community engagement; with our regional business and public sector stakeholders playing an important role in helping shape change across Suffolk. With an undergraduate degree in Environmental Analysis and a Post Graduate in Environmental Management for Business; she also is a Chartered Environmentalist and full member of both the Institute of Environmental Management and Assessment and the Institute of Environmental Sciences.

Justine's keynote talk is entitled: Transforming our Estates: Transition to a Net Zero Future

Keynote Speaker Abstracts 2023

One step beyond: it would be Madness not to engage with sustainability

Rosemary Horry[1]

[1] School of Built and Natural Environmental, University of Derby

Keywords: Environmental Management System, Mixed Methods, AEC Sector

Abstract

Sustainability is a word linked to environmental challenges that came to the fore in the Brundtland Report in 1987. At that time these challenges were seen as being the responsibility of governments. As time has progressed it has become clear that governments alone cannot solve the problems, they need the support of the public and fundamentally businesses. The work here suggests that an Environmental Management System (ISO 14001) implemented in a business can help not only to reduce negative impacts on the environment but also enable the company to engage with sustainability. My research has taken a mixed methods approach of using interviews and questionnaires as data collection instruments. Exploring the benefits and barriers of using ISO 14001 with professionals in the AEC sectors has enabled some interesting and unique findings to be exposed. The results have shown a polarising of use as to whether companies utilise ISO 14001 purely for environmental management purposes or whether they have chosen to include sustainability objectives within their system. The benefit of including sustainability is that work is not duplicated, the disadvantage appears to be focused on the concern as to whether they will achieve the more subjective aims. There also appears to be a gap in relation to the fact that many AEC companies are not including the construction sites within their EMS scope which could result in impacts not being mitigated effectively. If businesses do not push the boundaries and go one step beyond very little change will occur. They need to be taking small but determined steps to improve their sustainability and challenging their auditors. Not completing an objective is not always failure but progress in a complex journey.

Allotment gardens in Warsaw, Poland – form fruit and veg to designed huts

Grazyna Wiejak-Roy[1], Rafał Mazur[2]

[1] School of Architecture and Environment, University of the West of England, Bristol, Frenchay Campus, Coldharbour Lane, Bristol, BS16 1QY, United Kingdom

[2] Faculty of Architecture, Warsaw University of Technology, ul. Koszykowa 55, Warsaw, 00-659, Poland

Keywords: allotment garden, family garden, Poland, Warsaw, grey market, design, hut.

Abstract

Allotment gardens are a well-established phenomenon in Central and Eastern Europe. Their users, predominantly in towns, through cultivation of land and care for the green space, create green oases in now busy urban areas. As such these locations now are of growing relevance as they generate positive externalities such the effectively private management of public green space. Over the last few years, especially during and post the Covid lockdown, popularity of allotment gardens has increased as an alternative to travel and a safe place to be in. In this research we considered legal, political, social and environmental perspectives to understand recent use changes. This allowed us to focus on two underexplored domains - economic and technological. We explored them using Warsaw as the largest and most dynamic allotment garden market in Poland. From the economic perspective, we explored the allotment garden trading market to conclude with a rich picture of its peculiarities and highlighted its weaknesses. Understanding the changing market dynamics informed our analysis of modern allotment garden designs including new architectural styles applied in development of something completely new - namely "designer huts". We expect that our observations will inform policy makers and local authorities in developing long-term strategies to effectively support urban green spaces.

Improving the resilience of the existing built environment to disaster events

Keith Jones [1]

[1] Anglia Ruskin University, School of Engineering and the Built Environment, Chelmsford, CM1 1SQ

Keywords: community resilience, decision support system, systemic risk, built asset management plans.

Abstract

Improving the resilience of local communities to disaster events is a key challenge identified by the UN Sendai Framework and Sustainable Development Goals. How communities prepare for, respond to, and recover from the impacts of a disaster event depends on their vulnerability and resilience to the disaster event, which in turn depends upon the inherent resilience of the social, natural, and built environment systems on which they rely. This presentation will explore the interrelationships between these systems to identify the challenges faced by built environment professionals, and the wider research community, when they seek to develop interventions to improve the resilience of the existing built environment to disaster events. The presentation will argue the need for built environment professionals and researchers to consider the systemic nature of disaster risks using results from current and previous research projects on the impact of disaster events on community resilience to demonstrate how disaster risk can be framed and integrated into built asset management plans. The presentation will describe a resilience assessment and improvement framework that can be used by built environment professionals as part of a decision support system to guide building owners and users through the identification of adaptation and mitigation interventions that they can programme into their disaster management and business continuity plans.

The complexity of sustainability in construction: Who knows what?

Emmanuel Aboagye-Nimo[1]

[1] Faculty of Computing, Engineering and the Built Environment, Birmingham City University, Millennium Point, Birmingham, West Midlands, B4 7XG, UK

Keywords: Competence, Complexity, Knowledge mapping, Sustainable principles.

Abstract

Over the years, the adoption of sustainable principles has undoubtedly been accepted as the way forward. Most large construction projects implement some form of sustainable measures, be it during the design phase, construction phase or during the handover and use phases. As complex as the sector is, many stakeholders strive to play their part in ensuring such principles are implemented successfully. Design teams and construction teams often set key performance indicators to include some form of sustainable aspects. However, the challenge still remains, who knows what and just how much do they know? From the engagement with policymakers and professional bodies such as CIOB, RICS, ICE etc., it is evident that sustainable measures are embedded in training and best practice guideline documents. However, there is still room for improvement when it comes to knowledge in sustainable construction. Specialist consultants work extensively with many project teams to set pragmatic targets. This practice is however, considered a luxury for relatively smaller projects. On the professional side, some practitioners in project teams acknowledge their own limitations when it comes to expert knowledge in sustainability. From the client and end-user perspectives, there is very limited knowledge regarding sustainability. For example, some industry practitioners leading projects try to attend as many CPD events but still lack the confidence in the subject matter. On the hand, end-users struggle to adapt to making use of innovative sustainable features in their new homes e.g., heat pumps etc. Additionally, some end-users acknowledge the need for behaviour change for them to gain optimum benefits of such features but struggle to do so. A debate on benchmarking sustainable knowledge must be initiated to help advance the targets that have been set including the incoming Future Homes Standard set to be introduced in 2025.

Immersive technologies and their application in the construction sector: a review of usefulness, opportunities, and challenges

Abdul-Majeed Mahamadu[1]

[1] The Bartlett School of Sustainable Construction, University College London (UCL), 1-19 Torrington Place, London, United Kingdom

Keywords: Virtual Reality, Augmented Reality, Mixed Reality, Digitalisation, Transformation and Construction.

Abstract

Virtual and Immersive technologies are becoming commonplace in the Architecture, Engineering and Construction sectors, as a result of proliferation of low-cost immersive devices and increasing use of digital design and construction workflows. Immersive technologies include, Virtual, Augmented, Mixed and Extended Reality technologies. These technologies create experiences through the development, simulation and integration of virtual and physical environments. This keynote seeks to review the maturity and state of application of these technologies in the construction sector through a review of research projects and case studies that have been developed and tested in various construction scenarios. The application areas include design collaboration, stakeholder engagement and safety training. The technologies applied include distributed Virtual Reality for remote virtual communication as well as integration of artificial intelligence techniques into VR for enhancing immersive experiences. Based on these practical case studies, the keynote will outline implementation, utility and applicability challenges for construction as well as outline some opportunities for mainstreaming immersive technologies in the construction sector.

Transforming our Estates: Transition to a Net Zero Future

Justine Oakes[1]

[1] Estates Directorate, University of Suffolk, Waterfront Building, 19 Neptune Quay, Ipswich IP4 1QJ

Abstract

Over a span of seven years the University of Suffolk has undertaken a rigorous decarbonisation initiative across its estate, seeking to address sustainability concerns within the built environment. This presentation outlines the strategic process employed, whilst also integrating key insights into retrofit implementation activities associated with our most recent Carbon Plans as we work towards delivering Net Zero.

Aligned with the UN Sustainable Development Goals, the University is committed to achieving carbon neutrality for scope 1 and 2 emissions by 2030, with a broader net-zero ambition encompassing scope 3 emissions by 2050. Concurrently, we aim to limit landfill waste to 5% by 2030 and enhance nature-positive outcomes to 30% by the same year. These ambitions do not sit in isolation from each-other and much attention has been given to ensuring retrofit activities encompass all our objectives, acting as a valuable tool for leveraging funding for design outputs that will benefit scope 3's.

Our estate encapsulates a historical mix of architecture, spanning from 1887. As with most University Estates, low-rise, mid-rise, and 1960s and 1970s buildings coexist, housing a variety of installations including chiller plants, air handling units, boilers, and photovoltaic arrays. Having recently been revealed by HESA as the sectors leading UK University for carbon reduction of scope 1 and 2 since 2016, this case studies showcases the journey to date focusing on how we got here ahead of the significant journey still to come.

Table of Contents

Building and Environmental Design

#316 - Evaluating the Impact of Innovative Technologies on The Delivery and Affordability of South African

Jeffrey Jr. Mahachi[1], Alireza Moghayedi[2], Kathy Michell[3], Jeffrey Mahachi[4]

[1] School of Engineering and Built Environment, University of Cape Town, Cape Town, South Africa

Keywords: Innovative Technologies, Low-Income Housing, Delivery and affordability, Social Acceptance

Abstract

The study evaluated the impact of innovative technologies on the delivery and affordability of low-income housing in South Africa. Various technologies, including UAVs, BIM, GIS, 3D Printing, VR, AR, AI, Smart Sensors, and Modular/Prefabrication, were explored. A mixed-method approach was used, collecting qualitative data through expert interviews and quantitative data from 100 surveys. Thematic analysis and descriptive/inferential statistics were employed for data analysis. Results showed that these technologies can accelerate housing delivery and improve cost-efficiency. Specific technologies such as 3D printing, modular/prefabrication, BIM, GIS, VR, OOP, and PPM were identified as beneficial for housing planning, design, and construction. Challenges such as high costs and limited social acceptance were also identified. The study emphasized government support through financial incentives and investment in research and development. Promoting the use of these technologies in both affordable and high-end housing projects was deemed important. Overall, the study highlights the significance of innovative technologies in addressing the affordable housing crisis in South Africa and calls for government intervention to overcome challenges and ensure affordable housing for all.

#340 – Implication of AI for integrated decision making in housing energy efficiency from outside: A conceptual platform.

Javad Asadpoor[1], David Thorpe[2], Haywantee Rumi Ramkissoon[3], Yong Wah Goh[4]

[1] Department of Architecture, Mashhad Branch, Islamic Azad University, Mashhad, Iran

[2]School of Surveying and Built Environment, University of Southern Queensland, Springfield, Australia

[3]Professor, Executive Co-Director, Centre for Enterprise Dynamics in Global Economies (C-EDGE), University of South Australia, Adelaide, Australia.

[4]School of Psychology and Wellbeing, University of Southern Queensland, Ipswich, Australia

Keywords: Energy Efficiency; Occupants' Perception and Attitude; Artificial Intelligence

Abstract

Over the past several years, efforts have been made to use artificial intelligence (AI) in explaining what people are thinking, thus facilitating their decision-making. In a housing context, AI is employed to identify the housing heat loss from the external environment. Recent studies stress the lack of attention on exploring the interplay between the different aspects of housing energy efficiency. Occupants' perceptions and attitudes are also identified as another gap in achieving the housing energy efficiency target baseline. Although there are many online databases which provide proper information in relation to housing energy efficiency, they are not able to explain the interplay between different aspects of this concept, and to link the information to different people's perceptions and attitudes. In the context of the current study, we argue that AI is able to tell which building is suitable for responding to an occupant's perceptions of housing energy efficiency from the outside. This paper develops a conceptual platform for this study, drawing on an extensive review of the literature. The literature was reviewed in two different stages. Firstly, an overall review collated evidence and rationale for supporting the main argument of the study. Then a number of previous studies which adopted different research methodologies were discussed to develop the methodological platform of the study. The conducted reviews show that AI is able to predict the interplay between the different aspects of housing energy efficiency and to explain occupants' perceptions of housing energy efficiency from the outside, via developing a smart online photo-based database through a combination of secondary data related to different aspects of housing energy efficiency and primary data related to occupants' perceptions of housing energy efficiency. This database is applicable in evaluating the energy efficiency of a house in relation to occupants' needs, expectations, and preferences, and in providing a balanced interplay between the different aspects of housing energy efficiency.

#351 – *Is timber the answer?* Can the use of Cross-Laminated Timber in the multi-storey residential development contribute to meeting the key sustainability targets set in Construction 2025?

John Weirs [1] and Robert Tant[2]

[1] Faculty of Engineering & Environment, Department of Architectural and Built Environment. Ellison Terrace, Newcastle upon Tyne, NE1 8ST

[2] Mace Group Ltd. 155 Moorgate, London, EC2M 6XB

Keywords: Cross-Laminated Timber, Construction 2025, Sustainability, Eliminating Waste

Abstract

Global construction is forecast to grow by over 70% by 2025. To put the UK at the forefront of global construction, the industry and government created a joint strategy, 'Construction 2025', outlining targets based around cost, delivery, a reduction in imports and reduction in emissions. It is the emissions target on which this paper focuses. Latham, Egan, Wolstenholme and Farmer all criticised the industry's lack of collaboration with little improvement being made from these reports. If 'Construction 2025' emission targets are to be met, radical changes must be made. Timber, as a construction material, has progressed significantly over the last 15years, particularly with the development of Cross-Laminated Timber (CLT). Consequently, significant growth in its popularity in the multi-storey residential market has resulted. This study aims to establish if adopting CLT as the main structural element could be the multi-storey residential development sectors' solution to contribute to the reduction in emissions as set out in the Construction 2025. A quantitative research methodology was adopted to gather data from industry professionals, exploring their views in relation to CLT's sustainability credentials. The findings illustrate that a reduction in emissions was the highest priority among construction professionals. It also found that the adoption of CLT in the multi-storey residential sector can contribute to the sustainability targets set out in Construction 2025 as well as across the whole life cycle of the building.

#379 - A review of BIM guidelines and frameworks in the Construction Industry

Oluwaseun Enoch Akindele[1], Saheed Ajayi[2]

[1]Research Assistant in Construction Informatics, School of Built Environment, Engineering, and Computing, Leeds Beckett University, LS13HE, United Kingdom

[2]Reader in Digital Construction and Project Management, Leeds Beckett University, School of the Built Environment and Engineering, Leeds, Leeds Beckett University, LS13HE, United Kingdom

Keywords: BIM, Framework, Guideline, Government.

Abstract

Building Information Modelling (BIM) has the potential to significantly improve the efficiency and productivity in the architecture, engineering, and construction (AEC) industry. Thus, many government authorities, cooperate institutions and organisations worldwide have implemented various frameworks and guidelines to promote the adoption of BIM. This study investigates and reviews extant government-approved BIM guidelines and frameworks to highlight the documents ' strengths, weaknesses, and disparities. A comprehensive literature review was conducted on 17 government-approved BIM guidelines and framework documents published across the United States, Europe, Asia, and Australia. The study reveals a global detailed and comprehensive roadmap schema to the guidance and requirement for BIM practice. The result recognised the absence of BIM training and education component and performance success measurement principles as the key vulnerability in the current government initiative BIM guidelines and framework documents. While the disparities are focused on the region of adoption, Level of detail classification and the purpose of BIM usage. The implication of this hinders the effective implementation of BIM in the construction industry, leading to increased cost, reduced quality, and limited adoption of the technology across the construction ecosystem.

#389 – A novel framework for carbon-neutral building design based on the integration of blockchain, building information modelling, and life cycle assessment

Xiaojun Luo[1]

[1]Department of Accounting and Finance, College of Business and Law, University of the West of England, Bristol, United Kingdom

Keywords: Blockchain; Life cycle optimisation; Building information modelling; Net-zero.

Abstract

Lack of data security and interoperability remains the major obstacles to complex carbon-neutral building design processes among large number of architects and engineers. Blockchain is a distributed ledger and allows information transactions to be managed in a decentralised and secure way. Building information modelling (BIM) can centralise all data and information in the same three-dimensional model. Life cycle optimisation can minimise embodied and operating carbon emissions during the building's whole life span. In this context, a novel framework for carbon-neutral building design is developed and designed based on the integration of blockchain, building information modelling, and life cycle optimisation. Blockchain is adopted to keep a record of any changes in architecture design, energy system design, and carbon footprint. BIM model is used to present the latest architecture design in a three-dimensional model, along with the latest information regarding energy system design and carbon footprint. Life cycle assessment is conducted to evaluate the trade-off between embodied carbon and operating carbon emissions and select appropriate parameters for architecture and energy system design. Information regarding future weather and material properties is also provided in the database. The proposed framework is tested on a real project setting to design a low-carbon industrial building. It is expected that the proposed framework can assist in designing different types of carbon-neutral buildings and achieving the Net-Zero ambition. It will provide practitioners and researchers with constructive information for the integrated use of blockchain, BIM, and life cycle assessment while creating awareness in the architecture, engineering, and construction industries.

#411 - A BIM-based Life Cycle Assessment of Façade Cladding Materials: A Typical Office Building in Ankara

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Keywords: Building Information Modelling, Life-Cycle Assessment, Global Warming Potential, early design stage, environmental assessment

Abstract

Building Information Modelling (BIM) based digital tools streamline the environmental performance assessments of buildings during the early design phase. This study investigates the potential of BIM-LCA integration through the whole life cycle assessment of a hypothetical office building in Ankara. Three alternative building models with different façade cladding materials are modeled in Revit Architecture. The operational energy use of the alternative models is estimated with Autodesk Insight and Green Building Studio (GBS). Nevertheless, the thermal performance of building components is calculated separately considering their thermal transmittance (U-value) since there is no sensitivity in these simulation tools regarding the thermal performance of different façade systems. After determining the operational energy use of the alternative models, their global warming potential (GWP) is measured with OneClick LCA. According to the results, the alternative model with the wooden façade cladding yields the minimum greenhouse gas emissions despite being transported from abroad, and the ceramic and aluminum cladding follows it. After identifying the optimum alternative in terms of GWP, shading elements are installed on the façade. Although increased material use due to the shading elements leads to higher GWP, the overall performance of the building dramatically improves since less energy is required for heating and cooling. The results showed that using energy simulation tools can significantly improve energy performance and reduce the GWP of buildings in the early-stage design.

#420 – The impact of roof design on embodied carbon and BIPV energy of a primary school building - An LCA-based study on the embodied carbon and PV generated energy of seven roof designs on a two-form entry primary school in Leeds, UK

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Keywords: Life Cycle Assessment, Solar PVs, embodied carbon, renewable energy.

