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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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2022



The Eighth International SEEDS Conference 2022

(Sustainable Ecological Engineering and Design for Society)

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Sustainability Across the Built and Natural Environments

Frenchay Campus and Online, UWE, Bristol, UK 31st August – 2nd September 2022

It has been thirty-five years since the seminal report *Our Common Future* (often referred to as the Brundtland Report), published by the World Commission on Environment and Development, proposed progressive environmental strategies and recommendations towards the attainment of the United Nations “A Global Agenda for Change”. Since then, we have seen many pivotal international actions, summits, frameworks, protocols, conventions, and declarations proposed. Amongst the most important was the Millennium Development Goals (MDGs), established by the United Nations in 2000, with 191 nations committing towards their delivery by 2015.



Moving forward, the United Nations “2030 Agenda for Sustainable Development”, adopted by all Member States in 2015, proposed a shared blueprint for peace and prosperity for people and the planet, both now and into the future. At its core are the Sustainable Development Goals (SDGs), which are an urgent call for action by all countries to join in a global partnership towards their achievement. We are almost mid-way through the timeframe for the delivery of the seventeen SDGs so it is apt that society takes an opportunity to reflect on many of the triumphs towards their realisation and also seek steer on the directions of their future travel.



SUSTAINABLE DEVELOPMENT GOALS

17 GOALS TO TRANSFORM OUR WORLD



Drawing on the themes of all the SDGs, the 2022 SEEDS conference (now in its eight year) offers an integrated platform for academics and practitioners to reveal their personal and collective contributions towards the seventeen priorities. That said, the 2022 conference themes, but not exclusively, include:

- Sustainable
 - Businesses
 - Construction
 - Buildings
 - Urbanisation
 - Health and Safety
 - Contamination and regeneration
 - Organisational management
 - Partnerships and collaborations
 - Social value
 - Waste management
 - Project management
 - Disaster management
 - Education and training
- Ecological
 - Plants and animal biodiversity
 - Ecosystem services
 - Agriculture and soils
 - Environmental management
 - Green infrastructure
 - Nature based solution
- Engineering
 - Energy and carbon
 - Building performance
 - Transport
 - Geotechnical
 - Bridges
 - Civils and infrastructure
 - Flooding
 - Water efficiency
 - Medical
 - Communications
 - Software
- Design
 - Architecture
 - Interior architecture
 - Urban design planning
 - BIM and digital innovation
 - Product development

Welcome to Bristol

Bristol is a diverse, creative and integrated city in the South West of England, chiefly built on its maritime heritage (first listed as a trading port in 1051). This is most notably underscored by its role in the 17th and 18th Century Atlantic commerce, when the city profited from the tobacco and slave trades. It is estimated that approximately one-fifth of the British slave trade passed through Bristolian ships. While the bygone city grew rich from these maritime endeavours, nowadays the city still wrestles with this brutal legacy (photo beneath).



Protestors toppling the statue of the former sea merchant and slave trader, Edward Colston (1636-1721), in June 2020 (www.metro.co.uk)

Bristol's societal wealth is reflected in its contemporary diverse urban population (~441,300 inhabitants celebrating 45 different religions (2011 census)). The vivacious city is surrounded by many towns and villages set in rural countryside. Today, Bristol is the sixth largest city in England and is the largest centre for culture, employment and education in South West England. Blue and green areas cover almost one-third of the city, which includes 1600 hectares of public parks and green spaces. Furthermore, Bristol is the most energy and carbon efficient city in the UK. Therefore, the city is widely recognised for its 'green appeal' because it is devoted to environmental initiatives and supporting sustainable businesses, alongside improving sustainable consumer practices. Moreover, it is estimated that more than 50,000 of the city's inhabitants are involved in 'green' activities. Thus, it was perhaps no surprise that, in 2014, Bristol was named 'the best place to live in the UK' (Sunday Times newspaper) and, in 2015, it became the UK's first European Green Capital.

The European Green Capital Award is an annual accolade given to European cities in recognition of their high environmental standards, their commitment to environmental improvement and sustainable development, and their ability to be an exemplar for other cities to follow. Bristol's year as European Green Capital was a city-wide initiative with many organisations involved, including educational, arts and cultural institutions, business networks, visitor and tourism bodies, amongst many others. This is underpinned by the city's ambitious low carbon strategy, which addresses Climate Protection, Sustainable Energy and Sustainable Transport initiatives.

As a city, Bristol has signed-up to achieving the UN Sustainable Development Goals (SDGs) head-on and the actions in its 'One City Plan' have been mapped against them. The plan articulates a vision for making Bristol a fair, healthy and sustainable city for all by 2050. Cities are increasingly seen as key for tackling global challenges through local actions. It is, therefore, noteworthy that Bristol is leading the way as the first UK city – and one of just a handful around the world – to publish its own progress report for the United Nations, which summarises progress and challenges in areas ranging from education to economic growth and from inequality to climate change and highlights the wide range of organisations working to make Bristol, and the world, a more sustainable place.

Bristol benefits from a vibrant civil society that is steadfast in delivering sustainability across social, economic and environmental dimensions. The Bristol SDG Alliance is a network of city stakeholders committed to driving interest and action towards the implementation of the SDGs in the city, the region and nationally. This informal network, which includes the city's two large universities, and through a partnership approach, supports efforts to 'localise' the SDGs and integrate them into the One City Plan. Consequently, the city is widely recognised for its commitment to environmental sustainability and, in 2018, Bristol was the first UK city to declare a climate emergency and set a target of carbon neutrality by 2030.

Welcome to the University of the West of England, Bristol

Given its involvement in the Bristol SDG Alliance, it is perhaps not surprising that UWE Bristol is a sustainability university. Sustainability is embedded in its services, culture, research and teaching. UWE Bristol has invested heavily in campus improvements and new technologies. Through its 2030 Strategy it is working to address the urgency of the climate and ecological crisis and strives to fulfil its role in the achievement of the United Nations' Sustainable Development Goals. For instance, UWE Bristol have pledged to:

- Be carbon neutral as an organisation, with net-zero emissions of greenhouse gases by 2030;
- Work through the ISO 14001 standard to set clear targets and plans to reduce water and energy use, cut waste generation including food waste, and support biodiversity;
- As signatories to the UK Plastic Pact, eliminate all but essential single-use plastic and meet the 2025 targets for recycling and reuse;
- Establish all our campuses as clean air and smoke-free zones;
- Invest in and secure year-on-year improvement in travel sustainability for staff, students and visitors;
- Work with our students to explicitly address climate change and environmental challenges through our teaching, learning and curriculum; and
- Support research that addresses issues relating to climate change, environmental challenges and biodiversity; targets, timescales and detailed plans will be set out in the UWE Bristol Transforming Futures Climate Action and Sustainability Strategy.

UWE Bristol's commitment to sustainability is driven by its students, its staff and its senior management team: *"It is about recognising that we are one planet, one world. We all have a collective responsibility to engage individually and collectively... to move to a different place in our mindset and our actions. This is a hugely important agenda that is going to be with us forever"* Steve West, Vice-Chancellor, President and CEO, UWE Bristol.

UWE Bristol and our Students' Union have gained external recognition for their impressive efforts to improve their sustainability performance across the entirety of the university – for their teaching and research, for their professional services and for the dynamism and creativity of individual students and staff. Consequently, UWE Bristol has amassed a vast portfolio of environment and sustainability awards. For instance, it is a regular winner at the national green gown awards and has received gold for being 'Best Fairtrade University'. Furthermore, the Students' Union at UWE received the 'Highest

Scoring Students' Union' Award at the NUS Green Impact Awards and were reaccredited for the NUS Responsible Futures award. We will hear more about these successes from the first of our keynote presenters, Professor Jim Longhurst – Assistant Vice Chancellor for Environment and Sustainability at UWE Bristol.



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SEEDS Keynote Speakers 2022

Professor Jim Longhurst, University of the West of England
Dr Polina Baranova, University of Derby
Dr Poorang Piroozfar, University of Brighton
Dr Samuel Abbey, University of the West of England
Prof Michael Fullen, University of Wolverhampton
Dr Lidia Badarnah, University of the West of England
Prof Sue Charlesworth, University of Coventry
Dr Isaac Akinwumi, Covenant University (Nigeria)
Dr Vanessa Holden, Edge Hill University

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Prof Llyod Scott, Technological University Dublin

Keynote Speaker Biographies



Professor Jim Longhurst is Professor of Environmental Science and Assistant Vice Chancellor for Environment and Sustainability at UWE, Bristol. He leads the university's sustainability agenda ensuring that sustainability considerations are present in the university's teaching, research, campus operations and civic engagement work. His 35-year research career has focussed on air and carbon management and urban sustainability. He has produced over 225 peer reviewed

journal articles and book chapters and edited 24 books. His career, research and consultancy income exceeds £14 million.