Abstract

Purpose *– Life Cycle Assessment (LCA) is a method of quantifying the environmental performance of materials and products. It is also applied to whole buildings with the aim to reduce their carbon footprint. The purpose of this paper is to undertake the LCA of a building with varying roof designs, all with Building Integrated Photovoltaic Panels (BIPVs) to determine their impact on embodied emissions. The reason for this is to tailor up-front building design to create low carbon, and eventually zero carbon buildings as we strive for net zero carbon.*

Design/Methodology/Approach *– The study has two main parts: a) to calculate the solar energy generated by BIPVs on each roof design, b) to carry out LCA Cradle to Practical Completion (A1-A5) stages of the building options based on a 100-year life span.*

Findings *– The two storey buildings produce significantly less carbon than single storey buildings of the same gross internal area. All roof designs assessed mitigate enough carbon from BIPV generated energy to offset the embodied carbon within a year based on current UK electricity grid values. Upfront embodied carbon emitted during construction will generate a larger share of the whole life carbon of building as the electricity grid decarbonises, justifying the requirement to design for net zero carbon.*

Originality/Value *– The findings of this study further develop the construction industry's knowledge of LCA and progress the transition to Net Zero Carbon. They can also support policy development to meet the government's 2050 Net Zero target.*

#423 - An Investigation into whether Natural Insulation can Replace Synthetic Insulation, helping to reduce the Construction Industry's Environmental Impact on the Planet.

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Keywords: Sustainable construction, Hard to Treat Properties, Optimizing Thermal Efficiency, Natural Insulation Options

Abstract

This research aims to demonstrate that natural insulation materials can achieve equal or better thermal efficiency than synthetic insulation, evidencing a viable alternative that has a significantly lower impact on the environment. The testing will compare sheep wool, hemp wool and wood fibre natural insulation materials against synthetic insulation materials mineral wool and PIR foam insulation under a range of different circumstances, such as dry conditions, tap water saturating and varying concentrations of saline solution saturating, replicating a coastal location. Such testing will be undertaken within laboratory conditions and will be recording variances within thermal conductivity and thermal resistance.

The data will be used to identify whether there are certain natural insulation materials that resist tap water and saline solution saturating, which can be used to prevent decreases in thermal performance of the insulation within specific environments such as nearby to the coast where there is higher salt within the moisture in the air.

An experiment within a period solid monolithic stone constructions in a coastal town in Cornwall is currently in progress. This is investigating whether the orientation of the building and seasonal variations have an adverse effect on the main wall U-Value, aiming to evidence that a more dynamic approach to Building Regulation Standards may be more beneficial to prevent the risk of the 'greenhouse effect' or black spot mould and dampness occurring, thus increasing the thermal efficiency and internal air quality of a building.

#428- Realisation of Sustainability within the Life Cycle of Construction

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Keywords: Construction, Environment, Life cycle, Sustainability, Projects.

Abstract

The aim of the study was to determine a framework of interventions for the realisation of sustainability within the life cycle of construction. The quantitative method was adopted for the study, which entailed the completion of a self-administered questionnaire by a range of built environment professionals in the employ of parastatals, general contractors, municipalities, and consulting practices.

Findings include: sustainability and environment are ranked fifth and seventh in terms of the importance of seven project parameters; prefabrication promotes health and safety, and sustainability; innovative construction methods reduce waste and promote sustainability; designers lack the competencies to conduct design hazard identification and risk assessment (HIRA); life cycle cost analysis and value engineering promote sustainability to a degree, and it is important to consider and promote sustainability during all six stages of projects.

Conclusions include: cost and quality still predominate in terms of the importance of project parameters; prefabricated structures and components promote sustainability; innovative construction methods produce less waste, are cost effective, and promote sustainability; designers are not empowered to conduct HIRA; life cycle cost analysis and value engineering focus on cost saving as opposed to promoting sustainability, and sustainability should be considered during each stage of projects.

Recommendations include: all project parameters should be afforded equal status during the life cycle of projects; innovative materials and construction methods should be considered; life cycle cost analysis and value engineering should be integrated within the project life cycle assessment; health and safety and sustainability should be embedded in tertiary built environmental programmes, and professional associations and statutory councils should evolve and / or promote environmental continuing professional development (CPD).

Reducing Consumption and Waste

#326 – Exploring Potentials and Barriers of Industry 4.0 Technologies to Facilitate the Transition to Circular Economy in Construction: A Systematic Literature Review

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Keywords: circular economy; construction industry; Industry 4.0; barriers and enablers

Abstract

The UK construction has made a significant progress in recovering non-hazardous construction and demolition waste (CDW). Nevertheless, construction is still responsible for 60% (130MT/year) of all waste produced. There have been claims in the literature that Industry 4.0 technologies have potentials to support the transition to a circular economy (CE); however, these claims have yet to be tested in the construction context. A systematic literature review including 31 hits was conducted to explore potentials of Industry 4.0 technologies, referred to as Construction 4.0, for supporting the transition to CE in construction and identify barriers to their adoption. Findings revealed that the adoption of Construction 4.0 is still associated with technical and managerial barriers and requires the involvement of all stakeholders. The most prominent technical barriers were the lack of standards, fragmented data-sharing platforms and individual technologies' lack of holistic capability for solving CE problems. The costs of purchase, implementation, training, maintenance and operation were prominent among the managerial barriers. Overall, Construction 4.0 solutions were limited to separate situations and did not support circularity throughout the whole construction process. Hence, a framework was developed mapping technologies to different stages in the construction process where they can support circularity. Future research will seek to develop a model to systematically employ Construction 4.0 technologies throughout the construction process to enhance its circularity.

#335 – Circular economy in construction: a systematic literature review of the application of material passports

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Keywords: Circular economy; Material passports; Construction digitalisation; Building Information Modelling; Industry 4.0.

Abstract

The construction sector is one of the most resource-intensive and polluting industries. According to the European Union (EU), the industry accounts for over 50% of virgin resources, contributes to 35% of total waste, and emits over 12% of greenhouse gases. Under these circumstances, there is an urge for the industry to transit from a linear economy model to a circular one, whereby materials and products can be recycled and reused. To support such a paradigm shift in the sector, the EU introduced Material Passports (MPs) in 2016, through which a digitalised database inventory of materials, components, and products to be used in a building can be built. Since then, researchers have attempted to develop different ways to implement and utilise MPs. However, a systematic review of how MPs have been used to facilitate the circular economy in construction is missing. To address this knowledge gap, this paper aims at conducting a systematic literature review to examine the extent to which the MPs have been used in a building life cycle using the preferred reporting items for systematic reviews and meta-analysis (PRISMA) approach. Findings indicate that existing applications have primarily focused on the design and decommissioning phases of the building lifecycle; however, the operational and maintenance phase has been given scarce attention. Findings also point out the digitalised potential of MPs with other Industry 4.0 tools.

#341 – An Evaluation of Retrofit Toolkits for Multistakeholder Application.

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Keywords: Retrofit toolkit evaluation, questionnaire design, social housing.

Abstract

Of the 28 million residential properties within the UK, 19 million are poorly insulated and hence energy inefficient. It is a challenge to improve the energy efficiency of these buildings. Retrofitting measures reduce energy consumption in homes and improve occupant comfort, make homes healthier, and reduce fuel bills. Local authorities across the UK are undertaking thousands of retrofits each year, however, the measurement of the impact of these retrofit activities is haphazard. The retrofit assessments taking place are fragmented, complex to implement, expensive, inconsistent in their approach, and therefore not a comparable, standardised assessment of the retrofit work done. The lessons learned and best practices are not being shared and there remains uncertainty around the benefits that are being delivered to communities. This research aims to understand how to improve retrofit assessments.

To address this problem, the UK Green Building Council (UKGBC) developed a toolkit called the Build Upon 2 Framework. It was meant to evaluate retrofit projects and standardise how to quantify social, environmental and economic benefits of projects. In addition to collecting technical data from energy models such as the Energy Performance Certificate and economic data from contractors, the toolkit uses occupant questionnaire as a central tool to understand the impact of the retrofit from the occupant's perspective.

However, the questionnaire is untested, this research aims to explore its effectiveness and make recommendations on its development and implementation. It analyses the results from a case study retrofit project in the North of England where it was deployed by a local council.

This research may lead to the revision of the UKGBC toolkit which may be adopted by other organisations wishing to undertake standardised evaluations of their retrofit projects and may also be used as a reference toolkit by organisations funding retrofit to ensure their projects include consistent retrofit evaluations.

#360 – Redefining the E-waste Management Framework at the University of Leeds: Challenges and Opportunities for Sustainability

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Keywords: Obsolescence, E-waste Awareness, Inter-Organisational Resource Utilisation, Institutional Responsibility.

Abstract

The rising gap between the amount of e-waste being produced and recycled is one of the major environmental concerns facing the world today. The UK stands second internationally in terms of the e-waste generated per capita. The dependence on electronics has increased, especially in institutions of higher learning, due to the expanding digitalisation of education (e.g., e-learning). Additionally, the sheer volume of research necessitates using cutting-edge electronics, while the frequent hardware/software upgrades result in a high rate of obsolescence. Despite being major e-waste producers, the universities typically lack the capability to ensure that their end-of-life equipment is handled sustainably. Thus, effective e-waste management at the university level is vital for achieving a circular economy. This study aims to critically evaluate the policies and practices concerning e-waste generation, handling, and disposal at the University of Leeds.

Based on a literature review, a set of open-ended questions was formulated. Next, semi-structured interviews were conducted with the University staff. The discussions attempted to gauge the level of e-waste awareness and evaluate the effectiveness of current practices. Finally, the anonymised data was qualitatively and quantitatively analysed to identify recurring experiences and opinions.

The results highlight several challenges, which include, inter alia, lack of time and capacity with the staff, diversity of electronic lab equipment across faculties and absence of a pan-University e-waste management unit. In addition, various drivers for sustainable e-waste management at the University are identified, such as better information dissemination, managing inventory of e-waste, and institutionalising responsibility for e-waste.

In conclusion, the study explores e-waste at the level of universities in an effort to bridge a significant research gap. It formulates a comprehensive framework to manage e-waste based on the best practices collated from universities across the globe, tailors it to the University's needs, and provides recommendations for e-waste monitoring.

#391 - Environmental life cycle analysis of Qatar's construction industry

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Keywords: Construction, Life Cycle Assessment, Sustainability, Qatar, Triple Bottom Line (TBL) Approach

Abstract

The production of waste, the effects of global warming, and embodied energy use are all significantly impacted by the construction industry. The fastest-growing industry in Qatar has been construction over the past two decades, which is predicted to expand by 3.6% in real terms in 2023 after expanding by an estimated 4.7% per year in 2022. From 2024 to 2027, the construction industry is anticipated to grow at an average annual rate of 3.8%, helped along by investments in the housing, oil and gas, industrial, and renewable energy sectors. Qatar has committed to achieving a significant portion of its goal to construct a substantial number of 'green or carbon-neutral' buildings across the Middle East and North Africa (MENA) by the year 2030. If the construction is not monitored and kept under control, it will consume a significant amount of energy and produce waste that will impact the surrounding ecosystem. Life cycle assessment, often known as LCA, has become an essential component in the building industry's push toward green infrastructure design. This is because LCA provides a method that is both objective and reliable for determining the environmental implications of various building techniques, components, and assemblies. Using an approach known as life cycle assessment, the purpose of this study is to determine the environmental impacts that are most significant to construction projects across their full life cycles in Qatar. This study helps identify potential risks and possibilities in the Qatari construction project by conducting a thorough and analytical analysis of the existing literature. The results of this study show that the construction industry has a significant adverse impact on Qatar's environment in terms of energy use, greenhouse gas emissions, and waste generation. According to research, LCA can help identify areas in the construction industry where sustainable practices can be promoted and environmental effects reduced.

Renewable Energy Technologies

#331 – Impact of Green Energy-proven Technologies on the Socio-economic and Environmental Performance of Buildings

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Keywords: Green Energy, Technology, Socio-economic.

Abstract

Countries around the world are facing challenges of climate change as the conditions become more severe than normal. Moreover, environmental performance encompasses the environmental sustainability of buildings or infrastructures, which aims to reduce the environmental impact of the buildings. The construction industry has significantly contributed to global climate change. The onset of climate change means that green building technologies are now needed not only to reduce built environment contributions to climate change as mitigation but also required to help buildings adapt to projected climate changes as adaptation drives. Therefore, the study is a literature review on the impact of green energy-proven technologies on socioeconomic and environmental performance. Green energy-proven technologies are renewable or sustainable energy technologies that are accepted in practice and do not utilize scarce resources and have little or no detrimental effect to the environment. The aim of implementing green energy technologies is for the effective and efficient use of energy resources. Green energy technologies play an important role in reducing energy consumption and preserving the environment. Green technologies form part of the drive towards sustainable construction as the shift to a low-carbon economy relies heavily on renewable energy generation. The study will contribute to the existing body of knowledge of green technology, particularly in developing countries.

#354 - Social Housing Construction in Ireland; Achieving Nearly Zero Energy Building (nZEB) Standards Through Passive House Methodologies and Renewable Energy Systems

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Keywords: Ireland, Nearly Zero Energy Buildings (nZEB), Passive House (PH), Social Housing.

Abstract

Since 2018, nearly Zero Energy Building (nZEB) standards have become effective on all public buildings, and since 2020, for all new build dwellings in the European Union (EU). This standard requires buildings to have a high-energy performance as defined in the EU Energy Performance of Buildings Directive Recast 2010. Passive House (PH) standards require high-performance dwellings to achieve a consistently comfortable internal environment. In Ireland, over 97,000 new social homes are to be built between 2022 and 2030, thus, there are huge sustainable opportunities for social housing construction. This research aims to establish capital and operating costs of passive housing versus typical housing construction in Ireland and to identify energy-efficient solutions to reduce space heating energy demands in households. A mixed-method research approach is utilised, incorporating a literature review, a case study, semi-structured interviews, and a questionnaire survey with experienced professionals within the Irish construction industry. Findings show that additional construction costs were associated with increased airtightness, extra quantities of insulation, mechanical heat recovery systems as well as higher-performing windows and doors. Cost reductions are achievable by changing from the conventional heating system and removal of the chimney stack. Challenges such as inflated material costs, workmanship, finances, and airtightness were identified. Passive Houses are outstandingly cheaper to operate in comparison to an average dwelling in Ireland. Renewable energy systems such as solar photovoltaics, air source heat pumps, and mechanical heat recovery systems offer substantial savings over time. Low-income tenants and homeowners are negatively affected by energy inefficiency as it affects their dietary decisions, disposable income, and both physical and mental health due to financial stress. Ultimately, the key contribution of this research illustrates that while higher initial expenditures are incurred, nZEB dwellings built to Passive House standards are a viable solution for social housing in Ireland while offering various benefits.

#393 – The Potential for Seaweed as a Replacement Fuel for Combustion in Sugar Cogen Power Plants

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Keywords: Sargassum seaweed, bioenergy, co-generation, waste minimisation.

Abstract

The Government of Mauritius has introduced energy policies to reduce the use of fossil fuels in response to global heating. Electricity from renewable sources mainly generated for the island by sugar cane factories through cogeneration. The approach uses bagasse during the sugar-cane crop season and coal during the off-crop season to feed the boilers of their power plants. With an annual decrease in sugarcane production, due to field abandonment by planters, coupled with an increase in coal import prices and electricity demand, there is an urgency to compensate for this fuel deficit. In this context, "Sargassum sp" - a common seaweed washed up along the coastline was assessed as a potential bioenergy substitute. Currently Sargassum is a waste material regularly cleared from public beaches and hotel fronts and dumped in rudimentary landfill sites. The study undertook an analysis of the fuel and chemical characteristics of Sargassum in pure form as well as in comixed half ratios with coal and bagasse. Then, the technical feasibility of integrating a pre-treatment model for the seaweed into an existing bagasse process line at a power station was studied by developing a functioning pilot mechanical processing plant. The analytical results indicated a low calorific value of 12.9MJ/Kg, although this was comparable to other biomass resources. The dry mass was only 26.6% which would make Sargassum unfavourable towards direct combustion without pre-treatment. Alkali metals, found in the dry ash, could cause boiler corrosion and fouling. Therefore, there are challenges in the use of seaweed for power generation. The pilot plant was able to take in fresh Sargassum and treat it to produce feedstock for the power station. Future research (LCOE, Sensitivity Analysis) on the economic viability of integrating Sargassum into existing boiler feed lines for the power station will be undertaken.

#394 - Potential Applications of Photovoltaic Technologies for Biomimetic Adaptive Solar Building Envelopes

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Keywords: Bio-ASBE, biomimetics, adaptive building envelope, PV technologies.

Abstract

Building envelope as an interface between the outside and inside of the building serves more than its loadbearing function and has a pivotal role in regulating and saving energy. This role necessitates the adaptability of the building envelope to the surrounding environment like what natural organisms do in response to different stimuli in nature. Solar energy as one of the momentous renewable energy resources can be harvested and regulated following principles inspired by natural organisms' strategies through the building envelope. Nowadays, photovoltaic technologies have advanced significantly and therefore could offer lots of possibilities for the design of biomimetic adaptive solar building envelopes (Bio-ASBEs). In this regard, this research's focus lies in providing a comparative analysis between three PV technologies including crystalline silicon, perovskite, and organic solar cells in order to provide a context for their potential application for the design of Bio-ASBE.

Building Performance, Analysis and Evaluation

#317 – Window maintenance versus replacement: A comparative life cycle analysis from subarctic Sweden

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Keywords: Building Renovation, Energy Efficiency, Life Cycle Carbon, Life Cycle Costs.

Abstract

Previous building renovation studies have evaluated the life cycle (LC) impact of replacement to new, more energy-efficient windows, comparing it to optional renovation measures and base scenarios. However, periodic maintenance to avoid replacing existing windows has attracted less attention in research and practice, especially in subarctic climates with high heating demands by buildings. The objective here is to assess the LC impact of various scenarios of maintenance and replacement of different window types on a 1980s multi-residential building in subarctic Sweden. The scenarios were compared based on estimated climate impact and costs during product and operational stages. A reference study period (RSP) of 60 years was chosen. Results show periodic maintenance of existing windows to be the preferable option regarding LC climate impact and costs. In the replacement scenarios, the reduced heating energy use affected the climate impact more than the costs. The scenarios showed varied sensitivity to changes in RSP, intervention rate, and discount rate, increasing the uncertainty of the assessment. The results highlight maintenance is worth considering among property owners when deciding on renovation measures, but also in future research studies.