His current national roles include Vice President of the UK Institution of Environmental Sciences, President of Environmental Protection UK, chair of the Board of Directors and Trustees for the Environmental Association of Universities and Colleges (EAUC) and Director of the Bristol Green Capital Partnership CIC. He co-chairs Bristol's Advisory Committee on Climate Change and chairs the University Advisory Group supporting South Gloucestershire Council's climate action programme.

In 2020 and 2021 he convened and co-chaired the QAA and Advance HE Advisory Group which prepared the updated guidance on Education for Sustainable Development for the HE sector. On behalf of the EAUC he served on the Climate Commission for UK Higher and Further Education.

Jim's keynote talk is entitled: A Case Study of Sustainability at UWE Bristol: a 28 Year Journey

Dr Polina Baranova FHEA CMCM expertise lies at the intersection of strategy, strategic management, environmental sustainability. Polina is a Senior Lecturer in Strategic Management and Doctor of Business Administration Programme Leader at the University of Derby. She is Co-track Chair of the Sustainable and Responsible Business Special Interest Group (SIG) at the British Academy of Management.

Dr Baranova's research investigates SME approaches towards environmental sustainability and the relevant environmental strategies. Her recent publications are in enterprise support and learning interfaces that drive environmental performance of SMEs. She is specialising in the development of environmental capabilities and working with a wide range of policy, business and societal stakeholders towards supporting sustainability transitions in the region and beyond. The recent publications are in the Journal of Business Strategy and the Environment, Local Economy and International Review of Entrepreneurship.



Polina's keynote talk is entitled: Green growth and sustainable regional development: strategic outlook based on the green growth trends in the East Midlands 2015-22



Dr Poorang Piroozfar is a reader in Architectural Technology and Digital Construction in the School of Architecture, Technology and Engineering, University of Brighton where he also leads the Digital Construction Lab. Poorang has designed, led, and delivered multi-/cross-/inter-/trans-disciplinary research projects at the intersections of and/or with knowledge, theory, technology, people, society, environment, and technology. His research investigates the drivers, requirements, benefits, and responses to deployment of advanced technologies in architecture, the built environment, and construction. Amongst some ancillary others, Digitality forms a core concept cross-connecting other themes in his research projects. Poorang has led seven PhD students to successful completion, delivered

nationally and internationally funded research and contributed to UK policy documents on offsite manufacturing/construction. He has won over eight international research awards for his research and journal/conference publications.

Poorang's keynote talk is entitled: Digitality: A new era or a historic U-turn?

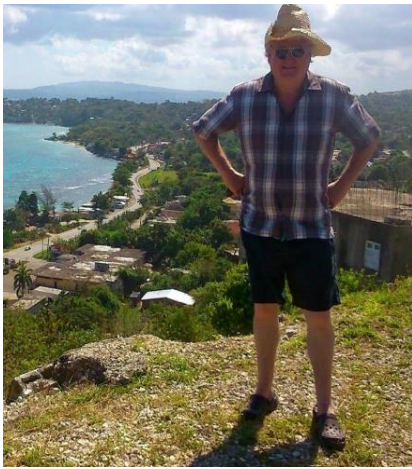
Dr Samuel Abbey is a Chartered Engineer, Scientist, Senior Lecturer, and an Associate member of the Centre for Architecture and Built Environment Research at the University of the West of England (UWE Bristol). He is a fellow of the HEA, and an active member of the British Geotechnical Association, and Institute of Materials, Minerals and Mining, and the International Association of Soil Mechanics and Geotechnical Engineering. With over eight (8) years' experience in teaching and learning, leadership, management and administration, research and enterprise in the UK Higher Education sector.



He is a strong educational leader and experienced academic with a sustained record of accomplishment of excellence in research and provision of exceptional learning experience for students. Abbey is the Departmental link tutor (UWE Bristol's international college), taking the lead role in organising departments' contribution to UWEBIC'S applied learning and liaising with UWEBIC staff regarding departmental programmes and curricula. He is passionate about University's quality assurance and enhancement processes, and he is currently serving as an external examiner for the BSc (HONS) Construction/Civil Engineering at the University of Bolton. He has led strategic enhancement of civil engineering programmes, identified international opportunities for the strategic development and growth of the community of postgraduate researchers at UWE Bristol, and delivered on their implementation. He recently emerged as the first runner-up for the researcher of the year award in 2021, this followed shortly after he received an individual exceptional contribution award in 2020. In recognition of his continued strategic exploits in the development of the civil engineering programme, and sustained record of PhD supervision and completion, and postgraduate research students'

development at UWE Bristol. He has also achieved external recognition based on his enormous contributions to the wider academic and professional community. He is an editorial board member of geotechnical engineering (specialty section of *Frontiers in Built Environment*), and a Guest Editor and Topic editorial board member (advisory panel), for the geotechnics and sustainability MDPI journals respectively. He has authored, co-authored over 40 academic peer-reviewed publications, and led the research team that investigated the use of RoadCem in combination with reduced cement and by-product materials for PowerCem Technologies Company, UK. The outcomes of Abbey's research provide sustainable soil stabilisation methods and increase environmental sustainability, and resilience of the built environment.

Samuel's keynote talk is entitled: Emerging Trends in Sustainable Soil Stabilisation Techniques



Professor Michael Fullen received the degrees of BSc and MSc from The University of Hull, (UK), a PhD from the UK Council for National Academic Awards (CNAAB) and a DSc from The University of Wolverhampton. Currently, he is Emeritus Professor of Soil Technology at the University of Wolverhampton. His research activities are mainly concerned with soil system dynamics (i.e., soil erosion, soil conservation, desertification, desert reclamation and the nature and properties of urban soils). His fieldwork is mainly based in Europe and Asia. He has published widely in Soil Science (as of July 2022, he has authored one book, co-edited three journal special issues, 256 refereed papers, 241 conference papers and 26 consultancy reports). He is a referee for 59 journals and a

member of the Editorial Board of 25 journals. He is also Associate Editor of the Journal 'International Soil and Water Conservation Research.'

Mike has jointly supervised 30 PhD theses to completion and 14 Post-Doctoral Researchers and has been Examiner for 36 PhD theses. He has received research grants from over 30 institutions, principally the European Union. He is also Vice-President and UK Representative on the Council of the European Society for Soil Conservation (ESSC) and Editor-in-Chief of the ESSC Newsletter. Mike is also WASWAC Vice-President, Councillor and Representative for the United Kingdom and was elected as an Academician of the Lithuanian Academy of Sciences. He is a Visiting Professor at Yunnan Agricultural University, Kunming, P.R. China.

Mike was Joint Winner of the 'Gerold Richter Prize' from the ESSC in May 2015, winner of the First 'Antonio Teixeira Guerra' Award from the Federal University of Rio de Janeiro in April 2017 and winner of the 'Friendship with Yunnan Award' from the People's Government of Yunnan Province, P.R. China in November 2017.

Mike's keynote talk is entitled: Nature has no concept of waste

Dr Lidia Badarnah is a senior lecturer in architecture at UWE Bristol. Her work contributes to an emerging body of research that seeks to redefine environmental design in architecture through mimicking natural systems (i.e., *biomimetics*), changing approaches from conventional separated building systems to adaptive and integrated solutions and methods for enhanced sustainability and resilience in architecture. She received her PhD from TU-Delft and carried out her postdoctoral studies at MIT, and further developed her teaching and research at Cardiff University and AA London before joining UWE as a lecturer. She has received competitive fellowships and awards and has been invited to give talks and workshops internationally, focusing on investigating behavioural and morphological patterns in organisms for the development of adaptive solutions for buildings. She is the PI on the VC's Early Career Development Award project, investigating water harvesting solutions inspired by nature in collaboration with the Natural History Museum in London; and a Co-I on the GLOW project (funded by EPSRC), an interdisciplinary project that explores the ways in which bees' social organisation and communication patterns can help us manage energy in our homes more efficiently and inspire us to change our behaviour accordingly.