#334 – Discrepancy in Regulatory Provisions and Practices – the Design of Public Buildings in Lahore, Pakistan

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Keywords: Building Bylaws, Building Performance Evaluation, Local Planning Authorities (LPAs), Planning Permission

Abstract

Lack of clarity in building regulations and associated byelaws result in poor quality building design. This is the case in Lahore, where the quality of public buildings, including sensitive buildings such as hospitals, hostels, and family homes, is compromised, particularly in relation to Building Environment, Building Comfort and Building Function, impacting on both users and neighbourhoods. This study produces an account of the implications of the planning approval process and practice for erecting public buildings by public and private developers in Lahore. It seeks first, to review and analyze regulatory provisions and prevailing practices of erecting public buildings in the city. Secondly, to carry out a non-technical / social evaluation of the performance of public buildings by the end-users and, thirdly, to consolidate the technical views of officials regarding regulations/byelaws and their implementation. A mixed method research approach is applied to capture and analyze data collected from the identified target groups. The study establishes that the building regulations/byelaws for the public buildings are not sufficient as well as generic in nature, therefore seeking enhancement in terms of categorical specification. There should be Additional regulations/byelaws devised and introduced which consider types, purpose, and activity levels in public buildings. In terms of practice, there is a lack of appropriate building and development control in relation to the erection of public buildings. This results in low satisfaction of the end-user/occupant and the public. Further research areas are indicated which can attract interest of a diverse range of researchers, practitioners, and planners related to the construction and wider built environments.

#337 - Energy Performance Certificates and Historic Buildings: A Clash Between Method and Context

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Keywords: Energy performance certificates, Historic buildings, Sustainable refurbishment.

Abstract

Many of the built environment's sustainability and carbon reduction agendas are geared toward 2050. Yet, it is estimated that up to 80% of the buildings that will exist in 2050 have in fact, already been built. It is therefore argued that if any of the climate change goals are to be met, we need to radically reduce the carbon emissions from our existing building stock. Energy performance certificates (EPCs) are vital in the UK government's strategy around climate change and energy use reduction within the built environment. Worryingly, an increasing amount of literature is now questioning the reliability of the data from EPCs and if it is fit for purpose. The research will focus on the group of buildings most impacted by the use of EPCs, the historic (pre-1919) housing stock. Alarmingly, some of the most effective measures of reducing carbon emissions and energy usage in historic houses have only a small impact on the EPC score a building receives. The paper aims to understand the key issues that cause a performance gap and how many historic dwellings perform much better than their EPC might suggest. The research draws upon existing literature before mobilising primary case studies and supportive datasets. Analysis and subsequent findings challenge the current rhetoric, whereby many small benign changes can have a considerable effect on reducing carbon and energy usage and that many of the recommendations that owners of historic buildings receive on the EPC report are either, at best, far more financially costly and, at worst, extremely damaging to the historic fabric and the heritage of the dwelling. The existing EPC framework is fundamentally ineffective in accurately predicting energy and carbon usage in historic dwellings.

#343 - Analysis of a Best-Fit Web Based Carbon Assessment Tool for SME (Small and Medium Enterprise) Projects that Evaluate Operational and Embodied Carbon in Housing Stock

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Keywords: Sustainable Built Environment, Life Cycle Assessment, Embodied Carbon, Web Based Carbon Assessment

Abstract

Carbon reduction has become a global priority over the last 20 years. Different sectors are looking at ways to both reduce and to a lesser extent offset both their embodied and operational carbon. This paper outlines the process of selecting a best fit software to carry out life Cycle assessment (LCA) of whole buildings. Selection criteria were identified from three categories of data: the software performance regarding LCA, the alignment with the software selection to a project implemented by a Welsh small or medium sized enterprise (SME), and the utility of the software to non-experts in the LCA field. A total of 17 applicable LCA software tools were identified through a systematic literature review, and investigation of the local market. Web based carbon assessment tools (WBCATs) catering exclusively to LCA stages (i.e., use stage) or exclusive to limited components of buildings were eliminated from consideration. Five LCA software tools were targeted for further analysis using a qualitative Likert-scale rubric along with a financial comparison using quotes provided by the software development representatives. The results of the study illustrated a prominent level of consistency in the technical qualities of the software. The highest score variance was noted in categories relating to software applications concerning project specific attributes, specifically concerning useability by LCA non-experts and the software design aligning with building analysis. Licencing prices were similar between products but served as a decisive factor in comparing the software options. One Click LCA was identified as most congruent with the required project needs and aligned best with the financial scope of the project. OneClick selection was supported by extant literature, which highlights both the useability for non-LCA experts, and the quality of the datasets incorporated into the One Click package. The results support the importance of the project design and intended use of the WBCAT in selecting the correct software tool. In this vein there is no one best WBCAT, but there will be a best fit dependant on design needs. This conclusion is congruent with existing literature where the selection of a WBCAT for use in a study is determined through regional, resource, and LCA parameters.

#358 - Evaluating the Impact of Modern Methods of Construction on the Lifecycle Carbon Emissions of Housing: Towards Net-Zero Emission House

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Keywords: Modern Methods of Construction, Conventional Method, Affordable housing, Lifecycle carbon, Embodied carbon, Operational carbon, Sustainability.

Abstract

Housing is one of the significant contributors to carbon emissions in the UK, estimated to account for approximately 15% of the country's total carbon emissions. This research evaluates the lifecycle carbon emissions of various Modern Methods of Construction (MMC), particularly category 2 pre-manufacturing structural panels, compared to conventional brick houses for affordable housing in the UK. The study employs the EDGE application modelling software to estimate the lifecycle carbon emissions of different construction methods and overall housing systems. The comparison of carbon emissions from the four systems reveals that modifying construction methods and materials from conventional to MMCs and local-natural materials can result in significant reductions of up to 75% during the construction phase and up to 15% during the operational phase, contributing to an overall decrease of up to 35% in the total lifecycle carbon emissions of the houses. Moreover, the research highlights that changes in construction methods have a more substantial impact on carbon emissions during the construction phase than during the operational phase. Material and construction method selection in affordable housing is identified as a critical factor significantly influencing the lifecycle carbon emissions. In conclusion, the findings emphasize the importance of adopting sustainable building materials and construction methods in affordable housing to reduce the lifecycle carbon emissions produced by the construction industry. Such measures not only contribute to lowering environmental impact but also enhance the overall sustainability of houses and households.

#384 - Assessment of Project Monitoring and Control on Public Buildings Projects: A study of Municipal Building Projects in Nigeria

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Keywords: Public buildings, Construction, Project success, Building project

Abstract

Over the past decades, the construction project control system has struggled with some global challenge that hinders infrastructural projects' time delivery and budget. The threat is the most common, expensive, and risky problem associated with public-private construction projects. Within this context, this study aimed to assess the effectiveness of project monitoring and control strategies on municipal buildings project in Nigeria. A random sampling method was used to obtain data from 119 respondents. Descriptive and inferential statistics, including mean and standard deviation, multiple regression and Pearson correlation, were used to analyse the data with SPSS software. The study found that effective project monitoring and control strategies were associated with timely completion of building projects, satisfaction with project performance, and cost reduction. The factor influencing project monitoring and control include conflicts of construction information between project stakeholders, lack of resources allocation to the monitoring and control unit, and corruption between government agencies and project contractors. The study also found a moderate relationship between the variables under consideration with a Pearson correlation coefficient of 0.45, which was significant at a 95% confidence level. The results suggest that project monitoring and control strategies play a crucial role in determining the success of public building projects. This study highlights the importance of effective monitoring and control strategies and provides insight into the factor that influence project success in the construction industry in Nigeria.

#399 – Field Testing for Envelope Construction Quality in Social Housing: In situ testing of envelope air leakage to estimate energy consumption between the current and green models

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Keywords: Social Housing, Air Leakage, Energy Consumption and Green Models.

Abstract

Air infiltration, the exchange of outdoor air with indoor air through leaks in the building envelope, is a crucial factor that influences the energy performance of buildings. This study presents a comprehensive assessment of air infiltration in social housing units in Egypt using blower door tests and estimates its impact on energy consumption using simulation modelling. A field study was conducted on four social housing units, consisting of two conventional and two green building models. Blower door tests were performed on each unit following ISO 9972. The assessments made in four residential structures show an average air permeability of 19.52 $m^3/h{\cdot}m^2$, the traditional units' average air change rates at 50 Pa (ACH) were measured to be 9.22 h^{-1}. The green model, in contrast, displayed average air change rates of 7.34 h^{-1} and 13.94 $m^3/h{\cdot}m^2$ for air permeability. By just improving the quality of the window frame, green building models are 20% more airtight than conventional ones in terms of ACH and 28% less in air permeableability. Simulation modelling was conducted to understand the impact of air infiltration on energy consumption. The measured air infiltration rates were used in the simulation models, along with climate data, thermal properties of the building envelope, and HVAC system efficiency. The simulations demonstrate that in terms of cooling loads, heating loads, overall energy consumption, and Energy Use Intensity (EUI), the total annual electricity use in the green models was reduced by 2.3% compared to the traditional models. These findings highlight the importance of reducing air infiltration to improve energy efficiency in social housing units. In conclusion, this study underscores the significance of addressing air infiltration in social housing. It recommends the adoption of green building practices to reduce air infiltration, leading to improved energy performance and greater sustainability in social housing units.

Energy Behaviour & Behaviour Change

#309 - Lessons not learnt: Improving learning transfer in projects.

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Keywords: *Lessons learnt, Mitigation, Risk, Innovation*

Abstract

This paper explores, project management literature, observations, and primary data from an unpaired experiment to explore the benefits lesson learnt methodologies can bring to future and ongoing projects. Within project management literature, learning and development is agreed as a benefit to the innovation of future projects. However, modern day practice of projects overlooks the lessons learnt process as a vital component to innovation in a project setting. Using a sample of Project Management MSc students to create unpaired experiment to produce quantifiable scientific data that may produce evidence to identify these benefits, barriers and methods to overcome those barriers. The data collected provides supporting evidence that lessons learnt methodologies can improve the identification of mitigation actions for projects. The data supports lessons learnt practice, because it shows that the normative practice of projects is a subject that needs to be developed. The lack of using lessons learnt in modern practice is explored to understand how the hard paradigm project management has created strict constraints to learning transfer, producing less time to implement effective lessons learnt. In addition, social cohesion works on human beings to make them reluctant to learn from previous social constructs in both negative and positive settings. The experiment provided evidence of how these natural barriers to learning transfer may be partially overcome.

#332 - The Health and Safety Audit Report as an essential document – a case study investigating Audit Reports in terms of their value in knowledge management and the implications for, and impacts on, delivering behavioural change in construction organisations.

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Keywords: health and safety, audits, knowledge management systems, behaviour change.

Abstract

The Health and Safety (H&S) audit process is implemented on construction sites worldwide and Knowledge Management Systems (KMS) are used to streamline the process of gathering, capturing, transferring and sharing knowledge allowing organisations to drive behavioural change. But what happens to the findings of H&S audits and what value can be derived from them from the behavioural change perspective? This forms the research question investigated in this case study. Themes investigated were: the importance of H&S audits by regulatory authorities, KMS and their benefits to behavioural change in the organisation and finally, the main reasons for poor linkage of H&S audit outputs with the KMS. The research investigated the audit process and how effectively lessons learned are captured and transferred into the KMS in a construction company operating across multiple sites. This involved a mixed methods approach with completion of 20 on-line surveys and 10 individual semi-structured interviews. The data was analysed in line with information from a literature review and a number of recommendations emerged. It was important that these recommendations were realistic, implementable and cost efficient so they could bring value in terms of allowing the outputs from H&S audits assimilate into KMS thereby facilitating behavioural change in the organisation.

#336 -Intermittent vs Constant Gas Central Heating Usage

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Keywords: SAP, Heating, Gas Usage.

Abstract

The current energy crisis requires us to re-evaluate our methods of energy usage. The UK government has committed to decarbonising all sectors of the UK economy to meet a net zero target by 2050. With approximately 24.8 million households in England and Wales (ONS 2021), it is important that residents understand how energy is utilised efficiently. Misunderstanding energy usage will negatively impact upon achieving the UK government 2050 net zero goal.

Regarding domestic energy usage, identifying areas of consumer uncertainty and evaluating them through experimentation will educate the consumer, promoting clarity and understanding. This will assist towards achieving the UK net zero target, whilst encouraging sustainability through informed, efficient consumer energy usage.

It was found that increasing space heating duration from nine hours per day using a SAP intermittent heating pattern to a constant 24 hours per day heating pattern only increased space heating energy use by 31%. This behaviour is attributed to heating thermal mass of elements during heating periods rather than more efficient heating system operation.

#339 – Learn, Unlearn and Relearn into a Sustainable Future: Sustainability Consciousness in Nigeria

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Keywords: Sustainability Consciousness, Socio-economic Development, Climate Change, Environmental Sustainability.

Abstract

After years of speedy urbanization, population growth, and industrialization, Nigeria is now home to some of the world's environmental and natural resource problems (Dwivedi and Vajpeyi, 1995). Nigeria is faced with the twin goal of meeting socio-economic development and ensuring environmental sustainability simultaneously. The development of a nation's environmental policy is very much dependent on its economic level, politics, and the environmental knowledge of its citizens (Ikporukpo, 1983 & 2002). This paper emerges from an ongoing PhD research on the evaluation of environmental policies in Nigeria, the lived experiences of victims of environmental degradation in Nigeria and a better approach to the topic of sustainability consciousness within the Nigerian context.

However, Nigeria has made some progress, and the overall record of accomplishment is mixed at best, and the reason for this is well known; bad governance, elevated levels of corruption, poor accountability, little or no checks and balances within the arms of government, written regulations being riddled with gaps and inconsistencies amongst policies (Goodland, 1992 & 1994). Also, environmental regulatory agencies lack funding and trained personnel, a duplication of targets and duties, public infrastructure needed to control certain environmental issues are yet to be built, difficulty to monitor small and informal firms within Nigeria, and most importantly, the political will to enforce and monitor regulations are often limited (Ikporukpo, 1983).

The major research question is, "can the needs of the environment be made a priority for Nigeria with the ever-raising socio-economic issues?". This research adopts an interpretivist phenomenological analysis approach, whereby in-depth semi-structured interviews of both actors and stakeholders of environmental degradation in Nigeria, policy makers, and decision makers in oil companies, would be used to explore and interpret these events.

#347 – Using Innovation as a tool to enhance sustainable project outcomes

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Keywords: Innovation, COVID-19, Small and Medium-sized Enterprises, Behaviour Change

Abstract

A significant objective of the United Nations Sustainable Development Goals is to provide a critical framework for COVID-19 recovery. This process is achieved through 17 sustainable development goals, including Goal 9, which focuses on building resilient infrastructure, promoting inclusive and sustainable industrialization and fostering innovation. Innovation, particularly in the SME industry sector, is significant in developing sustainable engineering and technological developments and practices, and thus fostering positive behavioural change in industry and the community. To improve the understanding of this process during the COVID-19 pandemic, research was undertaken to investigate the association between innovation practices in SMEs to better appreciate how innovation could be effectively used to enhance SMEs' performance during the COVID-19 pandemic crisis. A literature review assessed the impact that the COVID-19 crisis has had on SMEs' performance, the role of innovation and the factors affecting its effectiveness. Subsequently, a survey was undertaken to collect and analyse data from 43 randomly selected SME engineering organisations in Australia with respect to their innovative processes during COVID-19. The research found that product, process, marketing, or management innovations have been introduced in SMEs where the COVID-19 pandemic occurred. These findings have led to the primary conclusion that enterprises affected by the COVID-19 pandemic introduced more innovative solutions than those not disturbed by the crisis. Furthermore, consumer behaviour and digital technology skills were confirmed to positively influence the effectiveness of innovation during the COVID-19 crisis. In conclusion, this research has demonstrated the importance of ongoing innovation in engineering organisations in times of crisis, both as an agent of change and to develop areas like positive consumer behaviour and the digital economy. Its results can therefore be used as a guideline on how innovation can effectively be used to enhance SME performance, and thus positively impact on the achievement of sustainable development.

Sustainability, Ethics, and Responsibility

#313 – Towards a sustainable post COVID-19 higher education era in Zimbabwe: The compatibility of online teaching and learning platforms with courses in the Built Environment

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Keywords: Built Environment, Higher Education, Online Teaching and Learning, Zimbabwe.

Abstract

An upsurge in the use of online teaching and learning in higher education in Zimbabwe was triggered by the outbreak of the COVID-19 pandemic, as a necessity to anchor the survival of higher education in response to lockdown restrictions imposed by governments worldwide, as they strived to control the spread of the pandemic. However, the forced switch to online teaching was without adequate preparedness in higher education institutions in Zimbabwe. While there are several online teaching and learning platforms available, a need therefore existed to understand how they can reliably enhance sustainable teaching and learning especially in the Built Environment, where no similar studies had been carried out in Zimbabwe to the knowledge of the researchers. In a structured questionnaire survey, a combination of purposive, stratified and convenience sampling were used to collect data from Built Environment departments in four major higher education institutions in Harare and Bulawayo. A total of 176 lecturers and students participated. Descriptive and inferential statistics were used to analyse the data. WhatsApp was the most implemented as well as the most effective of the online platforms, potentially owing to its antecedent, widespread use as a social media platform, coupled with its ability to offer sustainable cost solutions to online teaching and learning. Google Classroom was the second most implemented of the online teaching and learning platforms, as it was also perceived by lecturers and students as the second most effective in enhancing student learning abilities. YouTube and video conferencing platforms were also perceived to be effective in enhancing student learning abilities. The study advocates for a post-COVID-19 transformation from sole reliance on campus-based, classroom teaching and learning in higher education in Zimbabwe, to blended learning in order to harness the advantages of online teaching and learning. Acquisition of cost-effective systems and technologies by higher education institutions is encouraged, in order to equip lecturers and students and empower them for participation in online teaching and learning.

#327 - Are local authorities on the road to Net Zero or the Road to Nowhere? A modified Delphi approach to assist smaller local authorities diagnose improvements to Net Zero governance and decision-making.

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Keywords: Local authorities, Net Zero, Delphi, Governance

Abstract

Local authorities in the United Kingdom face significant challenges to meet local and national Net Zero commitments. They must work within defined legal, constitutional and democratic decision-making structures but without a unifying Central Government regulatory or policy mandate or a clear and consistent governance model to achieve area-wide decarbonisation. Much of the research and evidence presented in the literature draws upon the experiences of larger urban local authorities in the single (Unitary) or upper tier of the two-tier (County Council-District Council) structure where most investment will be needed to tackle Net Zero. Building on previous research, this paper proposes the use of a modified Delphi to work towards a consensus of solutions tailored to the organisation and its local area. The approach was developed and trialed on a sample of local authorities as a way establishing a diagnostic tool to derive a suite of solutions to improve their decision-making and local governance arrangements to deliver Net Zero programmes of work in their areas.

#348 – An Evaluation of the Impact of Oil Exploration on Sustainable Development Objectives for the Communities Within the Niger Delta Region of Nigeria

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Keywords*:* Built Environment, Degradation, Niger Delta, Sustainability.

Abstract

Oil exploration has been on-going in the Niger Delta region of Nigeria for six decades. The oil production in the region, which accounts for about ninety percent of Nigeria's crude oil turnover, foreign export earnings and revenues, has resulted in massive degradation of the environment, negatively impacted the biodiversity, and caused irreversible damage to the built environment and sustainable development of the communities. Similarly, the communities close to the oil fields and installations have experienced high corrosion rates for building roofs caused by gas flare-induced acid rain, soot deposition on buildings and farmlands, and contamination of soil and water bodies. This has impacted negatively on the sustainable development of these communities. Therefore, the aim of this paper is to explore the impact of the oil exploration activities on the promotion of sustainable development objectives for the communities. The study adopted a quantitative approach and obtained primary data using questionnaires which were administered to government ministries, departments, agencies, key leaders of the affected communities and representatives of oil producing companies in the Niger Delta region to explore the government's sustainability policy programmes and the oil exploration practices in the Niger Delta. Secondary data from existing literature was also reviewed to compliment the primary data. Findings from the study revealed that substandard practices by the oil companies, the quest to maximise profits, poor governance, and lack of political will on the part of the government are responsible for the lack of attention given to the promotion of sustainable development objectives for the communities in the Niger Delta. These findings hold a salient implication for the country's efforts towards the attainment of sustainable development goals for the oil producing communities and brought to bear the key issues underlying oil exploration and its associated sustainability problems for the built environment in the region.

#367 – Sustainability Literacy Evaluating Instrument for Construction Professionals

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Keywords: Sustainability literacy, Resilient Communities, Sustainability, Construction

Abstract

The construction industry plays a vital role in world economies over various sectors. Moreover, construction is one of the main sectors that significantly contribute to carbon emissions, resulting in global warming, climate change, disturbance of natural habitats, etc. In view of the negativity it causes, decarbonising economic sectors has become a global agenda, seeking to build secure and resilient societies, of which the construction industry is not an exception. However, achieving the desired level of success in decarbonisation has become challenging within the construction industry, especially due to the need for more sustainability literacy among construction professionals. Therefore, this study proposes an instrument to evaluate the sustainability literacy of construction professionals. In achieving the aim of this study, it incorporates a longitudinal research method while relying on secondary data. Data analysis is subjected to content analysis for a better understanding. Overall, the findings revealed that individuals' environmental background, innovative perspectives of sustainability, the degree of in-depth analysis or the coherent structure of sustainability knowledge, institutional support, psycho-behavioural intervention and managerial influence should be considered in sustainability literacy evaluating instruments. The outcomes of this study are highly useful and significant in attaining sustainability in construction to build resilient communities. Moreover, it is beneficial in assessing the interrelationship between sustainability literacy and sustainable approaches within the construction sector.

#371 – The Health and Safety Risks of Working during Heatwaves on Construction Sites in the Republic of Ireland and the United Kingdom

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Keywords: Construction Sites, Failure Mode and Effects Analysis, Health and Safety Risks, Heatwaves.

Abstract

The construction sector is vulnerable to extreme weather events due to most of the industry's activities being carried out manually by workers outdoors. However, there has been little study of the consequences of heatwaves on construction sites unlike other extreme weather events, such as floods and snowfalls. This research project aims to investigate the health and safety risks associated with heatwaves on construction sites in western Europe, specifically the Republic of Ireland and the United Kingdom. The research applies Failure Mode and Effects Analysis, with the help of five experts in both countries to evaluate these risks based on their likelihood of occurrence, the severity of their impact and their ease of detection. Semi-structured interviews were also carried out with these experts to investigate potential solutions to these risks and barriers to their implementation. The results show there is a lack of knowledge in the area, and an ill-preparedness with regards to employee welfare during hot weather events. There is also a significant lack of governing laws with respect to outdoor working in high temperatures, thus the need for the industry to improve upon health and safety on construction sites during heatwaves. The research explores solutions such as conducting pre-employment health checks and toolbox talks, supplying breathable personal protective equipment, providing suitable rest and welfare facilities, practicing crew rotation and providing mechanical aids where possible. More in-depth interviews with other experts are needed due to the lack of research in the area and its abstract nature.

#435 - Decarbonising the UK Research Ship Fleet – Theory meets practice.

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Key Words: Oceanographic Decarbonisation, Energy efficiency, Maritime and Transport sector

Abstract

Problem Statement*: Shipping is responsible for about three per cent of the world's carbon dioxide emissions, which have increased by 10 per cent since 2012. The latter contributes to a series of climate change issues and causes significant negative impacts on human health and the environment. A strict reduction target has been set for the Marine Industry of about 80 per cent by 2050.*

Aim*: The focus is to understand the process of decarbonisation for the research shipping fleet, the risk mitigation strategies employed, the challenges faced, Identification of factors that enhance and demote the process is explored.*

Objective 1*: Firstly, the study seeks to understand the Decarbonising Process employed by the UK Research Ship Fleet and its broader environmental impact.*

Objective 2*: It identifies critical factors that deter or promote the process of decarbonisation while exploring strategies to combat global emissions.*

Methodology: *This study takes a retrospective review of the decarbonising process for the Ship fleet, and it influences project performance using a mixed-method study approach. The findings can populate the broader UK Marine research fleet spectrum following an energy efficiency assessment for three research vessels.*

Research Contribution*: The outcomes of this paper will contribute to a better understanding of the decarbonisation of the UK maritime research fleet. Outlines the critical drivers and barriers that expedite decarbonisation. Lastly, an evaluation of energy efficiency is provided, detailing both immediate and long-term strategies. to combat emissions for the industry. The latter builds on the under-researched relationship between oceanography decarbonisation and energy efficiency for the Global Research Fleet.*

#452- Critical Barriers and Mitigation Strategies to IoT Technologies Adoption in the Real Estate Industry of Developing Countries: The Case of Ghana

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Keywords: Internet of things technologies, Barriers, Strategies, Real estate industry, Sustainability, Developing countries, Ghana

Abstract

Internet of Things (IoTs) technologies have been advocated in the smart real estate industry to address sustainability issues and contribute to the smooth operation of real estate projects, but their application is still plagued with barriers. However, few studies have been conducted on the IoTs technologies application in developing countries such as Ghana. This study aims to investigate the critical barriers and strategies for IoTs usage with reference to the Ghanaian real estate market. Twenty-three (23) barriers were identified from a comprehensive literature review, and a questionnaire survey was performed with 45 professionals within the Ghana Real Estate Professionals Association (GREPA). The ranking analysis results indicated that 18 barriers were critical. The five most critical barriers were limited budgets and resources for technology investment, security and privacy concerns including potential for cyber-attacks, resistance to change in the industry, limited availability of reliable and high-speed internet connectivity and compatibility with existing building infrastructure. Through a comparative analysis, it was observed that the primary barriers to the usage of Internet of Things (IoTs) technology in Ghana are distinct from those encountered in developed countries such as the United States, United Kingdom, and Australia. However, a common aspect across all these regions is the significance of the cost of technology investment, which remains a prominent obstacle hindering IoTs adoption. This study also showed that the most important strategies for enhancing IoTs technologies application were education and training of stakeholders, pilot testing validation, standardisation, prioritise interoperability and ensure data security and privacy. The findings of this study offer valuable guidance to policymakers and practitioners, empowering them to implement suitable measures for effectively integrating IoTs technology into the real estate market. Future research into the impact of IoTs technologies to the real estate industry need to be conducted in the context of developing countries.

Sustainable Cities

#315 – Towards the European Commission's Road Safety Goal of 'Vision Zero': Intended Routes of the SOTERIA Journey

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Keywords: Micro-mobility, Vulnerable Road Users, Road Traffic Accidents, Living Labs.

Abstract

The emergence of complex urban mobility environments, where unknown interactions between different types of vulnerable road users (VRUs) and between VRUs and motorised vehicles, poses the need for a clear understanding of user behaviours, fair and optimised use of public spaces, as well as age-friendly urban safety action plans and assessments, capitalising on the benefits that technological innovations and the plethora of available data can offer in advanced accident analysis, towards achieving EU's 'Vision Zero' goal of zero fatalities on European roads by 2050. The SOTERIA Project aims to accelerate the attainment of this goal for VRUs through a holistic framework of innovative models, tools and services that enable data-driven road

safety intelligence, facilitate safe travelling of VRUs and foster the safe integration of micro-mobility services in complex urban environments. At the operational level, the SOTERIA Project uncovers unexplored behavioural characteristics of VRUs and engages Living Lab communities (based in Germany, Greece, Spain and the United Kingdom) in social innovation activities for the co-creation of urban safety solutions and infrastructure designs. Simulation models and explainable Artificial Intelligence (AI)-driven analytics are developed for supporting policy decisions and informing interconnected services that support VRUs in safe and clean travelling. On-vehicle sensors and connectivity is fostered enabling minimisation of risky situations and behaviours. The approach will be validated in four thematic demonstrations within the SOTERIA network of cities, addressing different types of motorised VRUs (e.g. motorcycle, e-motorcycle, moped, e-moped, e-bicycle, e-scooter, hover-board (Segway), mobility scooter riders) and non-motorised VRUs (e.g. bicycle, scooter, skateboard and horse/pony riders, wheelchair users, babies/toddlers in prams, joggers, pedestrians). This article maps out the routes and inter-linkages of the activities and investigative axes that the project will take on its journey from 2022 to 2026, plus the expected impacts that will benchmark the project's successes.

#319 – Understanding urban trends while adopting rural development as a strategy to achieve urban sustainability in Nigeria

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Keywords: Urbanisation, urban trends, migration, rural development, urban sustainability.

Abstract

Urban areas are already home to 55% of the world's population with this figure expected to grow to 70% by 2050 which is in a span of a few years. Urbanization is seen as an essential force to the global efforts to build back better, and the World Cities Report 2020 confirms that cities remain central to the achievement of sustainable development. However, the speed of the urbanisation trends requires urgent and adequate sustainability measures in place. This is because the increasing trend without sustainability plans will create an overwhelming challenge that will override its transformative role in cities and negate the chances of it becoming advantageous to transition to sustainable development. While some scholars reveal that urban population growth is an important driving force to the rapid urban trends and urban expansion; others maintained that migration is a major driving force to global urban population growth. Importantly, it was noted that internal rural urban migration is the central cause of increasing urban trends in many developing countries. Strikingly, studies demonstrate that rural urban migrant congregate in urban areas in search of economic opportunities and a better life. It in effect shows that the increasing rural urban migration which causes increased urban trends is mostly a consequent of lack of economic opportunities and better life in the rural areas. This constitutes significant challenges in the urban centres and one of the most pressing of these challenges is identified as how to achieve urban sustainability. To achieve urban sustainability per se requires planning, management, and financing. The World Cities Report 2020 strongly affirms that adequately planned, managed, and financed cities creates economic, social, environmental values such that can vastly improve the quality of life of all. It can be argued that this planning includes making every effort not to neglect rural development as focusing on urban development alone is a costly negligence. Essentially, the rural development should gear towards providing quality of life and economic opportunities to the rural residents, without this, rural urban migration which results in unprecedented urbanisation will continue in the future. This will create more devastating challenges, making it more difficult to achieve urban sustainability. Based on this, the Department of Economic and Social Affairs of the United Nations in the 2021 World Social Report calls for action towards embarking on rural development to end the rural urban migration resulting from rural urban inequality. Moreover, sustainable rural development is considered in the SDGs as vital to the economic, social and environmental viability of nations. Accordingly, this paper focuses on understanding the trends of urbanisation while adopting rural development as an approach to achieve urban sustainability. The paper will draw from a wide range of

literature reviews and adopt a qualitative focus group discussions to ascertain the importance of rural development to urban sustainability.

#330 – Reinventing *Stahlstadt* – Research Methods to Reimagine Steel Towns, sustainability and collective geographies

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Keywords: Steelworks, Geography, Architecture, Landscape.

Abstract

In Jules Verne's imaginary, Stahlstadt, the city created by Prof. Schultze in "The Begum's Fortune" (1879) is the evil city "par excellence": unhealthy, unfair, and based on a warfare economy; its symbol: steel. The idea of the industrial town being dangerous, treacherous, and ruthless, as opposed to the idealistic world of the hygienic city, is one of the cliches of the late XIX century, especially if we see the importance of coal and steel for the European history between 1914 and 1960s. The steel industry has been vital to industrial development and economic growth, but its environmental and health impacts have been significant. In recent years, there has been a growing concern about the sustainability of steel production, particularly in regions where environmental regulations are lax.

This study investigates the relationship between steelworks and geography, with a focus on the city of Taranto in southern Italy. Taranto is home to one of the largest steel mills in Europe, and its proximity to the city has been a source of environmental and health concerns for local residents. The research utilizes data from a recently financed Horizon project that analyses the steel industry's impact on the environment and public health, with particular reference to non-communicable diseases. The study conducted at UoS focuses on the human geography component and the policy and regulatory framework that has contributed to the sustainability challenges facing the steel industry in Taranto. It highlights the need for stricter environmental regulations and a shift towards more sustainable production processes to ensure the long-term sustainability of the steel industry in the region.

Overall, the main aim is to provide valuable insights into the relationship between steelworks, heritage and geography and highlights the urgent need for action to address the sustainability challenges facing the steel industry in Taranto and other regions.

#333 - Factors Influencing Stakeholders' Willingness to Embrace Smart Home Technologies

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Keywords: Stakeholder, Willingness, Smart home, Sustainable City

Abstract

The concept of smart homes has drawn global attention towards achieving smart cities for building sustainable cities in both developing and developed worlds. This emanated from the idea of making humans acclimate to the easy usage of building facilities for actualizing a sustainable environment. This study assesses the stakeholders' characteristics, the level of their willingness to embrace smart home technologies, and possible factors influencing their willingness to embrace smart homes. A survey of professionals, investors, and users in Lagos Island, the economic nerves of Nigeria revealed that the degree of willingness to embrace smart homes was above average and factors influencing willingness to embrace smart home technologies are Technological, Environmental, Economical, and social, as the degree of each factor varies depending on the stakeholders' characteristics. The study recommends the synergies among stakeholders to embrace smart home technologies and that governments at all levels should create a supportive framework to accommodate proper implementation for the advancement of sustainable cities in Nigeria.

#368 – Creating Social Value by Building Extreme Low Carbon Homes

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Keywords: Passivhaus, Procurement, Modern Methods of Construction, Net Zero.

Abstract

The construction industry is facing numerous demands. For example, a contractor will have to ensure they achieve their cost targets and time and quality contractual obligations whilst also meeting any social value and environmental expectations. Social value is an increasingly important concept within the UK construction industry. Its importance has been reinforced by legislation, its growing weighting in public sector procurement, and the enhanced expectations of private sector stakeholders. Construction contractors therefore need to evidence their social value credentials in order to increase procurement success and meet stakeholder expectations. Addressing climate concerns is also a topic of increasing focus. Achieving extreme low carbon buildings has been proposed as one solution to this. The problem exists that there are numerous competing contemporary demands placed upon contractors. Such demands are often arguably viewed as disparate and competing and so potentially serve to restrict evolution and innovation across all areas. Practices that address both ultra-low carbon buildings and social value simultaneously could potentially serve to reduce the competing demands placed upon contractors and lead to a more focused and productive contractor output and greater benefits for the intended recipients. The links between social value and ultra-low carbon developments have not been well explored in the literature. This lack of research potentially hinders ultra-low carbon developments from achieving SV, or at least the recognition of the SV impact such developments have. The aim of this research to critically analyse both concepts to identify areas of cross over and consider if ultra-low carbon design can satisfy multiple stakeholder demands. The findings indicate a focus on achieving ultra-low carbon projects would lead to increased levels of social value achieved.

#416 - Addressing privacy concerns of citizen 's data in smart city design

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Keywords: Smart City, Smart Citizens, Governance, Privacy Concerns

Abstract

The introduction of Smart Technologies in recent years has resulted in greater opportunities for Smart Cities to be managed in a more efficient and sustainable manner. However, this approach relies, heavily, on a collection of Smart City users' data which, in turn, can be vulnerable without proper protections. Recent studies have indicated citizens' grave concerns about the privacy of their personal data in the context of Smart Cities. Although occupants' endorsement is crucial to smart city success, proper protections need to be embedded from the outset to ensure citizen confidence and system reliability. Research has shown that privacy concerns are not accounted for in the design of Smart Cities and principles of privacy are generally neglected at the design and subsequently construction stages. As such, this research aims to investigate the extent to which Smart City designers account for privacy concerns in the design of such cities. The privacy concerns in data collection practices within the Smart City context are categorised into dimensions that need to be used as steps to alleviate concerns. Also, privacy by design principles should ensure that user privacy is protected and increase the likelihood of citizen endorsement necessary for the success of Smart City initiatives. Essentially, it is evident from the literature that privacy is a low-ranking concern in Smart City design and the extent that it is considered in the design phase is not clear. In essence, although research highlights the requirement for privacy preserving practices, there is a lack of research into the current consideration of privacy concerns in design. The research was undertaken using the quantitative mono-method via a questionnaire, using themes developed from the literature review. A positivist standpoint intended to establish factual, quantitative data that can be interpreted objectively was taken. The results have shown that the categorised dimensions of privacy concerns and the principles of privacy by design are not being considered consistently in the Smart City design process. Research findings also indicated the need for a set of guidelines where privacy concerns and the principles for privacy by design can be embedded in the design process and used to develop forms of protection in the data collection and manipulation processes. The research concluded that citizens and users of Smart Cities would be more likely to endorse systems, increasing chances of success provided that privacy concerns are considered at the design stage and the principles of privacy by design are implemented from the outset.

Sustainable Construction

#373 – Barriers, Benefits and Future of Insulated Concrete Forms as a Building Method in the Republic of Ireland

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Keywords: Construction Method, Insulated Concrete Forms, Republic of Ireland.