Lidia's keynote talk is entitled: Design Lessons from Nature: Towards multi-functional building solutions for environmental adaptation



Prof Susanne Charlesworth is Professor of Urban Physical Geography at Coventry University in the Research Centre for Agroecology, Water and Resilience. She is the author of peer reviewed journal articles on urban pollution and Sustainable Drainage Systems (SuDS), many book chapters, and has co-edited books on aquatic sedimentology, water resources and SuDS. She is particularly interested in the application of SuDS in challenging environments such as refugee camps and informal settlements. Sue is also interested in the use of Nature Based Solutions to bioremediate New and Emerging Pollutants such as personal care products, pharmaceuticals and microplastic.

Susanne's keynote talk is entitled: Managing surface water in slums and refugee camps: are Nature Based Solutions or Sustainable Drainage Systems the answer?

Dr Isaac Akinwumi is a Senior Lecturer in Civil Engineering in the Department of Civil Engineering at Covenant University in Nigeria. He completed his PhD at Covenant University and was a Commonwealth Split-site PhD Scholar at the University of the West of England. His research focuses on using wastes in modifying materials (soil and concrete) for construction and on water supply, sanitation, and hygiene (WASH), among others. He has published articles in international peer-reviewed journals and has received research grants and fellowships. He was the Pioneer Technical Chair of the International Conference on Sustainable Infrastructural Development. He is an Affiliate of the African Academy of Sciences (AAS) and a Member of the Nigerian Young Academy. Dr Akinwumi is currently the Director, International Office and Linkages at Covenant University.



Isaac's keynote talk is entitled: Infrastructure is key to repositioning Africa for Sustainable Development



Dr Vanessa Holden has BSc and MSc degrees in 'Geography and Environmental Biology' and in 'Environmental Technology' awarded by Lancaster University and the University of Wolverhampton, respectively, and a PhD in 'Physical Geography, Coastal Geomorphology and Sedimentology' awarded by Lancaster University and Edge Hill University. She has held several post-doctoral research positions, which have focussed on coastal sedimentary monitoring, adaptation of coastal ecological settings, plus social and economic impacts of climate change and community understandings of changing coastlines, before she decided to utilise her expertise in industry-facing roles. She was the company Director of Strata Environmental, which provided consultancy support for

environmental change, particularly coastal change, and evidence-based reporting. Her consultancy projects have been far-reaching and have provided pivotal evidence for organisational decision-making. She has published scientific articles in international peer-reviewed journals and contributed chapters in several books on Climate change, Coastal dynamics, and Sustainable Planning, amongst others. Her research findings have been presented to a wealth of international audiences at conference venues across many European nations. Moreover, her research has and continues to inform policy decision-making, where she has been a voice on coastal partnership committees and helped shape local shoreline management plans.

Vanessa's keynote talk is entitled: Comparative Insights and Review of the Use of Artificial Marker Horizons to Measure Vertical Sediment Accretion Rates to Inform Management.

Keynote Speaker Abstracts 2022

A Case Study of Sustainability at UWE Bristol: a 28 Year Journey

Prof Jim Longhurst¹

¹University of the West of England, Bristol, UK

Abstract

This presentation will describe UWE's sustainability journey from the mid-1990s until the present day. Key drivers for action and challenges encountered will be discussed. Critical amongst these have been student expectation and demand, staff engagement, senior staff leadership and external certification to ISO 14001. UWE's current engagement with sustainability is set by Strategy 2030, which frames our ambition as follows 'Through our 2030 Strategy we will work to address the urgency of the climate and ecological emergency and strive to fulfil our role in the achievement of the United Nations' Sustainable Development Goals'. UWE's location in Bristol has been an important driver for change particularly during Bristol's year as European Green Capital in 2015. UWE has helped shape the city-region's sustainability engagement contributing significantly to Bristol's bid to be a Green Capital and subsequently supporting the development of the One City Climate Strategy and One City Ecological Strategy. In turn, these initiatives inspire and encourage the university to redouble our efforts as well as providing new opportunities for research, live briefs in teaching and volunteering, placement and dissertation opportunities for students. Students increasingly expect their university to take sustainability seriously and to prepare them for living their life through the changing climate of the 21st Century. Future students will be even more concerned about the climate and ecological emergencies and universities will need to adapt to this changing expectation.

Green growth and sustainable regional development: strategic outlook based on the green growth trends in the East Midlands 2015-22

Dr Polina Baranova¹

¹University of Derby, Derby, UK

Abstract

Green growth plays a pivotal role in sustainable development as it balances economic growth and the care for the natural environment. There is a distinct lack of data on the green growth trends regionally and nationally. This talk is based on the 7-year study of the green growth trends in the East Midlands undertaken by the Derby Business School and the East Midlands Chamber of Commerce. Collected as part of the Chamber's Quarterly Economic Survey (QES), this unique data set presents an insightful picture of the business engagement with the green growth. The data shows there has been almost 30% increase in the green growth activity in the East Midlands during the period 2015-2022. There is an increasing trend of diversification into new green products and services as well as green markets. Green skills development is an important factor for green growth success. Businesses urgently require support with green funding and finance to capitalise further on the green growth opportunities in the region and beyond. Policy and business support agencies are critical in supporting increasingly diverse green growth strategies of small and large businesses.

Digitality: A new era or a historic U-turn?

Dr Poorang Piroozfar¹

¹University of Brighton, Brighton, UK

Abstract

In 1995, when the book “Being Digital” was first published, the concept of computation, although probably not significantly different from what it is nowadays, was cognised and comprehended quite differently. 11011 years on (the exact number of the years Elaine must put up with Nicholas being digital back in MCMXCV - 100), the question is how the concept of digitality has changed and how we have changed with and through it; and more importantly what implications this (may) have had on the ways in which we formulate theory, comprehend practice, and conduct business in the AEC sector?

With an exploratory interactive introduction, this talk brings this challenge up and imposes above questions to stimulate the debate about whether we are back to where we were (felt to be or alerted to have been) 27 years ago or we have entered a new era, perhaps without planning, aiming or even noticing it consciously and resolutely.

Emerging Trends in Sustainable Soil Stabilisation Techniques

Dr Samuel Abbey¹

¹University of the West of England, Bristol, UK

Abstract

Expansive clay soils are susceptible to swell or shrink due to seasonal moisture variation, and the effects of swelling and shrinkage of expansive soils on infrastructural systems (such as buildings, road pavements, pipelines) is a well-known problem to geotechnical engineers. In the United Kingdom and United State of America alone, damages accrued to expansive clays is quantified to exceed \$12 billion and surpasses cost of damages from other natural disasters such as earthquakes, flooding, hurricanes, and tornadoes combined. Undoubtedly, the successful use of cement and lime in the mitigation of shrink-swell behaviour and improvement of the engineering properties of expansive clays cannot be overemphasized. However, the construction value chain is accounting for up to 25% of global GHG emissions, mainly driven by raw material processing and buildings operation, and the environmental impact of continuous emissions of toxic gases (carbon footprint) accompanying cement production has raised many concerns. With concerns about the environmental impact of the built environment becoming increasingly urgent, the use of more eco-friendly materials for stabilisation of expansive clays to create alternatives to cement and lime is sacrosanct. The use of one or a combination of GGBS and PFA, Geopolymers, RoadCem, paper sludge ash, brick dust waste, fibres, construction, and demolition waste with focus on improving plastic and compaction characteristics, unconfined compressive strength (UCS), Shear strength, Swell, California bearing ratio (CBR), and Microstructural characteristics of the stabilised is gaining interest. Because it is well known that the activities within the construction sector have a major impact on the environment, due to the significant amount of cement-based concrete and waste being generated amongst others, it is therefore, imperative to understand the alternative eco-friendly solutions for stabilisation of problematic soils.

Nature Has No Concept of Waste

Michael A. Fullen¹ and Colin A. Booth²

¹ The University of Wolverhampton, School of Architecture and the Built Environment, Springfield Campus, Grimstone Street, Wolverhampton WV10 OJP, UK.

² Centre for Architecture and Built Environment Research (CABER), Faculty of Environment and Technology, The University of the West of England, Bristol BS16 1QY, UK.