Abstract

Insulated Concrete Form construction has only recently gained popularity in the Republic of Ireland, despite its initial appearance in the 1970s. This research project investigates the history of insulated concrete forms in the country as well its benefits, barriers to its use, and its ability to become a leading construction method in the future. To achieve these objectives, interviews were carried out with five industry experts in the use of insulated concrete forms nationwide. The research results showed that the benefits of insulated concrete form construction include lower costs, faster construction times, improved mechanical and thermal performance, better airtightness, and greater strength despite being lighter than traditional concrete blocks. Barriers to its use include voids in the concrete, uncertainty surrounding the strength of the render finish and water ingress at door thresholds and windows. The lack of knowledge and skills among installers was identified as another main barrier to its wider adoption. The research recommended mandatory training for installers, educating students about insulated concrete forms in secondary schools and colleges, and effective promotion of its benefits. Overall, it concluded that insulated concrete form construction has enormous potential to become a dominant construction method in the Republic of Ireland.

#374 – A Critical Literature Review of Existing Off-Site Construction Evaluation Tools

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Keywords: Construction Performance, Evaluation Tools, Ireland, Off-Site Construction.

Abstract

Despite the benefits of off-site construction as a more sustainable alternative to traditional construction, its use in the Republic of Ireland remains limited, with its performance a critical talking point that requires further analysis. This reinforces the need for evaluation tools in the form of methodologies, frameworks, models, and rating systems, to improve off-site construction's overall performance. This research aims to review such tools in the literature as a function of their country of origin, publication year, the specific off-site construction method they evaluate, their assessment mechanism, scope and applicability. The review shows that most of these tools were developed outside of Ireland, reinforcing the need for tools that are specific to the needs of off-site construction in the country. The most common evaluation tool developed was methodologies, with 44% of the reviewed tools using this assessment mechanism. Several tools targeted specific off-site construction methods such as modular construction, off-site construction waste disposal, and off-site manufacturing. This literature review is needed to highlight the strengths and limitations of existing tools in order to promote their use within the industry. It also provides a way forward for researchers looking to develop new tools that address the limitations of existing ones. A theoretical framework identifying factors behind the development of OSC evaluation tools as well as their potential implications is proposed.

#397 - Environmental Management Practices on South African Construction Projects

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Keywords: Construction, Environment, Management.

Abstract

Construction projects are usually associated with an adverse impact on the natural environment. Furthermore, there is a range of environmental legislation and regulations that regulate aspects relative to the environment.

A quantitative study was conducted among general contractors (GCs) in South Africa to determine: the status of construction environmental management practices; general perceptions of contractors with regards to environmental management, the role and influence of project stakeholders in a project environmental management system, and the benefits that accrue. Construction Industry Development Board (cidb) contractors registered in grades 2 to 9 constituted the sample stratum.

Findings include: inadequate environmental management knowledge, and non-compliance with environmental regulations predominate in terms of the causes of environmental degradation on projects; provision for environmental rehabilitation, and implementation of the project's environmental management plan on site predominate in terms of the frequency at which environmental issues are dealt with on sites; a range of environmental management practices can be deemed to be undertaken; clients and principal contractors predominate in terms of the extent to which the various project stakeholders influence environmental management practices on sites; reduction in environment incidents and legal compliance predominate in terms of the benefits that accrue due to an environmental management system being implemented on a project.

Conclusions include: contractors realise that environmental management is a key project parameter; environmental management interventions are implemented; environmental degradation occurs on site, and there is a need to improve environmental management on projects.

Recommendations include: the role of each project stakeholder should be identified; employer and professional associations should evolve environmental guidelines; environmental management should be embedded in tertiary built environmental programmes, and professional associations and statutory councils should evolve and / or promote environmental continuing professional development (CPD).

#414 - Sustainable Construction: A comparative study between the United Kingdom and the Middle East

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Keywords: Construction Industry, Sustainable Construction, Carbon Foot Print, Sustainability Policies

Abstract

The construction industry contributes to over 45% of global energy consumption and up to 40% of the total carbon dioxide emissions produced from manufacturing and transporting building materials and the usage of equipment. Sustainable construction, as opposed to traditional practice, involves a whole systems approach, early stakeholder collaboration, reducing resource consumption, removing toxins, and applying life cycle costing. However, there are barriers to fully implementing a sustainable practice across construction projects. Globally, the ME region is one of the fastest growing; however, there are slow efforts to implement sustainable construction practices in these countries. Egypt and the Kingdom of Saudi Arabia are estimated to generate 50% more carbon emissions per capita than the United Kingdom. As a result, this research aims to conduct a comparative study between the UK and the Middle East to evaluate the level of adopting sustainability in construction, barriers to implementation, and benefits of adopting such an approach, as well as comparing the available policies and regulations for achieving zero carbon emissions in these regions. Data was collected through a quantitative study using online questionnaires and the result was analysed using statistical techniques, starting with inferential statistics using an independent sample T-Test and descriptive analysis.

#427- Barriers to the Adoption of Sustainable Construction in Small and Medium-sized Irish Contractors: A Qualitative Insight

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Keywords: contractor, Ireland, sustainability, SME.

Abstract

With the results of climate change becoming more apparent, sustainability is becoming increasingly popular in all sectors and construction is no different. While larger contractors are leading the way, the same cannot be said for small to medium sized contractors. The aim of this paper is to uncover the barriers facing small and medium sized Irish contractors to adopting sustainability within their practices. The lack of research in this area is the motivation behind this study, as there is currently no information available on this topic regarding the Irish sector. This paper commences by identifying themes and underlying barriers identified within the literature. Subsequently, these themes and associated factors are explored in a series of twenty semi-structured individual interviews from small to medium sized contractors. Five themes and associated factors are identified. Firstly, cost, including cost of materials, cost of training, and cost of practice. Second, lack of understanding along with lack of education, lack of training, and lack of information are also noted. Third, lack of Government legislation is also highlighted, specifically grants, training, and regulation. Fourth, environmental, including materials, training, and practices. Fifth and finally, lack of demand, with lack of client demand and lack of industry demand being factors. The benefit of this research is that both industry and legislative bodies need to first identify and acknowledge the barriers that result in small and medium sized contractors not adopting a more sustainable approach, prior to then enacting targeted assistance to address these barriers, as identified within this study.

#430 - Use of Offsite Construction in addressing Post-Covid Housing Supply Crisis and Sustainability Issues: The Perception of Stakeholders in Scotland, UK.

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Keywords: **Offsite construction, housing crisis, end-user's perception; sustainability**

Abstract

Reports reveal that Scotland requires about 10,600 dwellings per annum between 2021-2026 to deal with backlog, yet construction activities fell by 2.6 % in 2020. Offsite construction method is presently gaining traction as researchers have claimed that the technology has scope for addressing the above issues with traditional construction in addition to quality, health & safety, cost, time savings and sustainability. Despite these perceived benefits, uptake has been slow. This study argues that prior studies have presented unbalanced viewpoints about offsite buildings by neglecting the sensitivities of other key stakeholders. The study aimed to understand the end-users' and construction workers' perceptions of the use of offsite technology in the construction industry in facilitating housing supply in Scotland during and after the pandemic. Adopting a quantitative research design and survey instrument, with a sample size of N=98, statistical analyses were performed including Spearman's correlation, Wilcoxon, and Man-Witney statistical tests. This study found both stakeholder groups shared a positive view of MMC future and potential, however, on replacing traditional construction, a significant difference (p-value = 0.002) in perception was observed. End-users were mainly undecided (56%), while 51% of construction workers in disagreement were more resistant to change, implying a mutual reluctance to committing to the technology. Importantly, the study revealed that end-users were more concerned about sustainability (waste reduction potential of offsite construction), but house price, size and location of buildings were more important. For drivers and post-pandemic adoption strategy, both groups showed consensus on waste reduction benefits and the need for promoting awareness of benefits case to a wider market, however, there were disagreements in other areas with respective biases towards mortgage-ability and industry capacity.

#432 – Exploring the Potential of Implementing the Toyota Production System in the Construction Sector: A Quantitative Analysis

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Keywords: Lean Construction, Project delivery, Toyota Production System, Quantitative analysis.

Abstract

This research study examines the potential of adopting the principles of the Toyota Production System (TPS) in construction projects and its impact on project delivery. Utilising a quantitative data collection and analysis approach, a questionnaire was administered to a focus group consisting of 11 participants recruited from the construction industry. The collected data were analysed using the Spearman rho correlation to measure the strength of the relationship between variables. The findings of the study reveal that the TPS principles are not unfamiliar to the construction sector, as most respondents agreed that all four components of TPS can be adapted to construction activities and will improve project delivery. The study demonstrates a strong correlation between the adoption of TPS and improvements in productivity and project delivery in construction projects. In addition, the study identified challenges such as limited opportunities to learn from previous projects and a lack of proper documentation as hindrances to the seamless adoption of TPS in the construction industry. The generalisability of the findings is limited due to the small sample size, as such, further research is ongoing to gather data from a broader range of stakeholders within the construction sector.

#436 – Innovation lessons: Combining digital fabrication and circularity with bio-based materials

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Keywords: Net-zero Construction, Circular Economy, Modern Methods of Construction, Hemp Bio-Composite

Abstract

Suitable for buildings up to 18m in height The ADEPT system is a fully integrated prefabricated construction solution comprising a breathable thermal envelope, cladding, internal walls, internal finishes and provision for integrated MEP services. The system can be delivered in panelised or volumetric elements, or both, according to client requirements. Standardised, repeated elements combine with optimal material efficiency to make a system which is affordable, scalable, quick to build and suitable for awkward access or infill sites. Demountable panels and components allow partial or complete disassembly, re-use and a circular economy of parts, as well as non-destructive alterations during the lifetime of the building.

The ADEPT system targets both operational net carbon neutral and negative embodied carbon, making efficient use of biogenic materials and circular design principles. Integral to the system is a novel patented hemp bio-composite which delivers improved indoor air quality through hygrothermal buffering. Whole life carbon assessment is integral to all stages of the design, fabrication and assembly of the system as well as future maintenance and alterations.

This paper describes the hemp bio-composite and presents a case-study of the ADEPT system, together with a life cycle assessment

Water and Air Quality

#324 – An examination of Nature-Based Solutions' ability to retain New and Emerging Pollutants – Preliminary results from a UK field test

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Keywords: Nature-Based Solutions, New and Emerging Pollutants, Retention.

Abstract

New and Emerging Pollutants (NEPs) include a vast range of compounds which are often not included in water quality monitoring campaigns or legislation for environmental protection. Traditional water treatment systems are not designed to treat NEPs and previous research has highlighted that many NEPs can persist through them and enter the aquatic environment. NEPs then cause a range of sub-lethal negative effects on wild organisms. The issue of NEP pollution is even more acute in informal settlements which lack formal drainage systems of any kind. This study describes a UK field test of Nature-based Solutions designed to retain and treat NEPs and constructed with low cost and recycled materials at its forefront. The test site consists of 6 individual test beds, 3 of which have been left to self-seed as controls and another 3 which were planted with *Salix viminalis* propagated from an existing tree on site. The systems were watered multiple time a week with water spiked with 8 NEPs (Amoxicillin, Caffeine, Ibuprofen, Nevirapine, Paracetamol, Sulfamethoxazole, Triclosan, Trimethoprim) at 1000 ng/L to simulate NEP addition by informal settlement dwellers, starting February 2023. Water samples were collected from each test bed monthly and NEP concentrations were evaluated by online-SPE LC-MS, while microplastic emissions were assessed via µFTIR microscope. In the system's first year since initial construction in spring 2022, a total of 40+ species of plants were identified in the self-seeded systems, along with multiple animal species. All test bed systems showed a great capacity to deal with extreme summer heat without requiring large inputs of water and were capable of absorbing large volumes of water from winter rain before flooding. Initial results have demonstrated the presence of microplastics being emitted from the system predominantly in the form of PET, PTFE, and cellophane. Analysis of chemicals NEPs is ongoing.

#344 – "The Great River Thames Washout" - The Impact of Seasonality on microplastic abundance

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Keywords: Microplastics, Water quality, Rivers, Pollution.

Abstract

In the UK, microplastics are considered an emergent contaminant but not pollutants and, at this moment, are not monitored as part of water quality tests. As a result, microplastic abundance within many UK rivers is unknown. This also means that the many factors influencing microplastic abundances within individual rivers, such as seasonality and rainfall, are currently understudied. This study focused on the seasonal impacts, including the effect of rainfall, on microplastic abundance within the surface water of the river Thames. Ten sites in eight areas were sampled along the tidal section of the river, starting at Teddington and ending in Southend-on-Sea. Three litres of surface water were collected monthly at high tide from land-based infrastructure from May 2019 - May 2021. A total of 6657 pieces were identified and recorded throughout this study. However, there was no significant variation between seasons and microplastic abundance, with the mean microplastic abundance along the River Thames ranging from 10.29 ± 4.34 L^{-1} (Spring) to 14.83 ± 7.49 L^{-1} (Autumn). However, there was a substantial difference between MP abundance observed between consecutive seasons in 2019-2021. Fibres were the most abundant throughout, making up 77.1 - 85.96% of samples in all four seasons. A total of 1041 pieces of suspected microplastic were analysed via Fourier transform IR (Infrared Radiation) spectroscopy, of which 176 pieces were not identified. Out of the 41 different polymers identified, the most common were PVC (24.5%), PS (9.8%) and PCP (7.69%). Polychloroprene was less observed in the Spring months compared to other seasons. This study demonstrates a yearly variation in seasonal microplastic abundance with less MP observed in the 2020 year, suggesting other factors, such as Covid-19, have a more substantial impact on microplastic abundance than environmental factors.

#390 - Mapping the Occupational Health Risks of Silicosis among Workers in Construction and Mining using GIS: A Case of Rajasthan, India

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Keywords: Silicosis, Occupational health, GIS Mapping, Dust Exposure, Rajasthan

Abstract

This paper highlights the significance of Geographic Information Systems (GIS) mapping in assessing and managing the risks associated with silicosis, a prevalent occupational lung disease caused by exposure to respirable crystalline silica dust. With a focus on silicosis in India, specifically in the state of Rajasthan, the study explores the background, types, occupational industries, and activities related to silicosis. Silicosis poses a significant public health challenge in Rajasthan, primarily affecting workers in the mining industry and other occupations associated with silica dust exposure. The health and socio-economic impacts of silicosis are substantial, placing a burden on affected individuals, their families, and the healthcare system.

This paper examines the regulatory mechanisms in place and evaluates their effectiveness in preventing and mitigating silicosis. While these regulations play a crucial role, the complex nature of silicosis demands innovative approaches to enhance risk management. GIS mapping emerges as a powerful tool for identifying high-risk areas and guiding targeted interventions. By integrating spatial data with information on occupational industries and activities, GIS mapping can provide a comprehensive understanding of the geographic distribution of silicosis cases and the underlying factors contributing to its prevalence. The benefits of GIS mapping for silicosis risk assessment and management are numerous. It enables proactive interventions, facilitates medical resource allocation, and aids in the identification of vulnerable populations. Furthermore, the methodology section outlines the data collection process and reliable sources used for mapping silicosis-related risks in Rajasthan, ensuring the accuracy and reliability of the GIS analysis.

In conclusion, this paper emphasizes the significance of GIS mapping in understanding and addressing the risks associated with silicosis. By leveraging spatial data, policymakers, researchers, and occupational health practitioners can develop targeted interventions, improve prevention strategies, and ultimately reduce the burden of silicosis on affected individuals and communities in India, particularly in Rajasthan.

Building Resilience

#350 - SYNTHESIS OF SMALL-SCALE MINING COMMUNITY FLOOD VULNERABILITY AND RESILIENCE STRATEGY IN GHANA.

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Keywords: Communities, Flood Vulnerability, Ghana, Small Scale Mining.

Abstract

The impacts of floods on communities can be devastating, leading to loss of property, displacement, and even the loss of lives. Despite efforts to address flood risks, the academic community's understanding is still low. This paper synthesised the factors influencing flood vulnerability and the resilience strategies of three small-scale mining communities in Ghana. The study employed interviews, document reviews and content analysis. The flood vulnerability factors include physical, social, economic, and environmental. The effective coping strategies identified include participatory, community engagement, community-based disaster risk management, policy-level, and individual-level strategies. It can be concluded that illegal small-scale mining communities in Ghana are vulnerable to floods without any proactive measures to minimise the detrimental impact on the lives of the residents. Effective flood management programmes should be implemented in small-scale mining communities to increase their preparedness for the impact of floods. The study's limitations include limited sample size, biased responses from respondents, and challenges in controlling the quality of the qualitative data. The paper provides insights into possible interventions to mitigate the impact of floods in small-scale mining communities.

#356 – Mainstreaming disaster risk strategies into the built environment

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Keywords: Collaboration, Plans, Risk, Strategies, Technology.

Abstract

Disasters have become increasingly frequent and destructive worldwide; therefore, there is a need to integrate disaster resilience strategies into all aspects of society. The aim of this paper is to investigate how disaster resilience strategies can be mainstreamed into the built environment, with a focus on identifying best practices, challenges and opportunities for improvement. A comprehensive review of relevant literature was conducted, including peer-reviewed articles, reports, and case studies. The methodology adopted is a qualitative method which is purely a literature review. An extensive literature review search of electronic databases such as Scopus, Web of Science, and Google Scholar, as well as manual searches of reference lists of relevant articles, was conducted. The findings of this study suggest that mainstreaming disaster resilience into construction processes is crucial to reduce the negative impact of disasters. Moreover, the need for collaboration between stakeholders, such as architects, engineers, contractors, and local authorities, to develop comprehensive disaster risk management plans. The need to incorporate new technologies and building materials to enhance the resilience of buildings, such as the use of earthquake-resistant materials and the adoption of passive cooling strategies. The study provides insights into how disaster resilience can be mainstreamed into construction processes, highlighting the importance of collaboration, innovation, and capacity-building. The study underscores the need for a holistic approach to disaster resilience in construction, which involves not only improving the physical structures but also considering social and economic aspects. The study provides valuable information for policymakers, researchers, and practitioners involved in the construction sector to enhance disaster resilience and contribute to sustainable development.

#387 - Assessing the Role of Water-Sensitive Urban Design in Urban Form for Climate Change Adaptation: Lessons Learned from Best Planning Practices

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Keywords: Water-Sensitive Urban Design, Climate Change Adaptation, Urban Form, Best Planning Practices.