Keywords: Resources, Assets, Reuse, Recycle, Waste management

Abstract

The premise is presented that 'waste' is a totally anthropogenic concept. In nature, there is no such thing as 'waste.' Supportive evidence is abstracted from research projects spanning over three decades. The lessons from four projects ('SHASEA,' 'BORASSUS,' YUANYANG' and 'C2C-BIZZ') are integrated and synthesized to support this argument:

- 1. The 'Sustainable Highland Agriculture in South-East Asia' (SHASEA) Project was established to promote sustainable agro-environmental development in the highlands of South-East Asia. The Project examined the effectiveness of selected agronomic and soil conservation treatments by using both modified and novel cropping practises within small farmer-managed fields, mainly in Yunnan Province, South-West China.*
- 2. The 'Environmental and Socio-economic Contribution of Palm Geotextiles to Sustainable Development and Soil Conservation' (BORASSUS) Project evaluated the long-term effectiveness of biological geotextiles in controlling soil erosion and assessing their sustainability and economic viability. Biological geotextiles offer potentially novel bioengineering solutions to environmental problems (e.g., soil conservation, sustainable plant production and improved ecosystem management). Biogeotextiles can provide effective socio-economic platforms for sustainable development.*
- 3. The 'Agro-environmental Sustainability of the Yuanyang Rice Terraces of Yunnan Province, China' (YUANYANG) Project is investigating the complex and sustainable agro-environmental system of terraced rice paddy fields developed by the Hani minority people of Yunnan Province. The Hani have maintained this intricate and elaborate system for over 1,300 years. If we can understand how this system is sustained, we can learn lessons, which can hopefully be applied more generally to improve environmental management systems.*
- 4. The 'Cradle-to-Cradle of Businesses Sites' (C2C-BIZZ) project promotes and develops closed loop recycling systems. At the end of a useful lifetime, C2C items are disassembled and reassembled for other uses. If possible, recycled materials are 'upcycled' to become more valuable resources. For instance, recycled bomb shrapnel was used to construct the first generation of Honda vehicles. Lessons from the 'C2C BIZZ' Project are presented. This was a collaborative project between six countries in North-West Europe.*

In summary, we contend that the concept of 'waste' is unhelpful and, as such, we propose a view of socio-economic development and improved environmental management, achieved through dynamic and interacting synergistic systems. Further, we advocate that what many perceive, and label, as 'waste' are resources that, through appropriate and intelligent management systems, can simultaneously and synergistically advance socio-economic and environmental sustainability.

Design Lessons from Nature: towards multi-functional building solutions for environmental adaptation

Lidia Badarnah¹

¹ The University of the West of England, Bristol, UK

Abstract

My talk focuses on research at the interface between natural systems, environment, and buildings, elaborating on the correlation between morphology, behaviour, function, and environmental conditions to promote adaptation. In this talk, I will provide an overview of numerous means by which organisms adapt to different environmental conditions by the regulation of heat, air, water, and/or light. Through my journey in research and teaching, I will discuss how learning from nature, especially from complex skin structures and assemblies, could lead to meaningful exploitation of functional morphologies into buildings, and potentially result in a new class of adaptive energy-efficient solutions that responds to change and minimizes the impact on the environment.

Managing surface water in slums and refugee camps: are Nature Based Solutions or Sustainable Drainage Systems the answer?

Professor Susanne Charlesworth¹

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Abstract

SDG6 espouses “Water for all”, but does that include the infrastructure needed to drain all settlements? Water is also said to be a human right, but generally concentrates on potable supplies and provision of toilets – is drainage a human right? Informal settlements are ubiquitous in developing countries. They are constructed in areas which are otherwise unsuitable for formal habitation, i.e., on steep slopes or on low lying land with high groundwater tables. On the other hand, refugee camps are set up formally under conditions of extreme crisis, but similar to informal settlements, drainage and greywater management are initially generally absent. Subsequent disposal of wastewater on the street leads to polluted streams flowing through both settlements causing negative impacts on human and environmental health. Conventional infrastructure for water management such as the installation of a wastewater treatment plant would not be relevant in such contexts, what is needed is an approach that is multiple benefit and flexible such as Nature Based Solutions or Sustainable Drainage Systems. This paper will give details of the design, construction, operation and maintenance of a SuDS management train in a refugee camp in the Kurdistan Region of Iraq, illustrating the importance of community engagement. It will also describe attempts to retrofit SuDS devices in an informal settlement in South Africa, and subsequent experiments to improve water quality using bioremediation. Finally, a project focused on favelas in Brazil will outline how SuDS or NBS could be used to manage disease vectors in the context of the Zika virus outbreak in Brazil, 2015-16.

Infrastructure is key to repositioning Africa for Sustainable Development

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Inadequate infrastructure in Africa has contributed to its slow progress toward achieving the 17 United Nations Sustainable Development Goals (SDGs). Available and functional infrastructure in some African countries is unevenly distributed, resulting in the diminishing rural African population. Some infrastructural provisions are already outdated or failing due to poor maintenance. The fast rate of population growth in Africa is worsening this situation resulting in a large number of people lacking access to adequate housing, quality education, safe drinking water, adequate healthcare services, electricity, internet, and adequate transport, among other physical and social infrastructure. Poor infrastructure is responsible for the low quality of life in some African cities and towns, resulting in increased human migration from Africa. Proper planning, investment and partnership are needed to transform Africa's infrastructure. Without adequate infrastructure, Africa will not achieve the SDGs by 2030.

Comparative Insights and Review of the Use of Artificial Marker Horizons to Measure Vertical Sediment Accretion Rates to Inform Management

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Keywords: Saltmarsh, Intertidal Flats, Accretion, Marker Horizons

Abstract

Artificial marker horizons were established along the north Sefton Coast to create a spatially orientated baseline of the vertical accretion rate of contemporary sediments occurring on the surface of intertidal flats and saltmarsh. Regular monitoring of the marker horizons enabled the construction of a database of accretion levels in the study area over a range of timescales from bi-monthly to seasonal, annual and bi-annual. Measurement of vertical accretion rates is important to understand saltmarsh responses to sea level rise since the balance between the surface elevation of the marsh, through the process of vertical accretion, and a rise in sea-level is critical. Adjacent to an urban area, the study area is backed by hard defences with the saltmarsh providing valuable additional soft defence. The assessment and quantification of sedimentary processes in this context was therefore important. Although differing methods of measuring accretion rates have been utilised previously in saltmarshes, little comparative work had been undertaken on the suitability of various marker types for specific environments, for example, from the 'High Marsh' to the 'Pioneer Zone'. Whilst the use of six different artificial marker horizon types were primarily employed to assess the most accurate method of recording accretionary patterns across the high marsh, mid marsh, pioneer zone and unvegetated mud flats, importantly, the different methods also enabled an assessment of accretion rates observed between marker types. Saltmarshes perform multiple roles in coastal dynamics and ecology. Alongside their important habitat provision, they provide soft engineering solutions to coastal defence, they are important carbon sinks and have a role in storing pollutants dispersed by the sea. Because of these globally significant characteristics, it is vital to determine whether a marsh is accreting or eroding, to support management decisions on coastal defence, fluctuations in sea level and climate change.

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BIM, Software and Digital Innovation

#263 - BIM's Contribution on HSE Improvement of the Construction Industry

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Keywords: Building Information Modelling, Construction, Health and safety, innovation

As is generally known, construction industry has one of the highest rates of occupational accidents of any economic sector. Construction remains one of the greatest industry sectors, even in times of economic downturn (Occupational Safety and Health Administration (OSHA), 2018; The National Institute for Occupational Safety and Health (NIOS), 2018). It is also one of the most hazardous and dangerous sectors, and despite considerable reductions in injury rates over the previous 20 years, construction remains a high-risk industry to work in (OSHA, 2018). Building information modelling (BIM) is now seen as a way to address workplace safety problems all across the entire life cycle, reducing risks and hazards and, as a result, increasing safety.

Despite the fact that building information modelling is not a new concept, it has seen a boom in popularity in recent years. This is due in part to government mandates, but mostly to considerable technological developments. BIM may assist produce safer assets, even though the focus is on getting the most value for money and enhancing efficiency. Nevertheless, instead of getting mired in a technical dispute, we should keep in mind that BIM is really a behavioural change initiative.

BIM allows for the effective integration of safety measures from the design stage through the construction phase and operation phase, as well as integrated safety planning within construction planning, resulting in continuous safety management across the construction process.

This study investigates the construction industry's implementation of BIM methodology and related technologies for building safety planning, and it demonstrates how this technology can be utilised to integrate safety measures into the design phase and construction site management.

#129 - Integrating wind variability to modelling wind-ramp events using a non-binary ramp function and deep learning models

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Keywords: Wind ramp prediction. Time Series Analysis. Deep Learning. Green energy.