Abstract

With the increasing threat of climate change to urban areas, it is essential to evaluate the effectiveness of WSUD in building resilience. This paper evaluates the potential of water-sensitive urban design (WSUD) in urban form for climate change adaptation. Using a case study approach, this study analyses current practices and policies in WSUD implementation and highlights the best practices for WSUD integration into the urban form for climate change adaptation. Four projects examined are WaterEcoNet project in Qihe County in China, BedZED in London, Singapore NEWater, and Melbourne Water Recycling Project. The analysis identifies the importance of using alternative sources of water to meet the increasing demands of growing urban populations. It also emphasizes the need for innovative water treatment technologies to ensure the safety and quality of recycled water and it exemplifies successful partnerships between government, private sector, and community stakeholders to implement sustainable water management solutions. Those several common themes related to water management and water reuse show the barriers to WSUD implementation and emphasize the need for a multifaceted approach that involves coordination between stakeholders, innovative design solutions, and supportive policy frameworks. The study also indicates some water problems in Turkey such as floods and drought which has a direct impact on the drinking water. A SWOT analysis will be done for Bursa city, which is one of the most water-stressed cities in the Marmara Region of Turkey, with limited water resources and high demand due to a growing population and expanding industrial sector. The city has struggled to provide adequate water supplies to its residents, particularly during periods of drought. The analysis results indicate that WSUD is an essential way to ensure urban resilience to water-related risks.

#408 – Analysing Seismic Vulnerability, Damage Scenarios and Inaccessible Areas in the Old City Centre of Coimbra, Portugal

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Keywords: Seismic Vulnerability, Damage Scenarios, Evacuation, Old Urban Areas.

Abstract

In recent decades, seismic risk evaluation in old urban areas has gained increasing attention from academics, planners, and decision-makers, being considered nowadays as a key aspect in the strategic definition of urban planning and management. This paper addresses the assessment and management of seismic risk in old urban centres by applying a simplified seismic vulnerability assessment approach to evaluate the seismic vulnerability of 284 buildings in the old city centre of Coimbra, Portugal. Data for the assessment was collected through a series of fieldwork campaigns carried out between September 2020 and November 2021 using, for such, data collection sheets. The results were used to create large-scale vulnerability and damage scenarios that, with the help of a Geographic Information System (GIS) tool, were then utilised to identify the routes and urban areas that can potentially become blocked after a seismic event. While not discussed in this paper, these results represent the first step of a broader research project in which a virtual reality (VR) environment of the urban area will be used to simulate rescue and pedestrian evacuation under different earthquake scenarios.

#433 – DETAILED MODELLING OF FLUID-PARTICLE INTERACTION IN SEDIMENT TRANSPORT WITH APPLICATIONS IN RIVERS

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Keywords: Sediment transport, LES, Four-way coupling, CFD- DEM.

Abstract

This work demonstrates four-way coupling between Computational Fluid Dynamics (CFD) and Discrete Element Method (DEM) through open-source CFD-DEM code, focusing on bed-load sediment transport at a particulate scale. The study combines numerical and experimental investigations to provide a comprehensive analysis. Large Eddy Simulation (LES) turbulent modeling is employed to capture turbulent scales, while inter-particle sediment collision is highlighted through four-way coupling.

The research showcases the mutual interaction between the fluid and sediment particles, emphasizing the impact of turbulence and near-bed flow velocity on particle motion. The presence of sediment particles in turbulent flows affects the fluid motion and associated turbulent activities. Furthermore, the study reveals the influence of sediment on the turbulent structures in the flow, attributed to momentum exchange between the particle and fluid phases. Fluctuation variations at the location of interacting particles demonstrate this effect.

Community Building and Co-Production

#376 - SUSTAINABILITY RESEARCH CENTRE (SRCe) – MEASURING COMMUNITY OUTCOMES, AN AUSTRALIAN EXAMPLE

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DESIM – R&D
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Keywords: Collaborative Planning, Circular Economy, Community Engagement, Sustainability

Abstract

In accordance with Sustainable Development Goals, achieving sustainable, regenerative development requires continuous measuring of outcomes on multiple bottom lines. The measurement of economic and environmental/ecological outcomes of sustainable development are reasonably well researched and implantation is in some cases well advanced. Measuring social outcomes, on the other hand, is lagging.

New technologies, like AI, blockchain, smart cities, Digital Twins, and new methodologies, as Circular Economy, are providing opportunities to address this gap in innovative ways. The question is: who evaluates outcomes? Who determines what the successful community is? How do we prevent misuse of these new technologies? Our research indicates that active participations of citizens would be necessary in defining and measuring outcomes of planning.

In this paper we have investigated the current system of public engagement and consultation as well as few alternative systems/tools explored in Australia. As a result, we have developed a proposal for an alternative model that could address some of identified problems of the existing system and anticipated difficulties in the future. The heart of that framework is the Sustainability Research Centre (SRCe), a hub and a place, physical and virtual, where community, industry and research collaborate.

Our plan is to implement this framework on our specific pilot project, in collaboration with specific community. The location of North Arm Cove in New South Wales (NSW), Australia is used as a case study for creation of an innovative, sustainable, regenerative development framework – North Arm Cove Initiative. This location has been selected 105 years ago by an American urbanist, architect and community builders couple Walter Burley and Marion Mahony Griffin, as a preferred location for their plans for the New York of Australia. Their Master Plan did not progress beyond the subdivision and sale of more than 3000 lots, to landowners who have been subsequently affected by prohibition of building homes on their land.

#401 - The role of social media in community engagement during the Climate Crisis: A UK case study that uses a new analytical perspective.

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Keywords: Community engagement, sustainable development, Schatzkian-based practice thinking, social media analysis.

Abstract

This UK-located empirical study examines the role of social media use during the community engagement of the delivery of a major new and socially valuable NHS hospital project using a novel analytical perspective that is a combination of qualitative and quantitative methodologies. The land use decisions taken by the project sponsor provoked opposing views within the community about what constitutes sustainable development as defined by the United Nations in the context of the current Climate Crisis.

The new analytical perspective digs deep and its findings from the case study reveal the 'moral imperative'' of the Climate Crisis (as an existential crisis that is particularly pronounced as a cause of 'eco-anxiety' within Generation Z) in a democratic context and problems with the current community engagement processes employed by the project sponsor that is typically used by the public sector in the UK. The findings also reveal the emergence and prominence of the tactical and increasingly sophisticated use of social media as the disputes between the groups escalated.

We argue that this new perspective may assist in the effective and efficient delivery (by avoiding delays) of badly needed future UK socially valuable infrastructure projects (e.g., schools, flood defences, hospitals, water reservoirs, transport systems) sustainably, whilst at the same time respecting community engagement and radically different perspectives of what 'sustainable development' means to different stakeholders. This may be achieved, it is argued, by promoting a deeper understanding of the actuality of the social interactions at the front end of such projects, via the analysis of social media uses, as a potential means by which to anticipate community engagement problems quickly and effectively, to avoid or at least mitigate, the risk of prolonged and corrosive intercommunity conflicts and costly delays being incurred.

#425 - The Emotional Intelligence Competence: A Perception of Project Managers Construction Industry

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Keywords: Emotional Intelligence, Teamwork, Collaboration, Conflict Management, and communication.

Abstract

This study aims to highlight the factors related to emotional intelligence competencies that influence the relationship between Project managers and Team members success in the Scottish construction industry. Traditionally, the construction industry is flawed, with many uncertainties, stress, and frustrations arising from project failures and unresolved conflicts. Studies have shown that Emotional intelligence competence, such as self-awareness, social awareness, self-management, and relationship management, are vital competencies that significantly influence construction workers. Therefore, this quantitative pilot study was conducted to confirm whether components such as collaboration, communication, conflict management and teamwork are related to project managers' emotional intelligence competencies and their effect on team members. Goleman (1998) defined Emotional intelligence as the capacity and abilities to recognise, analyse, and be aware of one's own and other's emotions, and then channel one's thoughts and actions toward cultivating peaceful, productive, success-driven environments for work. This paper highlights the factors that affect emotional intelligence competence of project managers in the Scottish construction industry. nineteen studies were conducted with Scottish construction project professionals such as project leaders, directors, managers, and team members. The respondents are as follows (five project leaders, three project directors, four project managers, three project team members, and other designations four). Among these study respondents 12 respondents worked in the construction project and building environment, three worked in education, two worked in the healthcare sector, and two worked in the oil, gas & energy sectors. Questionnaires completed online via Napier survey Novi website. The finding indicates that communication, collaboration, teamwork, and EI competences the relevant factors that significantly impact on the project managers performance level in successfully delivering projects, it was gathered that gender, age, experience, and not trivial factors that affect the EI competence of project managers. This study recommends that EI competence should be included in the training and recruiting processes and procedure which includes managing of construction workers.

#449 - Community resilience; people, place, and practice

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Keywords: Resilient Community, Housing, Built Environment and Older People (Font 10).

Abstract

This paper outlines initial findings from the Almshouse Resilient Communities (ARC) for the Future project, led by UCL in collaboration with UoS and seven almshouse charities. Overall, the project aims to provide answers to the research question: How can almshouse communities become more resilient? ARC takes a contextualised holistic approach, examining three forms of resilience and their interdependencies: (1) community or social resilience, (2) resilience in the built environment and (3) resilience in almshouse charity governance. This presentation examines the second form, resilience in the built environment, specifically spatial arrangements, community space and the role these play in place attachment and wellbeing for older people.

Drawing from interviews with residents and staff, site observations and field notes, this presentation explores the importance of internal and external communal spaces in relationship to place attachment, developing social capital and the contribution to resilience within the defined setting of the almshouse. Described through images and drawings these communal spaces are examined in the context of the residents' lived experience.

Analysis of the role communal space plays in the daily lives of older people in almshouses, enables speculation on the importance of providing opportunities for social interaction when designing and adapting housing for society more generally, reinforcing the connection between physical and mental health and housing for designers and housing professionals. Exploring initial findings from Phase 1 has informed subsequent phases; the final of which is the development of a toolkit for residents, almshouse charities and housing providers.

Building Performance and Retrofit

#346 - A Case Study on Retrofitting of an Existing Residential Building in Germany for Energy Efficiency and Performance

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Keywords: Resilient Construction, Flooding and Zero Energy

Abstract

Depleting energy sources and climate change are important concerns of the world today, and buildings have a considerable share in energy consumption. Taking into account the large ratio of existing buildings to new construction, reducing energy consumption and focusing on energy-efficient retrofitting of existing buildings become essential for sustainable development, and passive design strategies can improve the performance of the building. In this scope, this study was aimed at achieving energy efficiency and investigating the impact of glazing systems and the strategy of implementing a buffer zone to the north facade on annual energy consumption and cost of the building. To this end, a residential building located in Berlin called Scheibe Nord was studied, and energy analyses of before and after retrofitting conditions were conducted by using Autodesk Revit Architecture and Insight. In addition, photovoltaic panels were recommended for the retrofitting project, and alternative flats were proposed to contribute to the social aspect of sustainability. The results showed that triple glazing and focusing on the north facade with passive design strategies in Berlin can decrease overall consumption and energy costs. The reduction in energy usage can encourage owners and policymakers at governmental institutions to launch extensive retrofitting campaigns to address the current energy crisis.

#450 - Extending building life expectancy, using structural research and forensic data to inform inspection and monitoring protocols for RAAC structures.

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Acknowledged work of the full RAAC research team. David Lister, Bashar Alhnaity, Justin Fryer, Christian Stone, Joanne Booth and Richard White, Martin Liddell

Keywords: Building Survey, Concrete Panels, Condition Survey, RAAC, Risk Management

Abstract

The life of a building is normally extended well beyond its designed life. However, where the integrity of structural components are questioned a full investigation is necessary for assured safe operation. In this study, the structural integrity of buildings constructed from Reinforced Aerated Autoclaved Concrete (RAAC) during the 1970's was identified as a risk following the collapse of a concrete roof in a school. As RAAC was commonly used in public buildings during the 1970s and had exceeded an anticipated life span of 20-30 years there was concern that designed structural performance may be compromised.

A multidisciplinary team undertook an investigation of existing RAAC buildings. The team forensically surveyed and analysed buildings and RAAC planks were modelled and tested. Although components had exceeded their design life, those tested were found to perform beyond design requirement. However, the investigation found that RAAC fabrication and assembly on site could result in insufficient end-bearing, which could lead to failure. A method of inspecting the end-bearing was codesigned to ensure bearings are sufficient and the life of the building can be extended. The inspection and survey method could result in considerable savings, and should prevent unnecessary structural remedial action and demolition. Equally, it will help identify RAAC planks most at risk and in need of remedial action.

#409 - Pre-retrofit building performance evaluation of existing UK social housing dwellings

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Keywords: Retrofit, housing, energy, building performance evaluation.

Abstract

As part of the transition to Net Zero by 2050, the UK Government's Social Housing Demonstration Fund has been launched to upgrade a significant amount of the social rented homes in England to an Energy Performance Certificate (EPC) Band C standard, while delivering warm, energy-efficient homes and tackling fuel poverty. This paper uses building performance evaluation (BPE) methods to empirically examine pre-retrofit building fabric thermal performance, energy use, indoor environmental conditions and household characteristics of 32 social housing dwellings located in Warwickshire, England. Empirical data was gathered between 1 December 2021 and 30 November 2022. Thermography revealed a lack of insulation, with significant heat loss around wall joints. This was more pronounced in the 1920s triangular semi-detached dwellings which had the highest gas consumption at 12,000kWh/year compared to 4,500kWh in the 1960s terraces. The average annual energy cost across the sample was £1,645, with a maximum of £4,320/year. Statistical analysis of time-series data revealed that the 1960s terrace typology experienced the lowest indoor temperature across all seasons due to less number of exposed sides. Summer indoor temperature was 4°C higher than other seasons, often exceeding 30°C. Relative humidity of 52% was relatively stable. The 1960s terraced dwellings experienced the highest diurnal CO2 levels with peaks exceeding 1400ppm during occupied hours. Peak CO_2 concentrations reached 5000ppm with some daily averages over 3300ppm due to prolonged occupancy and inadequate window-opening to conserve heat. Since the dwellings overheated in the summer and were cold in the winter, an approach to retrofitting needs to combine building fabric and heating system upgrades with passive measures (shading, ventilation) for tackling overheating so that these homes can stay warm in winter and cool in summer. A data driven based approach to retrofit assessment and evaluation will also help in reducing performance gap.

#433 - DETAILED MODELLING OF FLUID-PARTICLE INTERACTION IN SEDIMENT TRANSPORT WITH APPLICATIONS IN RIVERS

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Keywords: Sediment transport, LES, Four-way coupling, CFD- DEM.

ABSTRACT

This work demonstrates four-way coupling between Computational Fluid Dynamics (CFD) and Discrete Element Method (DEM) through open-source CFD-DEM code, focusing on bedload sediment transport at a particulate scale. The study combines numerical and experimental investigations to provide a comprehensive analysis. Large Eddy Simulation (LES) turbulent modeling is employed to capture turbulent scales, while inter-particle sediment collision is highlighted through four-way coupling. The research showcases the mutual interaction between the fluid and sediment particles, emphasizing the impact of turbulence and near-bed flow velocity on particle motion. The presence of sediment particles in turbulent flows affects the fluid motion and associated turbulent activities. Furthermore, the study reveals the influence of sediment on the turbulent structures in the flow, attributed to momentum exchange between the particle and fluid phases. Fluctuation variations at the location of interacting particles demonstrate this effect.

#434 – Towards energy-efficient retrofitting of social housing in the UK: Assessing the occupant behaviour and indoor environmental quality of a council block in London

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Keywords: Indoor air quality, thermal comfort, building energy performance, health and wellbeing.

Abstract

The UK is confronted with a significant challenge as it possesses one of the oldest building stocks in Europe. This necessitates extensive retrofitting efforts to upgrade these buildings and bring them up to par with the environmental requirements. This is even more challenging when it comes to social housing, where they usually suffer from poor energy efficiency and indoor environmental quality (IEQ) issues. Therefore, there is an inherent demand to understand the current environmental conditions of these buildings. This study focuses on assessing indoor air quality (IAQ), thermal comfort, occupant behaviour and energy performance with the aim of improving the current conditions and identifying strategies for achieving energy-efficient retrofits. The paper utilises quantitative field measurements, and questionnaires conducted with the residents to evaluate the current state of the building's IEQ and energy performance. IEQ parameters such as air temperature, relative humidity, and carbon dioxide (CO2) levels are measured to assess thermal comfort, overall IAQ, and potential health implications for residents. These measurements were conducted using data loggers installed for 6 weeks during March and April in 2023 in 13 selected case study flats within the council block. Simultaneously, weekly meter readings were also collected for each of the flats. The measurements collected by the data loggers were then compared to the UK standards, guidelines, and benchmarks to evaluate the current conditions. Moreover, the analysed data was linked with the questionnaire survey conducted in the case study flats, to assess the impact of occupants' behaviour on IEQ and energy performance. The findings highlight the importance of considering IEQ and occupants' behaviours alongside energy performance during retrofitting initiatives, aiming to create healthier and more sustainable living environments for social housing residents. These results contribute to the development of evidence-based retrofitting guidelines and policy recommendations for social housing in the UK

Waste Management

#345 - Chemical characterisation and leaching properties of air pollution control residues (APCr) from municipal solid waste incineration (MSWI) sites in the UK.

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Key words: municipal solid waste incineration (MSWI), air pollution control residues (APCr), heavy metal, leaching properties.

Abstract

The thermal treatment of Municipal Solid Waste (MSW) in Energy from Waste (EfW) facilities is continuously increasing in the UK as a sustainable practice to reduce the amount of waste that is sent to landfill. However, the MSW incineration (MSWI) causes the volatilisation of hazardous compounds contained in the waste. These contaminants are removed from the gaseous emissions by air pollution control units. The solid waste generated during this cleaning process, known as air pollution control residues (APCr), are classified as hazardous because their chemical composition and leaching properties cause an environmental impact. The variable concentrations of metals and soluble salts make APCr treatment a difficult practice; hence, this waste must be carefully characterised before being treated either for disposal or for recycling. In this research, APCr from 22 EfW facilities in the UK, were analysed for heavy metals, mineralogy and leaching behaviour. The contents of heavy metals were determined by Inductively Coupled Plasma – Optical Emission Spectroscopy (ICP-OES), revealing that the elements of major concern, given their high contents (122 to 10,500 mg/kg), were Pb, Zn, Ba and Cr, of which the most concerning metal was Pb with leachable concentrations from 7 to 2,570 mg/kg. The mineralogy was analysed by X-Ray diffraction (XRD). From a total number of 45 mineral phases identified in APCr, the most common were Calcite, Quartz, Calcium hydroxychloride, Halite and Sylvite. Regarding soluble salts, chlorides exhibited the highest leaching rates, from 9,756 to 330,275 mg/kg; while the leaching of sulphates was between 53 and 27,566 mg/kg, and the leaching of fluorides varied from 23 to 44 mg/kg. The APCr characterisation provides valuable information for the implementation of a suitable treatment aimed to reduce or stabilise the contents of heavy metals and soluble salts, improving their leaching properties and enabling the APCr for further recycling.

#410 – Safe and Sustainable Collection and Transportation of Faecal Sludge

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Keywords: Faecal Sludge Management, Risk Assessment, Ant Colony Optimization and Sustainable Transportation.

Abstract

The villages or scattered hamlets with low population density and peri-urban areas with medium population density in India, has very less affordability for developing and maintaining the environmental services. In such cases an onsite sanitation system is adopted. As per the latest Census, 52% of all toilet-owning households in urban India rely on onsite sanitation systems. Faecal sludge collection from these sites is a challenging task due to poorly managed resources causing hazards during collection & transport (C&T) of faecal sludge leading to environmental degradation and risk to human health. The present study attempts to offer an approach for optimal and safe collection and transportation of faecal sludge particularly in underdeveloped towns and non-sewered areas in the cities. The risk associated with septage collection and transportation is a crucial aspect which differentiates the problem from other route optimization studies. The present study also covers risk assessment for the collection and transportation of septage from dispersed groups of sources considering wide variety of practical problems encountered during the collection and transportation of the septage. For understanding type, probability and severity of the risky events, a detailed questionnaire survey followed by the detailed analysis is performed. The scenario-based risk assessment is performed for 14 major risky scenarios. The system is optimized for safe sustainable routes using a meta heuristic ant colony optimization approach to generate the secure and optimum route for septage collection and transportation. This approach would reduce the ultimate cost of providing sanitation services to rural populations while minimizing the hazards associated in the collection & transport of faecal sludge. The paper also presents an illustrative example to further explain the utility of the proposed approach in decision making for safe and optimized route optimization for septage collection and transportation.

#412 – Waste Composite as Fine Aggregate Replacement for Lightweight Concrete

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Keywords: Waste Materials, Aggregate Replacement, Green Concrete and Sustainable construction.

Abstract

With the rapid increase in population, the non- biodegradable waste generated is increasing exponentially which can be potentially a good resource for construction material replacement. Fine aggregates are an important constituent of the concrete mix. This paper presents an experimental investigation conducted on multiple combinations of waste materials with an aim to produce a sustainable concrete mix. Desired concrete properties like weight, tensile strength, compressive strength, workability, cost effectiveness are checked and compared. More than 70% of the aggregates were replaced with waste materials including waste glass, rice husk ash, waste plastic, and M- sand. Other than these, EPS beads and clay balls were used as aggregate replacements to make the concrete lightweight. Waste Fly Ash has been used as a partial replacement for cementitious materials. All the procured materials were first tested for all the different properties including specific gravity, water absorption, fineness modulus, moisture content to ensure concrete quality. The same materials were also tried in different proportions to obtain the most suitable and efficient concrete mix with the proper replacement of aggregates. More than 70 concrete cubes were tested for desired concrete properties. It was found that a concrete mix with 10% crushed waste glass, 3% EPS beads, 10% Rice Husk Ash, 18% Clay balls, 10% Plastic and 50% M-Sand as aggregates' replacement with 5% waste fly ash and 15% silica fumes as cementitious materials' replacement produced the best result in terms of the testing criteria. This paper proposes a lightweight concrete mix with commendable properties with experimental evidences.

#421 – Smart Waste Management System Development and Evaluation Decision Support Framework

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Keywords: Waste management, Decision support, Framework, IoT

Abstract

Effective waste management (WM) is one of the most significant environmental problems and a major challenge for any large city. While there are numerous studies describing individual aspects of WM systems in specific contexts, there is no general approach that would unite all the accumulated results into a single framework. The aim of this study is 1) to explore how to develop an IoT-based smart waste management (SWM) system that improves the waste management processes of a city and 2) to develop an SWM system improvement and evaluation decision support framework (DSF), that could provide recommendations about WM implementation in cities, based on the city objectives, the characteristics of the city and the current WM status in the city. To develop the SWM DSF, we used data obtained from 173 primary studies of a literature review, surveys performed in three different cities, and ideas from waste management hackathons. The developed DSF includes five parts 1) Framework guidelines, 2) Context setting, 3) Goal setting, 4) Challenges to be tackled, and 5) Recommendations (provides the recommendations for achieving the set goals and solving problems, taking into account the specific context of the city). The SWM DSF has been tested and evaluated in 2 stages of testing: 1) by researchers at a university, 2) by a panel of experts in the field of SWM and decision support systems, including professors from leading universities of Finland and representatives of companies specializing in SWM. The test results showed the plausibility and usability of the framework. The developed SWM DSF can be used by representatives of the city administration of any city, as well as representatives of companies specializing in WM.

Planning and Sculpturing Positive Change

#308 - Do Project Managers have expanded short term memories?

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Keywords: planning fallacy; retention techniques; externalisation; capabilities

Abstract

Known human limitations for short term memory mean project managers managing local complexity either have ways of extending memory using plans and/or have expanded short term memory capabilities. The aim of this primary research is to investigate whether project managers DO have expanded short term memory capabilities. This was done using an inductive approach, conducting experiments with 2 sample groups (5 – Project Management based & 5 – Non-Project Management based). Observationally planning to represent the externalisation of detailed memory for recall, does not occur (for a variety of reasons) – So, some other method must be at play, expanded mind-capacity might be one of these solutions.

The research displayed a reliance on methods of externalisation within the project management (PM) control group, which was in turn, reflected in the results of both experiments undertaken (PRE intervention). To try and better understand the data obtained from conducting the research, an intervention sample was chosen from the non-PM group, as a sample which stood out with similarities in job role and responses to the project management control group. Implementing the planned intervention into the control group, created a dynamic which meant that the two groups were homogeneous samples (project management sample group) and heterogeneous samples respectively (non-PM control group). The results both point towards the Null Hypothesis, in that project managers do not have expanded short term memory capabilities when compared to a control group. The results displayed a higher number of tasks remembered for both interventions (PRE & POST), within the project management control group, whilst displaying a heavy reliance on methods of externalisation using technology. There was a reliance on externalisation, with the non-PM outperforming the opposing control group in both experiments. Exogeneous variables need to be taken into consideration when looking at the results from the project managers, at the time of the research taken there were distracting factors in play that may have influenced the responses in the experiment (whether they be professional or personal distractions). Any future experiments regarding this research will need to ensure that the exogeneous samples are moved to statistically significant samples, to provide an element of control to account for the specific experiences of the intervention group that result in a homogeneous sample group.

#312 – What could Project Managers learn from Entrepreneurs?

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Keywords: *Project Management, Entrepreneurs, Innovation, Risk Management*

Abstract

This paper reflects upon entrepreneurship with a view to enrich the management of projects in practice. It briefly explores the potential synergies and differences between the phenomenon of entrepreneurs and constraints of project managers. The literature review examines entrepreneur traits and behaviours in detail. Research is undertaken in the form of n=14 structured interviews with entrepreneurs and the responses are thematically coded and analysed. Findings show that entrepreneurs are motivated by opportunity (pull) and necessity (push) factors and desire control & autonomy; develop risk strategies to remove risk; deliver incremental product and position innovations and display a range of behaviours to overcome barriers. It concludes that agency, control and risk reduction are key factors in entrepreneurial success which are missing in project management controlled regimes. It presents two hypotheses for consideration: H1; an increase in project manager's autonomy will positively impact upon project success and H2; a reduction in pre-determined evaluation criteria will improve project innovation.

#322 – Cyber Community-based Facilities Management: A Conceptual Framework for Improving Sustainability in Higher Education Institution

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Keywords: Community-based Facilities Management, technological innovations, capabilities approach, higher education institution and sustainability

Abstract

The paper proposes a conceptual framework for improving sustainability in higher education institutions (HEIs) through cyber community-based facility management. The conceptual framework of the paper is based on facilities management (FM), the diffusion of innovation, and human development theory. The principles adopted for the conceptual framework are community-based FM, technological innovations, and capabilities approach. The framework is based on the idea that FM can be improved by utilising technology and the community's capabilities through HEIs characteristics to promote sustainability. The framework's four essential elements are technology, community capabilities, HEIs characteristics and sustainability. Technology is used to collect data, monitor, and control energy consumption, and improve overall facilities performance. Community capabilities refer to the skills, knowledge, and resources available within a community to engage in sustainable practices and initiatives. Characteristics of HEIs include facility type, public or private designation, location, institution district boundaries, size, student enrolment, age, and infrastructure condition. Sustainability development is achieved through the implementation of green practices, reducing energy consumption, reducing waste, resource efficient and socially inclusive. The framework proposed is appropriate for use by HEIs because they consume a significant amount of energy, emit a significant amount of greenhouse gas emissions, and develop and strengthen students, faculty, and staff capabilities. As a result, they play a critical role in promoting sustainability. The paper concludes by emphasising the importance of further research on the conceptual framework's implementation and effectiveness in promoting sustainability.

#323 – Facilities Management its Effect on Social Sustainability: The Context of South African Higher Education Institution

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Keywords: Facilities management, social sustainability, higher education institution.

Abstract

Facilities Management (FM) has a significant role in promoting social sustainability. This study aimed to investigate the impact of FM on social sustainability in a South African Higher Education Institution, specifically Nelson Mandela University (NMU). The study employed an exploratory research design and a qualitative approach, gathering data from observations of three lecture theatres and semi-structured interviews with key personnel from the institution's Estate and Facility Management unit using a purposive sample. The findings highlight the importance of FM in creating a learning environment, reinforcing its role as a strategic enabler of the institution's academic mission. The study also reveals that effective FM, as defined by robust maintenance strategies, user involvement, and integrating physical and digital infrastructures, significantly contributes to the institution's social sustainability. The study emphasises the importance of ongoing dialogue and research in this evolving field, as FM's role in promoting social sustainability in higher education becomes more important. The findings suggest that a strategic and integrated approach to FM can improve social Sustainability in HEIs, providing valuable insights for similar institutions worldwide.

Education & Training

#361 - Education as an Engine of Sustainability

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Keywords: Architecture for Children, Primary School Architecture, Perception of Space, Creativity influenced by Architecture

Abstract

In the context of the transition to a sustainable, green and smart architecture, The European Union adopted a series of laws that develop and maintain a network of green schools able to be the promoters and the central incubators of a community able to accelerate the process. Also, starting from the European Union Council's Resolution to have a strategic cooperation in education for its countries, the latest have adopted a series of laws and regulations. For example, Romania conceived The National Recovery and Resilience Program (PNRR), which led in 2022 to changes to The Normative Regarding Design Implementation and Operating School and High School Buildings (NP 010/2022), and become support for a future network of green schools through The Order for The Approval of Former Methodology Regarding the Organization and Operation of Green Schools (ORDIN 4.147/ 29th June 2022). Along the impact on the built environment, there is a need found in ONU's statements to expand the sustainability aspects to community involvement and equal education rights. Thus, The Green Schools have a managerial, a curricular, a social, an infrastructural component, that include subjects concerning sustainability, teachers and pupils involved in ecological activities as a permanent state etc. and should end in a positive impact towards the environment (greener spaces, reduction of pollution, digital resources, healthy nutrition), results in learning and quality of life. The questions are: Is the infrastructure good enough to implement these? What are the conditions and resources we need in order to achieve what needed by 2025, 2030, years that are mentioned as deadlines for some of the aspects? What can other countries with great results in its educational system teach the countries that still have more to achieve? In conclusion, there is some incertitude, but for sure, to involve the whole community and to use the technology that youth love so much in a sustainable way, to give them the opportunity to digitalize their school, may be a starting point on how to assure this and also, be the starting line for creative children in qualitative architectural spaces.

#377 – Knowledge Sharing in the Construction Industry: Implications for the future of Projects.

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Keywords: construction project management, experiential knowledge, **knowledge sharing**, **pandemic**.

Abstract

Effective knowledge-sharing is vital for project management and success. This research investigates knowledge-sharing occurrences on construction sites in retrospect of the COVID-19 pandemic, drawing lessons learned and creating a systematic account of such implications. Supervisors within the construction industries are noted to have substantial tacit knowledge due to their experience level, which those being supervised (supervisees) generally lack. However, due to the sudden arrival of COVID-19, limitations were imposed on physical interactions which had adversely impacted tacit knowledge sharing between supervisors and supervisees on construction sites. Although safety measures were instituted to curb the disease's spread, some experienced supervisors were uncomfortable appearing on-site physically because of the increased infection risk. Challenges such as social distancing and masking, was observed to hinder knowledge sharing and communication with supervisees even when supervisors physically appeared. This research, therefore, adopts a qualitative research design to investigate knowledge sharing occurrences on construction sites in retrospect of the COVID-19 pandemic, using semi-structured interviews. The narratives were analysed with NVivo. Based on various knowledge-sharing scenarios, this study offers holistic and categorical insights into construction site issues during project execution. These insights are presented in a conceptual model to aid supervisors and supervisees in effective knowledge-sharing. The research outcome can be applied where virtual working is increasingly being implemented, and it helps inform future projects during similar crisis scenarios.

Energy Efficient Modelling

#375 – How Digital Twins can be Used to Maximise Social Value Creation

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Keywords: Digital Construction, Sustainability, Responsibility, Digital Twins.

Abstract

The use of digital twins in the UK construction industry is growing. They offer a wealth of well explored benefits that essentially aim to make the construction industry more efficient and effective. Social value is a concept that is equally growing in prominence in both research and industry importance. Social value is predominantly concerned with ensuring the construction industry has maximum positive benefit on the communities in which it operates. However, a problem exists in that contractors have finite resources, and so to focus on multiple initiatives is not always practical or even possible. This is potentially serving to restrict development of both concepts and limit the benefits either can achieve. This impacts both the contractors caught it the middle of competing demands and also the wider stakeholders who would potentially be the recipients of enhanced efficiency and increased value. By addressing this problem this research seeks to reconcile the potentially competing concepts of digital twins and social value. The aim of this research is to identify areas where both concepts overlap so that contractors can have a single focus and achieve both digital twin and social value benefits. By conducting an in-depth and analytical review of the extant literature this research serves to identify overlapping themes and potential areas of value co-creation. The findings of this research reveal that with further digital twin development, and an enhanced and holistic view of social value, efficiencies in delivery can be created. This would serve to ensure social value data can inform digital twin decisions, allowing contractors to focus on both concepts, requiring fewer resources yet achieving higher value creation for all stakeholders.

#396 - Fourth Industrial Revolution (4IR) Adoption Strategies in the Nigerian Construction Industry

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Keywords: Fourth Industrial Revolution (4IR), Digital Transformation, Construction Industry, Qualitative research

Abstract

Despite the inherent benefits that digitalisation brings to businesses across sectors, the construction industry in most developing countries seems unprepared and reluctant to embrace the digital trend. The fourth Industrial Revolution (4IR) has been projected to improve construction performance and overcome challenges faced in the industry. However, the lack of effective strategies for the adoption of 4IR in Nigeria has hampered its full adoption. This study examines strategies for 4IR implementation in the Nigerian construction industry. Anchored on qualitative research, a total of eight cases were interviewed in Lagos, Nigeria. Data generated were analysed using conversational thematic analytical methods. The study established government support, digital collaboration, training, increase in research and development, and standardisation of the industry using BIM as the most effective tactics for the implementation of 4IR in the Nigerian construction industry. However, different construction companies have different approaches to adopting 4IR. The study has provided strategies to help construction firms implement appropriate measures to adopt 4IR in the construction industry, an area lacking research attention. The study recommends organising seminars, conferences, and continuous training of skilled workers as it is the right track towards full adoption of 4IR in Nigeria's construction industry.

#402 – An Evaluation of the Adoption of Timber Frame Construction within the Residential Housing Sector in the United Kingdom

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Keywords: Timber Frame Construction, Sustainability, Residential and AEC sector.

Abstract

The Architectural, Engineering, and Construction (AEC) sector has been called to innovate in delivering its products towards driving the sustainable construction agenda (social, economic, and environmental). Also, such innovation will be beneficial in meeting the demand for residential buildings in the United Kingdom (UK) and globally. Therefore, this study aims at evaluating the level of adoption of timber frame construction within the residential sector in the UK. The study adopted a qualitative research approach using a semi-structured interview. Interviews were carried out with eight (8) senior staff members working for a residential property development company. The interview explores the benefits and barriers to adopting timber frame construction in residential buildings. Interview findings revealed that adopting timber frame construction is a driver in promoting sustainability's social, economic, and environmental targets. Some benefits are speed in construction, enabling a safe working environment, apprenticeship opportunities, and less environmental pollution. However, lack of knowledge, consumer/client perception, and site logistics are barriers and challenges against adopting timber frame construction. Therefore, the study suggests the need for creating awareness and educating construction clients on the advantages and benefits of adopting timber frame construction in residential buildings.

#404 – Building Information Modelling (BIM) and Energy Simulation Tools for Efficient Energy Modelling and Analysis

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Keywords: Energy Simulation Tools, BIM, Interoperability, Energy Modelling

Abstract

Due to the growing concerns of climate change, the cost of energy, energy security and energy consumption in buildings has become a critical problem globally. As sustainability principles propose, a solution must be found to optimise and minimise building energy consumption due to growing global concerns. This study explored how Building Information Modelling (BIM) Technology can be integrated with energy simulation tools to identify ways to optimise building performance and reduce energy consumption. BIM technology has evolved over the years and expanded to include additional functionalities such as cost estimation, scheduling, clash detection, facility management, asset management and sustainability analysis. BIM has also become a comprehensive platform for managing the entire lifecycle of a building, from design and construction to operation and maintenance. Secondary data was extracted from existing literature and energy simulation tools. Eleven (11) energy simulation tools were identified and juxtaposed with individual capabilities and attributes. The ranking system of Simple Additive Weighting (SAW), a multi-criteria decision-making method (MCDM) was applied. The findings revealed the most compatible energy simulation tool for the BIM application for detailed energy modelling and analysis. The findings are significant and would contribute to further research on new versions of energy simulation tools compatible with BIM for improved energy modelling speed and accuracy.

#418 – Assessing Energy Performance of HVAC Systems within a Railway Infrastructure Environment

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Keywords: Energy Saving, Energy Systems, Railway Building Design, Thermal Loads Assessment.