Abstract

The forecasting of large ramps in wind power output known as ramp events is crucial for the incorporation of large volumes of wind energy into national electricity grids. Large variations in wind power supply must be compensated by ancillary energy sources which can include the use of fossil fuels. Improved prediction of wind power will help to reduce dependency on supplemental energy sources along with their associated costs and emissions. In this paper, we discuss limitations of current predictive practices and explore the use of Machine Learning methods to enhance wind ramp event classification and prediction. We additionally outline a design for a novel approach to wind ramp prediction, in which high-resolution wind fields are incorporated to the modelling of wind power.

#163 - Evaluating the effects of Innovative Technologies on the sustainable delivery of affordable housing within South Africa

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Keywords: Affordable, Delivery Process, Housing, Innovative Technology, Sustainability

Abstract

This paper examines the changes that human societies have wrought on the environment, which have resulted in a call for a fundamental shift in the design, construction

and habitation of affordable houses. This examination uses an extensive literature review to understand the effects of innovative technologies on the sustainable delivery of affordable housing within South Africa. The rationale for this examination stems from the awareness of rising urbanisation within South Africa, which has resulted in an increased demand for affordable housing. Innovative technology has served an essential role in improving human efficiency and the minimisation of human error in construction. Hence, this paper explains the potential effects of innovative technology for enhancing the sustainability of design, construction, and affordable housing. However, innovative technology will only be beneficial, if it aids in systematically decreasing the harmful substances produced in the ecosphere, maintaining the diversity of nature, and allocating fair and efficient usage of resources for construction purposes. This study was undertaken relative to innovative technologies such as Building Information Modelling (BIM), Additive manufacturing and off-site construction. The results showed that housing construction that uses these technologies could either simulate or circumvent issues that may damage the environment, thus increasing the sustainability of the delivered. Furthermore, by using the technology assessment tool, home developers can have a deeper understanding of what technologies to use, arising from how they will help improve the overall sustainability of housing projects. If implemented well, the sustainability of affordable housing will increase due to the correct application of such technologies.

#185 - Hacking Infrastructures – Parasitic Scenarios, Computational Strategies and Circularity

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Keywords: circularity, machine learning, pedagogy, infrastructures.

Abstract

Within our cities there is an abundance of under-utilised or obsolete infrastructural spaces. These include abandoned factories or warehouses, port infrastructures, oil and gas refineries, container terminals or docklands. As we are confronted with less inhabitable spaces within the urban, growing pressures for densification and in the light of a climate crisis, activating unused spaces and repurposing material systems is of significant importance for the built environment and the circular economy. The submitting team leads a design studio which focuses on these uninhabitable infrastructures, inviting students to develop architectural strategies based on circular approaches and machine learning to reimagine their use. By conducting research on abandoned infrastructural sites in Rotterdam, we develop a pedagogy which combines mapping available infrastructural components, the use of machine learning and computational design to test new material strategies and aesthetic expressions for circularity. Together with our students we develop future scenarios for the use of obsolete infrastructures as well as functional programs informed by today's socio-economic, cultural realities. These scenarios are accommodated through the computational development of parasitic-circular material systems based on these existing infrastructures. To this end, the studio as well as this paper explore infrastructures, circularity and correlated computational processes as driving design parameters. We instrumentalize machine learning for testing non-standard architectural composition of repurposed infrastructural components. AI with its subfields of machine learning and deep learning is disrupting many industries, amongst which the architectural discipline. Nonetheless, circular design seems untouched by these trends. Circularity poses computational designers in front of new challenges. We explore new material expressions for architecture using generative adversarial networks (GANs) and the resulting synthetic architectural images as a departure point for design. The creative process is rethought as a creative human-machine strategy. Our research addresses the UN SDG number 9 and 11, and touches also on number 12.

#245 - A Systematic Scientometric Analysis for Investigation of Building Information Modelling (BIM) adoption in the Construction Industry

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Keywords: Building Information Modelling, Construction, Scientometric Analysis, Adoption, Project

Abstract

Adoption of Building Information Modelling (BIM) technologies in design, construction and maintenance of the facility significantly affect the construction industry. Many countries across the world have adopted BIM at different levels over the past two decades. BIM in the construction industry is observing increased acceptability and adoption. Many nations including the UK, US, Germany, China, and others have mandated the use of BIM for their government construction projects. BIM has a major impact on increasing productivity, efficiency, quality of work, safety, sustainability, lowering project time and cost overrun. It promotes effective communication between the stakeholders in the construction projects. Application of BIM makes it easier to combine processes throughout the entire lifespan of the building. This study focuses on understanding the major advantages of BIM application in the construction industry. The paper also reviews the level of adoption of BIM technology around the world with a special focus on India. A systematic scientometric analysis is carried out to compare the level of adoption. The analysis of literature review highlights major challenges in adoption, research gaps, recent trends and various approaches to handling construction projects using BIM.

#166 - Cloud-based technologies necessitate extra security considerations inside the Digital Construction

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Keywords: Digital Construction, Lean, and Security.

Abstract

Building Information Modelling (BIM) and the Lean Construction (LC) approaches reinforce the advancement of the design and construction field because of their favourable impact throughout the project life cycle. Merging BIM and LC enhances data management, information flow control, cost-saving, time-saving, and improved quality. Combining BIM and LC approaches are the first development step and departure from the traditional method paradigm. Then, the continuous improvement concept and the need for adequate data management methods resulted in the rise of Cloud services and the current pace of refinement. Working on Cloud servers helps the engagement of teams from multiple locations, makes data more accessible and integrates data in a Common Data Environment (CDE), which improves information exchange. Despite the pragmatic influence of the Cloud services, the security of shared data and its protection is still a hurdle and requires further attention. The lack of security awareness could obstruct the usage of digital Construction besides the cybercrime probation increase because of the ease of data accessibility and its misuse. In addition, a lack of security consciousness has a detrimental impact on decision-making since the decision will underestimate the security factor that could cause significant future problems. The paper focuses on the impact of the BIM and LC interaction perspectives, it is considered a double side weapon, from one side the ability BIM and LC to support design from the crime prevention point of view. On the other side, to implement the interaction between BIM and LC, it is required to move towards Cloud-based system which can cause a negative impact and be a reason for more crime propagation because of the increase of Cyber-crimes. In addition, to investigate the reasons behind the use of Cloud services, highlight the business influence upon the design and construction market, emphasise the lack of security attention impact on the development process, and highlight threats of using a Cloud service.

#251 - Nexus of Artificial Intelligence and Sustainable Infrastructure Development towards a resilient A.E.C.: A review

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Keywords: A.E.C., Bibliometric, Systematic Literature Review, Sustainable Infrastructure Development.

Abstract

In sustainable infrastructure development, comprehensive planning is required to build more resilient societies and improve human wellbeing. The adoption of Artificial Intelligence plays a significant role in the A.E.C. delivering sustainable infrastructure development through machine learning knowledge-based systems. Moreover, digitalisation of sustainable infrastructure development through Artificial Intelligence provides enhanced efficiency and improved infrastructure management, better serving the end-user. However, with the opportunities it brings for the A.E.C. industry, the threats are as equal, compromising the industry's resilience to be better equipped for the new changes. This article aims to provide a two-phase bibliometric and systematic literature review on the SWOT (Strengths, Weaknesses, Opportunities and Threats) analyses of artificial intelligence-driven technologies as a response to the resilience of the A.E.C. industry in sustainable infrastructure development. The analyses' findings will provide a more comprehensive picture of the efforts to use A.I. technology for Sustainable Infrastructure Development. In addition, the article will provide an opportunity for the A.E.C. to be more resilient going forward with the changes that come with the use of A.I. Finally, a discussion of the prospects, key guidelines, and lessons learned should be implemented to ensure a favourable change in A.I. advancements and applications toward completely supporting Sustainable Infrastructure Development. The article is expected to contribute to Artificial Intelligence's knowledge in sustainable infrastructure development for a more resilient A.E.C. industry. It will also address the gap in sustainable infrastructure development by using Artificial intelligence as an innovative way to design, construct, operate and maintain infrastructure by better understanding current and future needs and the relationship between A.I. and sustainability.

#258 - Insights and Issues of Building Information Modelling (BIM) Implementation in the Architectural, Engineering and Construction (AEC) Sectors of Sub-Sahara Africa

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Keywords: Project productivity, Project performance, BIM benefits, BIM barriers.