Abstract

With the rapid development of railway transport in the UK over the last decade, energy consumption and carbon emission from heating, ventilation, and air-conditioning (HVAC) systems within a railway infrastructure environment has surged massively. This is fundamentally due to large floor areas, operation times, increased occupation and quality of services and plant equipment. Existing research on this topic focuses mainly on the integration of a single HVAC system for a chosen station. However, due to the complex configuration of a rail infrastructure environment, it is crucial to investigate how different HVAC systems perform within specific rooms, with a special focus on critical spaces within the station. This paper therefore aimed to evaluate the dedicated HVAC systems in association with emerging technologies and sustainable strategies that can be applied to specific spaces (including Retails and critical spaces such as Stations Operations Room, Comms Equipment Room, and Electrical Switch Room) within a station building in Manchester (UK). A key focus of the paper was to analyse and compare the energy efficiency of different types of the selected plant and assess the achievable energy saving due to the type of HVAC systems that was utilised for a specific space within the environment. Based on the results, it was found that Air Handling Unit (AHU) supplied by air source heat pump (ASHP) being configured for the regularly occupied spaces such as retails can implement energy efficiency, while the presence of south-facing window could lead to a significant increase of thermal loads for such spaces. It was also found that ASHP configured with Close Control Units (CCU) can be an energy efficient HVAC solution for both the Stations Operations Room and the Comms Equipment Room, while a Direct Expansion (DX) cooling system with outdoor condenser unit can achieve energy efficiency for the Electrical Switch Room.

Early Career Research Papers

#437 - SHA256: Comparing the energy consumption of different implementations.

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Keywords: SHA256, Power Consumption, and Energy Efficiency.

Abstract

Adapting energy-efficient approaches is essential in order to save resources ensuring the highest throughput. In addition, combining security-enabled approaches has also been a concern to protect the data as it has been now at the most risk by the introduction of cloud-based approaches. Thus, it is important to create a bridge between these concerns and ensure more research on security techniques that is also energy efficient. For that purpose, in this paper, one of the data security techniques such as hashing algorithm has been chosen specifically the SHA256 algorithm in order to analyse the power consumption of the implementations. SHA256 hashing algorithm has been implemented in the Visual Studio IDE in Python using four libraries named Hashlib, CryptoHash, Cryptography, and PyNacl and the power consumption has been calculated using the Intel Power Gadget software. After analysing the collected data and applying descriptive analysis, T-test and ANOVA test a detailed discussion has been formed which states that the PyNaCL library consumes the least amount of power per second and also emits the least amount of CO2. Therefore, the paper recommends using the PyNaCL library to implement the SHA256 algorithm in order to ensure the least energy consumption, in addition, indicates that it is possible to find out better approaches while implementing an algorithm when the concern is energy efficiency.

#438 - Python Unplugged: A Comparative Study of Seven Energy-Efficient Coding Techniques

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Keywords: Energy-efficient Python, Green Coding, Code Optimisation, Software Energy Consumption.

Abstract

This research focuses on the impact of Python code optimisation techniques on energy usage and performance, with the goal of promoting sustainable software development. Given the growing worldwide emphasis on minimising energy consumption, it examines seven alternative programming techniques to identify the most energy-efficient practices. Through extensive experimentation, it was found that built-in functions, lazy evaluation, and caching are some of the leading solutions for optimising energy usage and performance in Python programming. The research revealed substantial variations in energy efficiency and performance by conducting experiments to evaluate the effectiveness of these techniques, providing essential insights for software developers. The study not only sets the foundation for future studies in energy-efficient Python programming, but it also paves the way for new methods, such as training an AI model to predict the energy footprint of software programs before executing them.

#439- Energy Consumption Estimation of CI/CD Pipeline Agents

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Keywords: CI/CD pipelines, Azure DevOps, GitHub Actions, Power Consumption.

Abstract

The lack of flexibility and delays in the software delivery processes led to the creation of DevOps practices, such as CI/CD pipelines, to automate the process of building and deploying applications. These tools are widely used today in software development environments. However, there is little research on the sustainability involved in these processes. This study uses Intel Power Gadget to estimate the power consumption of a server running the CI/CD of a Node.js application on two different platforms: cloud-based pipelines from Microsoft Azure cloud, and GitHub Actions. Moreover, the manual build and deployment without automation tools were also calculated for comparison with the CI/CD approach. The study revealed that although not using automation tools generates slightly less energy consumption, there is no significant difference between using cloud-based pipelines and manually building and deploying an application. It is therefore concluded that the use of DevOps could be sustainable when using cloud services and optimizing the pipeline architecture.

#440 - A Comparative Study on the Energy Consumption of Four Prominent Node.js Frameworks.

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Keywords: NodeJS, Energy Consumption, and GHG Emission.

Abstract

Modern world is moving in a tangent such that virtual presence is equally or more important than physical presence. Web development has become so widely spread that anyone looking to have a career in the ICT sector must have good knowledge about it. But the environmental aspects of web development have always been neglected. Studies show that around two percent of total carbon emissions each year come from ICT sectors. In this research, 4 different frameworks of the popular backend-building language NodeJS namely ExpressJS, Fastify, NestJS, and Connect have been studied in terms of energy consumption. The experiments are set up in such a way that all the components like database, API services, API tester, etc are present and similar in every framework. Collected data were analyzed by descriptive analysis as well as inferential analysis and found that in terms of energy consumption, services of similar nature take similar energy irrespective of the framework being used. In addition, energy data was converted to GHG emissions with the help of standard conversion factor of 2022 to observe the environmental effects of each framework.

#441- The Greenest Way to Get Through the Great Firewall of China? An Energy Audit of Common Circumvention Tools Against the Great Firewall

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Keywords: Great Firewall of China, circumvention tool, and energy audit.

Abstract

In China, the Great Firewall of China (GFW) blocks or restricts access to various online content and services. To access the Internet without restrictions, many Chinese netizens use circumvention tools that employ encryption and obfuscation techniques to evade detection and filtering of the GFW, which increase the energy consumption of the devices and servers involved. This paper aims to compare the energy efficiency of five common circumvention tools: WireGuard VPN, Shadowsocks, V2ray, Xray, and Trojan-Go. An energy audit is conducted for each tool by measuring the energy consumption on the client side when downloading a specific file from a target server. Based on the empirical results, WireGuard VPN was recommended as the most energy-efficient tool, while Shadowsocks and WireGuard VPN both ranked the highest in the comprehensive score considering both energy and time consumptions.

#442 - A comparative analysis of energy consumption and carbon emissions of CloudSim, CloudAnalyst and CloudReports cloud simulators.

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Keywords: Energy consumption, CloudSim, CloudReports and CloudAnalyst.

Abstract

The technological advances, popularity and complexity of cloud computing systems make the need for cloud simulators evident. Cloud simulators are programs that simulate a real datacenter into your personal computer. Their main objective is evaluating the infrastructure, trying different configurations to find the best one and provide more energy-efficient solutions. By doing all these assessments, these programs consume energy and produce emissions. This paper studies the energy consumption of three Java based simulators respectively CloudSim, Cloud Analyst and CloudReports. All of these applications are extensions of CloudSim and are event oriented. To analyze and achieve a conclusion, descriptive, and inferential statistics are implemented on the data gathered from Joulemeter measurements. According to the results of this experimental study, by conducting the deployments of the same infrastructure, CloudReports is found to consume more energy and produce more carbon emissions compared to the other two programs. This is related to the complete graphical user interface it provides. However, it should be noted that CloudSim consumes almost 9 times less energy and has a command line interface.

#443 - Analysis of containerization deployment overhead on execution time and energy consumption

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Keywords: Container Platforms, Container Runtimes, Energy-Efficiency, and IoT devices.

Abstract

Containerization software has become increasingly popular in the last decades as it provides a lightweight operating system-level virtualization for a large variety of purposes, including cloud and edge computing. Even though it provides increased security, internal networking, and application isolation, it also tends to generate additional workload and overhead in comparison with native application deployment. This issue is especially relevant in regards with limited computation power and storage devices, such as mobile and IoT devices. The aim of this paper is to analyse this generated overhead of deploying applications in containerization solutions and its effect on total execution time and energy consumption. To do so, two widely used container platforms, Docker and Podman, were used. To evaluate the performance of the low-level container runtime of a platform, two OCI (Open Container Initiative) compatible container runtimes, namely runC and crun, are compared. This results in a comparison of 5 configurations - docker with runC, docker with crun, podman with runC, podman with crun, and native deployment. A test workload application that simulates CPU load was deployed on a Raspberry Pi single board computer for all configurations. The results show that in the containerization deployment models, container runtime selection seems to have a minor effect on overall execution time and energy consumption, while the container platform significantly affects both metrics. Among container platforms, Podman platform was found to be both faster and more energy-efficient than Docker. It has also been discovered that native application deployment might significantly decrease the energy consumption level at the expense of losing containerization benefits.

#444 - Benchmarking Power and Energy Consumption of Stream Processing Frameworks

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Keywords: Stream Processing, Energy Benchmarking, Sustainable Computing.

Abstract

The exponential growth of real-time data-centric systems relies on the continuous processing of large data streams through stream processing frameworks. However, these frameworks are resource-intensive, require numerous dependencies and induce high computing loads, resulting in increased energy consumption and carbon emissions. The selection of an appropriate stream processing framework can significantly reduce energy consumption and carbon footprint within a company's IT infrastructure. While several studies have compared the performance of stream processing frameworks, none have specifically examined them from a sustainability standpoint. This report aims to bridge this gap by conducting a comparison of energy consumption and performance among three different frameworks: Kafka Streams, Apache Flink, and Spark Structured Streaming. To achieve this, we implemented a real-world use case in Java and conducted multiple experiments at varying streaming rates, while monitoring the systems using Prometheus and Grafana. Our findings indicate that, on average, Kafka Streams and Apache Flink exhibit lower power and energy consumption compared to the Spark Structured Streaming module. Among the two, Flink proves to be the most efficient in terms of power for medium to high throughput applications, while Kafka Streams is most suitable when tolerating lower throughput, as both frameworks demonstrate similar power consumption levels. Additionally, we also analysed the CPU and RAM usage of each framework, revealing distinct patterns for each stream processing engine.

#445 - Comparative Analysis of Energy Efficiency in Virtualization Tools and Underlying Operating Systems.

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Keywords: Virtualization, Greenhouse Gas Emission, Cloud Computing, Sustainable Development Goals.

Abstract

According to current research into trends in information technology and impact on the global economy, it has been realized that the upward rise and adoption of digital technologies continue to contribute to the use of cloud computing technologies, with more concern placed on the energy consumed by these cloud infrastructures. In this paper, as much as the global concern is the energy consumption of different worldwide systems, the focus is directed to the energy consumption of cloud computing infrastructures. Hence, we look into the energy consumption levels of several chosen virtualization technologies and their underlying operating systems in the context of cloud computing, with a close look into their greenhouse gas (GHG) emissions. This work examines how cloud computing components affect energy usage in the global ICT ecosystem. The methodology used in the work was divided into two categories: the macro methodology that emphasized life-cycle analysis, and the micro methodology which used both experimental setup and inferential statistics to confirm details of the result. The findings of the study showed that the microsoft hyperV consumed the least energy, and it is expected that this finding will improve cloud computing practitioners' and policymakers' understanding of virtualization tools' energy consumption patterns alongside GHG emissions, helping them make sustainable environmental decisions.

#446 - Energy Consumption Analysis of Deep Learning Model for the Recognition of Bengali Lexical Sign Language

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Keywords: CNN-LSTM, Carbon Footprint, pre-trained models, Energy Consumption.

Abstract

In today's era, with the growing threat of global warming, it is essential to incorporate sustainability into deep learning models, specifically when it comes to carrying out heavy tasks such as the classification of images. In general, image data is heavier compared to numerical or even text data. Thus, it is essential to investigate the energy consumption and carbon footprint of these image classification models. To achieve this objective, this research focuses on building an energy-efficient deep learning model used to classify Bengali Lexical Signs. This dataset comprises 10,000 locally collected images that are trained using Convolutional Neural Network-Long Short-Term Memory (CNN-LSTM) as the primary model and other CNN pre-trained models, namely DensNet, MobileNet, VGG-16 and Inception V3. Before passing the images through the model, they are pre-processed to remove any noise and to induce robustness; data augmentation is applied. On the primary model, a k-4 cross-validation is also performed. The energy consumption data is collected during the training phase of each model using the Intel Power Gadget tool. From the energy consumption data, the carbon footprint is calculated using the value of the carbon intensity found in the UK for the prior thirty days. Further, a one-way ANOVA test, descriptive statistical studies, and the average power consumption of the processor are carried out using the energy consumption data to understand the behaviour of these models. According to the results, it can be deduced that the pre-trained models, namely Inception V3, VGG-16 and DenseNet, appear to have the lowest carbon footprint, while the primary model CNN-LSTM depicts a higher carbon footprint. Another interesting fact observed in this research is that Inception V3 and DenseNet models exhibit the highest energy consumption compared to that of other models. Therefore, from the study, it can be concluded that high energy is required for deep learning models which are used to process images and for other computer vision applications.

#447 - ENERGY CONSUMPTION FOR TRAINING AND INFERENCE OF MACHINE LEARNING MODELS AND THEIR PROCESSES

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Keywords: Energy Consumption, Sustainability in AI, Machine Learning, Carbon Emission.

Abstract

While the study of energy consumption in the field of computer architecture remains widely studied, it has received less attention in the field of machine learning and artificial intelligence. Artificial Intelligence and Machine Learning models are widely utilized in various applications including data science, computer vision, and natural language processing. Despite being a highly incentivized and sought-after field, most of its research is concentrated on the size of the models, amount of data, and accuracies without concern for computational constraints such as power and energy consumption. This partially stems from a limited availability of energy evaluating tools in machine learning and lack of support from frameworks and cloud providers, largely due to security concerns. This research evaluates energy consumption and carbon emissions of several machine learning and deep learning models in various use cases. This study uses existing energy measuring tools to provide insights into sustainable choices of models for lightweight applications.

#448 - Comparative Analysis of Energy Consumption and Carbon Footprint of Apache, Nginx, and Lighttpd Web Servers.

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Keywords: Apache, Nginx, Lighttpd, Energy Consumption.

Abstract

The increased demand and diversity of web applications has brought a significant increase in the energy consumption and carbon footprint of web servers. However, no that many results have been published that study the web server energy consumption and identify which one is the most environmentally friendly. As a result, this study aims to compare the energy consumption and carbon footprint of three popular web servers, including Apache, Nginx and Lighttpd. To get insights into the energy consumption aspect multiple experiments are conducted to see how much energy web servers consume on different workloads. The research results demonstrated that Nginx and Lighttpd are the webservers that consume the less amount of energy compared to Apache. The reason of this result can be attributed to their asynchronous event-driven approach to handle a large number of simultaneous connections which allows Nginx and Lighttpd to use less resource and handle more requests with less overhead compared to the other web servers resulting to lower energy consumption and carbon footprint.

#451 - Comparative Analysis of Power-Aware and Non-Power Aware Data Centre Simulations using Interquartile Range Allocation Policy and Various Virtual Machine Selection Policies in CloudSim

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Keywords: Resource Allocation, Selection Policies, Power Consumption, Cloud Data Centre.

Abstract

This project aims to investigate the impact of Resource Allocation and Selection Policies on the power consumption of a Cloud Data Centre compared also to it when it is Non-Power-Aware. The study will use CloudSim, a well-known simulation tool for cloud computing, to build a virtual environment that simulates a Cloud Data Centre. The main objective of the project is to evaluate the effectiveness of these policies in reducing the energy consumption of the Data Centre while maintaining performance and availability levels. The simulation results will be analysed and compared with the Non-PowerAware scene, to demonstrate the importance of the effective implementation of policies in reducing power consumption. The project aims to contribute to the ongoing research efforts towards achieving sustainable cloud computing by providing insights into the effectiveness of Power Aware Policies in reducing the carbon footprint of Cloud Data Centres.

#453 - A Comparative Study of Energy Consumption in Nature-Inspired Optimization Algorithms

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Keywords: Nature-inspired Optimization Algorithms, Green-ICT, Carbon Footprint, Energy Consumption.

Abstract

The problem of optimisation is a fundamental mathematical challenge encountered in various fields to determine the optimal solution to a problem while adhering to a set of constraints. Nature-inspired optimisation algorithms are a novel category of algorithms that take inspiration from natural systems to solve complex optimization problems. The utilisation of Nature-Inspired Optimisation (NIO) algorithms has gained widespread popularity in addressing a diverse range of optimisation problems in practical settings due to their straightforwardness, adaptability, and efficacy. NIO algorithms have been applied in diverse areas of ICT, such as metaverse and cloud computing, with a focus on virtual machines, storage, security, meta-analytics, and other related domains. This study presents a comparative analysis of energy consumption and associated carbon footprint of four widely used NIO algorithms. Intel Power Gadget was used to quantify the energy utilisation throughout the execution of each algorithm. Additionally, the carbon footprint of each algorithm is determined by referencing the UK DEFRA guide. The findings of this investigation indicate that different algorithms exhibit varying patterns of energy consumption to attain a common objective. Furthermore, a t-test was performed, indicating that the mean energy consumption of each algorithm exhibits significant differences from one another. Regarding prospective research it is worth considering various CPU architectures, including the Apple bionic chipset and the latest Intel processors, as potential options for executing these algorithms. The collection of energy consumption data for various CPU architectures can facilitate the identification of potential correlations between NIO algorithms and hardware resource energy consumption.

#545 - Comparative Energy Consumption Analysis of Video Streaming at Different Speeds on Different Internet Browsers

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Abstract

The use of Internet has boomed in the last decade, nowadays almost everyone owns a smart device that is connected to the Internet. This increase in the online network usage has led to a rise in energy consumption in the ICT sector. Both the end/edge devices and the backbone Internet infrastructure (switches, routers, servers, etc.) need to be constantly powered with a considerable amount of energy. Though, the production of electrical energy proves to be still a very harmful process for the environment, greenhouse gas emissions are discharged in the atmosphere at astonishingly high rates. A reduction in the energy consumption is what we are striving to achieve in the present. Therefore, it is essential to keep track of how much energy ICT applications and programmes use in order to foresee future modelling and device research possibilities. Video steaming started to represent a high percentage in the Internet usage in the last years. This is due to the rise in popularity of consuming digital entertainment over the traditional broadcasting. This research work tries to get some insights into the power consumption of different Internet browsers while videos are streamed at different speeds. To compare, a typical user environment was developed in order to analyse the proposed scenarios.

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