Abstract

BIM has received worldwide uptake because it improves the productivity and performance of projects. However, uptake is still in its infant stages across Sub-Sahara Africa (SSA). Therefore, this study explores stakeholder perceptions of the benefits and barriers of implementing BIM in the Architectural, Engineering and Construction (AEC) sectors of SSA. Based on a structured review of recent literature, a suite of known benefits and barriers to implementing BIM were identified. These were used to create an online survey questionnaire that was shared among AEC professionals working across the SSA region. The opinions, collated from 145 participants across 15 different SSA nations, were ranked using a weighted average method. Results reveal the main benefits are: (i) clients will increasingly insist on us using/ adopting BIM; (ii) adopting BIM reduce/ will reduce human resource and man-hours; and (iii) adopting BIM brings/will bring cost efficiencies; whilst the main barriers are: (i) lack of training and skills; (ii) high cost of implementation (BIM software, licences and associated applications); (iii) lack of in-house expertise. Based on these findings, the study recognises that BIM capabilities are fundamental for BIM adoption and implementation across SSA. Therefore, the study recommends the need for future research to explore the BIM capability and BIM maturity of organisations across the AEC sectors of SSA and, in doing so, create frameworks and/or highlight pathways to enable greater uptake.

#287 - An Investigation into the Role of Building Information Modelling (BIM) in Minimising Design Changes

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Keywords: BIM, design changes, minimise, investigation.

Abstract

Conceptually, Building Information Modelling (BIM) has been in existence for decades. However, BIM has only recently gained widespread application in the construction industry. There are mandates in place for BIM use in many countries. With this increased interest in the subject of BIM, there has been a lot of conjecture amongst academia on the potential benefits of projects utilising BIM. One of the reported benefits is early stakeholder engagement enhanced by better communication of design intent thus minimisation of the need for design changes which lead to cost overruns in projects. This study conducted an investigation into the nature of BIM in the construction industry and how effective it can be in eliminating the need for design changes during projects. The study employed close-ended questionnaire, with respondents comprising construction professionals. BIM was found to have significant potential for minimising and managing design changes. However, BIM was found not to be reaching its full potential in regard to the expectations of eliminating design changes. The main limitations being a lack of appreciation of the capabilities of the BIM process, especially as a collaborative model, and the current procurement routes do not effectively support the level of integration that can facilitate more effective management of design change.

#217 - Understanding the Benefits of Immersive Technology Use in the Furniture Fixture and Equipment Sector: A Systematic Review

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Keywords: Design Communication, Productivity and Efficiency, User Experience, Immersive Collaboration

Abstract

Like other sectors of the Architecture, Engineering and Construction (AEC) industry, immersive technology (ImT) has proven to be an effective tool in the Furniture Fixture and Equipment Sector (FFE), which recently attracted a lot of attention from researchers. Despite the increasing scholarly attention being given to ImT applications in the FFE sector, very few studies have explored the key benefits associated with the application of ImT in this sector, with no aggregation of findings and knowledge. To bridge this gap and to gain a better understanding of the state-of-the-art ImT application in the FFE sector, this study reviews and synthesises the existing research evidence through a systematic review. The relevance of this study cannot be overemphasised, given the vast number of published works albeit a lack of aggregation of the findings and knowledge. After a thorough search of key academic databases, a full range of journal articles and conference papers published between 2010 and 2022 (inclusive) that address the application of ImT in the FFE sector was systematically assessed. Built upon rigorous inclusion and exclusion criteria, 24 eligible articles were identified and reviewed. Predicted on a wide range of scholarly literature, this study identifies 20 critical benefits associated with the application of ImT in the FFE sector. This study provides an opportunity for the FFE sector to understand the benefits associated with the adoption of ImT that will encourage the adoption of ImT in the FFE sector which is in the process of digitisation.

#170 - Design for Sustainability: An approach based on the integration of BIM and Building Performance Analyses

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Keywords: BIM, BPA, carbon emission and building modelling.

Abstract

BIM has emerged as a modern method for the design and management of construction throughout the lifecycle of a project. BIM has been widely used in various activities such as architectural and structural design, scheduling, resolving clashes, data sharing, monitoring projects, and various applications during the construction phase of a project. Nowadays, most countries are motivated in building great infrastructures thereby causing increased carbon emissions and energy consumption. This leads to a rise in the greenhouse effect. To overcome this crisis the AEC industry has given more importance to sustainable design and construction. Different private organizations have introduced various advanced technologies which have capable in analyse the building performance for sustainable outcomes. In construction, the industry has followed innovative methods through a collaboration of BIM with the Building performance analysis (BPA)tools to enhance the sustainable design workflow. This research paper brings an overview of the importance of sustainable design in the AEC industry. The importance of the BPA tools which are used along with BIM for the analysis of energy consumption and carbon emission. The hypothetical case study has demonstrated the step-by-step procedure for fully integrating BIM and BPA by using the Revit application and IES VE (Integrated Environment Solution and Virtual environment). This producer can be able to understand the relationship between BIM and BPA tools. Mainly about the challenges faced during the interoperability process which will be affected the sustainable analysis. Through the integration of BIM and BPA tools can be able to understand the current level of limitations and benefits of the sustainable design workflow.

#171 - Enabling Quality in Lean Construction: Integrating the Principles of Total Quality Management with 9D-BIM

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Keywords: TQM, BIM and Total Quality Management.

Abstract

Recently Total Quality Management (TQM) has been proved to be the most successful continuous improvement system. Total quality management (TQM) process has been considered as a modern system in the field of quality, after quality assurance, quality control and ISO in the Construction sector. Although it was initially implemented in the manufacturing and automobile industries in Japan, later it was adopted by the construction sector. Design and construction are the two important phases of project life cycle which affect the quality of outcome of construction projects significantly. The current quality management practice in the construction industry includes issuing quality checklists, site inspection and testing, non-conformance reporting and corrective action but there is not a systematic way of recording the inspected data, hence, the quality status of construction cannot be determined. The newly emerging technologies such as Building Information Modelling (BIM) and lean construction can be used to control the quality in construction. One of the most popular management system standards among construction companies is ISO 9000—the construction sector has the fourth highest number of quality assurance certificates of all sectors in the world. A positive relationship between ISO 9000 certification and firm performance was observed in 69% of existing cross-sectional studies. TQM and BIM convey some level of association in terms of execution, productivity, information requirements and quality outcomes throughout the construction process although not much work is done in mapping their common denominators. This research focuses on mapping the TQM elements and BIM dimensions as means of inducing Quality as part of the ninth dimension of BIM (9D BIM). A framework for enabling quality in lean construction through the integration of TQM and 9D-BIM is proposed in this study.

Buildings and Performance

#120 - Homes fit for future generations

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Keywords: Housing standards quality sustainability holistic decarbonisation

Abstract

The Wellbeing of Future Generations Act (WFGA, 2016) was developed in parallel with the United Nations' Sustainable Development Goals (SDGs). This unique piece of legislation requires that all Welsh public bodies think longer term in their decision-making, by working together with people and their communities "to create a Wales that we all want to live in, now and in the future." (WFGA_The Essentials, 2015)

The Homes for Future Generations (HFFG) project (2020-2021) investigated how the seven goals enshrined in WFGA can be applied to deliver sustainable housing in Wales, "without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987). To achieve this aim, six architectural practices each designed a housing case study that complies with WFGA. The case studies were connected by a shared set of emerging guiding principles (one for each WFGA goal) and a single masterplan. These principles were tested and refined through the design process.

This paper articulates key lessons learnt through the HFFG project. The seven guiding principles are explained, with reference to seven themed essays that were developed in response to the design work. The paper describes potential benefits of compliance with WFGA (and, by implication, the UN SDGs). The paper also identifies and challenges key barriers that currently limit application of the WFGA goals to new housing. Conclusions drawn have relevance to planners and policy makers, designers and constructors, and to future owners and occupiers.

#184 - Human-Oriented Energy Efficient Housing Envelope through a comparative analysis of the UK and Australian Housing

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Keywords: Energy Efficiency; Housing Envelope; Sustainability; Human-oriented approach; UK; Australia.

Abstract

Compared with Australia, people tend to live in energy efficient housing in the UK, and their amount of carbon emission is lower though they use higher amount of energy. This means that they consume less fossil fuel, and pay higher attention to passive bioclimatic principles. The concept of an Empathic City requires a human-oriented approach rather than one that is machine-centric. Although it is indicated that energy efficiency is a key concept in climate change mitigation, by means of fossil fuel dependence reduction, recently the concept of sufficiency which depends on the proper energy performance of the whole aspects of a system has been stressed as an important factor in overall long-term energy consumption reduction. Housing sustainability and the reduction of overall energy consumption are related significantly to the function of envelope in the area of passive climatic principles and thermal performance. The housing envelope also has significant impacts on occupants' perceptions and plays a significant role in their housing selection. In the UK and Australia, occupants are eager to select a house which is able to respond to the bioclimatic principles in association with other aspects impacting their perceptions. Therefore, the envelope should be able to transfer messages about the energy efficiency in congruity with occupants' perceptions. It is therefore necessary to look at occupants' perceptions of envelope energy efficiency, and the interplay between the different aspects, e.g. demographic and socio-economic characteristics, building characteristics, and intra-urban environmental dimension in impacting housing energy consumption. To answer these questions, the main gap is to transfer abstract data related to human perceptions into concrete data through the concept of environmental image. Drawing on the idea that the contents of photos are able to express human perceptions, this study has developed a practical methodology to quantify housing energy efficiency perceptions. A comparison between the UK and Australian occupants would provide a better

picture of the interplay between the different aspects of Housing EE, and would address similarities and differences in peoples' EE perceptions and the determinants of their perceptions in two different contexts with different EE measures and experiences. This paper reviews the conceptual and methodological platform along with the future development of this research. Such investigations will assist housing authorities to enhance the occupants' positive perceptions via enhancing the congruity of energy-related attributes with their perceptions.

#249 - Agricultural Construction in Ireland: Issues and Strategies Concerning Substandard Farm Building Developments

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Keywords: Agricultural Construction, Building Regulations, Ireland, Planning Procedures.

Abstract

The construction industry in Ireland is heavily regulated, and typically abides by a rigorous planning process with strict rules and regulations. However, one area that has been subject to much scrutiny and confusion is agricultural construction, which has been described as a law unto itself. It fails to meet construction standards set by most other sectors, and this is evident throughout the country. Therefore, the purpose of this study is to investigate Irish planning and construction procedures within an agricultural context. It aims to unearth reasons why, despite recurrent, and sometimes fatal accidents, the agricultural construction industry is permitted to continue using alternative, more lenient regulations, compared to other building sectors throughout Ireland. A mixed methods research approach is adopted, incorporating both qualitative and quantitative analysis. Following a descriptive literature review, four individual interviews with participants from diverse agricultural backgrounds are undertaken, followed by a confirmatory questionnaire survey. This approach is implemented due to limited previous research on the topic and allows for greater scope during data collection. The results indicate that themes such as a lack of funding, cultural issues, inexperienced personnel, and weak existing legislation are recurrent issues evident throughout the study. Strategies to counteract the identified issues include more government funding such as grant aided schemes for farmers, stricter planning procedures to adhere to, and more formal training for planning inspectors and officials. Ultimately, the key contribution of this study illustrates that the current system is no longer fit for purpose, and identifies key issues and weaknesses, as well as outlining various strategies to develop and improve planning and construction processes, for agricultural construction developments in Ireland.

#253 - Post-Disaster Housing Performance Indicators and Criteria: A Review of Housing Regulations and Guidelines in Indonesia

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Keywords: Post-Disaster Housing, housing performance indicators, Indonesian housing regulation.

Abstract

Lessons from Indonesia showed quality issues in humanitarian response due to lack of monitoring, evaluation and compliance to standards. Evaluation phase is one of stages of post-disaster response cycles that requires appropriate indicators for measuring post-disaster activity outcomes. This paper presents the result of document review which explore current significant list of indicators and criteria that are deployed in planning, designing and monitoring post-disaster housing projects. Document analysis or document review method is adopted to explore indicators and criteria that have been established and used to regulate housing procurement and housing construction in normal situation and in post-disaster events in Indonesia. Two categories of data sources were used. The first data source category is specific laws, government acts and regulations, and guidelines of housing standards and requirements. Indonesian laws, acts and government decree in building and housing sectors in Indonesia have been selected because of their relevance to expert interview and research survey as part of ongoing research study conducted in Indonesia, and Aceh as a particular case study. Selected published handbooks and guidelines of post-disaster and humanitarian housing construction are reviewed and summarised as the second source category of data. Document review reveals indication that there is a gap in the comprehensiveness of housing performance indicators and criteria stipulated in the current documents particularly in addressing Disaster-Resilient Housing concept. There was no comprehensive list of performance criteria developed specifically to encompass disaster resilient housing concept for construction of post-disaster housing in Indonesia in particular.

#127- Evaluation of Attributional and Consequential Approaches for an Holistic Life Cycle Assessment

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Keywords: Life Cycle Assessment, Attributional LCA, Consequential LCA, Sustainable construction

Abstract

Buildings are responsible for a large portion of resource consumption and CO2 emissions, so the construction industry is one of those where rapid action is required. At this point, Life Cycle Assessment (LCA), a tool to evaluate the buildings' environmental impacts, is playing an increasingly important role in sustainable building design. There are two LCA approaches: Attributional Life Cycle Assessment (ALCA) and Consequential Life Cycle Assessment (CLCA). ALCA represents the potential environmental impacts linked to the life cycle of the assessed buildings, while CLCA examines the environmental consequences of the decisions. Although the attributional approach is widely used, there are limited studies explaining how to apply consequential LCA in the construction industry. While some studies identify differences between ALCA and CLCA, the methodological features of the consequential approach have not been discussed in detail. Nowadays, with the effects of climate change is becoming more distinct, detecting the environmental impact of a building over a certain period has highlighted. Therefore, a comprehensive approach to determining the future effects of our decisions is crucial for environmental sustainability. In this study, the existing literature on both approaches is critically analysed to explore the key characteristics of both approaches and evaluate the opportunities and challenges for a holistic life cycle assessment system that considers attributional and consequential approaches together. Furthermore, a theoretical approach to developing a holistic framework is introduced.

#208 - Is Passivhaus the Future for Social Housing Scheme? – Design, Procurement and Post Occupancy Evaluation

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Abstract

In order to meet the SDGs, new buildings, as well as retrofitted buildings, are developed to an increasingly higher environmental performance standard in both private and social sectors. This has been reflected in a higher standard for thermal performance specification in building regulations, as well as the increased adoption of energy efficiency focused building methodologies. Passivhaus standard, among others, has been slowly gaining popularity amongst local authorities in the UK. Last decade has seen a growing number of social & affordable housing developments designed to achieve Passivhaus standard. Yet the social, technical and economic barriers to more widely adopt this low energy building methodology as social housing model are still under explored.

Previous research identified cost, material and manufacturer, construction knowledge, as well as the performance gap to be some of the main barriers in delivering Passivhaus projects in general. However, it is unclear if these apply to social housing sector, or if other factors have more prominent effect on delivering social housing Passivhaus schemes. This paper reports on preliminary findings of a newly completed Passivhaus project in Lincolnshire with 8 units of households, in terms of its procurement, design, construction, and post occupancy evaluation. The investigation explores Passivhaus methodology from the perspectives of local authority, design and construction team, and the users' behaviour and experience, in order to identify the barriers and opportunities in key design, procurement and operational stages of delivering social housing Passivhaus project.

#141 - Perceived effectiveness of Building Regulations in promoting and facilitating low energy retrofit in historic buildings

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Keywords: Retrofit, Retrofit, Historic Buildings, Building Regulations, Conservation professionals

Abstract

This research is in response to conflicting messages from construction industry professionals around the correct approach to the challenge of retrofitting historic buildings (pre-1919) for energy efficiency.

Building Regulations are often cited as a barrier to effective retrofit of historic buildings (Jenkins, 2021)– both by those who consider the minimum stipulated standards inadequate to enact change, and conversely, by those who think Building Regulations impose too rigid methods that are incompatible with risk-free retrofit.

Recent new uplifts in Approved Documents Part L Conservation of Fuel and Power (DLUHC, 2021a) and Part F Ventilation (DLUHC, 2021b) directly affect retrofit design considerations in existing buildings. Building Regulations have a role to make sure buildings are going to be safe, healthy and high-performing and must play a crucial role in improving standards if we are to decarbonize existing buildings to targets.

The study uses two data collection methods to gauge what industry considers the impact the uplifted requirements will be on fabric improvements, specifically to historic buildings. The paper examines public responses to proposed changes from relevant organisations. This is counterpoised with some individual voices on the ground from conservation professional practice and building control. It draws conclusions on how the changes are perceived in terms of effectiveness.

Results show that the conservation profession tightly guards heritage works and avoids engagement in what appears to be a weak and ineffectual regulatory system. It is too early to gauge how uplifts that came into enforcement in June 2022 will impact the regulatory system for historic building retrofit, but the study indicates they have not yet gone far enough to bring about the ‘cultural shift’ The Hackitt Review (MHCLG, 2018a) so desperately called for.

Disaster Management

#237 - A weighted centrality-based scenario analysis for identifying the most suitable evacuation strategy for a tsunami hazard during a pandemic outbreak – Literature review and an expert opinion survey in Sri Lanka

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Keywords: COVID-19, emergency management, network centrality, rapid onset hazards, risk assessment

Abstract

The recent natural disasters that occurred during the worst outbreaks of COVID-19 demonstrates a significant risk of causing a sudden spike of COVID-19 cases and fatalities during the post disaster response and recovery period. This problem is caused as there is no sufficient knowledge of the transmissibility of a contagious disease among vulnerable communities during disaster response activities. The present guidelines issued by the Indian Ocean Tsunami Information Centre (ICG/IOTWMS, 2020) mentions that a tsunami evacuation order should take priority over COVID-19 self-isolation advice when evacuations are required. However, the guidelines do not indicate sufficient safe evacuation procedures for the vulnerable communities. Therefore, knowledge on this aspect is identified as a significant need to prepare integrated guidelines for disaster management during a pandemic outbreak. Accordingly, this research aims to develop a framework for analysing tsunami evacuation scenarios in three case study areas in Sri Lanka for identifying the relationship between the transmission of the COVID-19 contagious disease and the tsunami evacuation routes. The research adopts the network centrality concept for modelling the effects of the pandemic in the tsunami evacuation scenarios. An integrative literature review was conducted to explore the key components related to the areas of tsunami evacuation, road network connectivity and COVID-19 pandemic management. The key components were distinguished into three categories (risk identification, risk assessment and risk reduction) using expert opinion to composite the conceptual framework to integrate pandemic preparedness into tsunami evacuation planning. The result of the analysis demonstrates a significant risk in the transmission of the disease in existing evacuation routes. Accordingly, considering the result of the scenario analysis, a connectivity-based clustering evacuation strategy is proposed for planning tsunami evacuation during a pandemic outbreak.

#270 - A cross-sectoral, multi-stakeholder perspective on climate adaptation and risk reduction in south coastal – urban zone of Nigeria

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Key words: *Climate change, disaster risk, coastal-urban, development, Nigeria*

Abstract

The concepts of climate change adaptation and disaster risk reduction are important for relevant stakeholders to promote more sustainable development and increase levels of disaster resilience in urban areas.

Alongside increasing levels of urbanisation, coastal areas are especially attractive to human society and are currently home to 2.4 billion people and about 40% of world population. This represents 20% of total global land space, and 75% of the largest urban areas lie within coastal areas, with an estimated population to reach 1.4 billion by 2060. However, Nigeria is undergoing rapid urbanisation and population increases.

Despite their popularity for human settlements, coastal - urban areas are especially exposed to high levels of disaster risk, including coastal hazards as flooding and cyclones, and the impacts of climate change such as sea level rise. The close interactions between socio-economic development, the coastal-urban environment and climate risks are expected to increase the complexity and challenges that threaten coastal-urban development. These will require an improved, more harmonised policy response for enhanced sustainable development in Nigeria.

This paper describes research that is part of a broader study into the integration of climate change adaptation and disaster risk reduction within the coastal-urban Nigerian context. This initial phase of the study critically examines the understanding of disaster risk reduction and climate change adaptation concepts amongst key stakeholders in Nigeria.

A desk-based review of relevant literature was employed and used to identify challenges and formulate research questions. Qualitative semi-structured interviews were carried out with four categories of stakeholders in Nigeria. These were drawn from the Southern coastal-urban zone and sectors of the Nigerian economy.

The findings provide important cross-sectoral comparisons and national to urban perspectives within Nigeria. The results will inform the development of a policy framework that can be used to strengthen integration of climate change and disaster risk reduction at the urban level for overall sustainable development.

#283 - Does distribution and type of aid affect internal migration following a cyclone? Evidence from Bangladesh

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Keywords: Aid, Bangladesh, Climate change, Cyclone, Food security, Migration

Abstract

With the increasing frequency of extreme climatic events, it becomes crucial to understand the impacts of different post-cyclonic aid on human mobility. The identification of post-disaster mobility factors is important for planners to prioritise and respond accordingly. This paper explores the impacts of aid in form of food, cash, and agricultural inputs on internal migration following a series of cyclones on the southern coastal area of Bangladesh. Impacts of sources of aid such as institutional or social network sources were also analysed. 472 households across 16 blocks (moujas) were selected for participation, using a stratified sampling strategy. Data were captured via a survey which included individual and household-level demographic, migration, and aid-receipt following cyclones. Data were analysed using a mixture of descriptive and inferential statistical methods. Multinomial logistic regression revealed that migration was significantly higher among households which did not receive institutional food aid. More specifically, non-receipt of food aid and cash aid after a cyclone, different sources of income, non-availability of alternative sources of income, lack of land ownership, and severity of cyclone increased migration among the households where a minority of household members migrated. In contrast, non-receipt of food aid and severity of cyclone were found to be significant factors to increase migration among the households where a majority of household members migrated. We argue that the decision to migrate of the households where a majority of members migrated increased with the increase of severity of cyclone.

#286 - Towards a Framework to Support Flood Risk Adaptation Measures for Vulnerable Communities

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Keywords: Flood Insurance, Community Resilience, Flood Risk Management.

Abstract

The UK Government's strategy Making Space for Water (2005) heralded a change in its approach towards flood risk management (FRM). Since then there have been major improvements in aspects of FRM, such as forecasting and the dissemination of information. Similarly, flood insurance, another facet of FRM, has changed too. Flood Re provides affordable flood risk insurance for low-income home-owners and provides access to contents insurance for those households in the rental sector (private and social). However, a significant proportion of those rental households (circa 4.5 million) are found in vulnerable communities, often located in areas of high risk of flooding. This study examines how tenure effects access to FRM. Using a case study approach, the research investigates attitudes toward the uptake of FRM in parts of Boston (Lincolnshire, UK), where two-thirds of its properties are in areas with a significant (high and medium) chance of flooding and just over 25% of the total housing stock in Boston is rented (private and social). Moreover, the town has experienced a significant population increase (15.9% increase 2001–2011), with substantial changes in the makeup of households and dramatic migration from the Eastern Europe. According to Index of Multiple Deprivation (IMD), four (~11%) of the Super Output Areas (SOA) in Boston are in the top 20% deprived locations in the UK. This ongoing study is adopting of a mixed methods approach to gathering information to understand the relationship between property tenure and FRM, so as to support the development of a framework that could help organisations and agencies responsible for promoting elements of FRM, ensure greater opportunity and wider access to FRM (including insurance), at local level: building greater community resilience and, hence, improving sustainability.

Education and training

#260 - Balancing indoor CO₂ concentration levels and thermal comfort: Actions in primary school classrooms

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Keywords: CO₂, concentration indoors, thermal comfort, school buildings, monitoring

Abstract

Current climate emergency context requires urgent action to reduce energy consumption in buildings while maintaining healthy indoor environment. Promoting good indoor environments, in particular increasing ventilation, has been a prominent strategy to mitigate the risk of COVID-19 transmission indoors. However, this strategy could be detrimental to thermal comfort, particularly in the heating season in temperate climate zones. This paper presents the findings from a pilot project conducted in 2 primary schools in South Wales (UK) monitoring the indoor environmental conditions in a small number of classrooms that implemented operational guidance issued post-COVID-19. The study measured CO₂, temperature and relative humidity. It explored the perceptions of indoor environment by pupils and teachers, with focus on thermal comfort and freshness of air. This paper presents the results of the monitoring study and discusses the behavioural adaptation strategies enacted in the primary schools to balance the requirement of reducing CO₂ concentration levels while promoting thermal comfort.

#262 - Identifying the factors affecting University-Enterprise Collaborations for Disaster Resilience

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Keywords: University-Enterprise Collaborations; Disasters; Industry, Government, Universities

Abstract

Strengthening collaborations among multi-stakeholder partnerships is one of the Sustainable Development Goals in delivering the development agenda. Such collaborations can be established at global, national and local levels. For example, the benefit of collaborations among multi-stakeholders has been evident during the COVID-19 pandemic in finding solutions to end the pandemic. Moreover, the vaccine's development and production can be considered one of the most successful collaborations between academia, industry, and the governments.

Having understood the significance of such collaborations, a group of academics in Asia proposed a project to strengthen university-enterprise collaborations (UEC) to strengthen disaster resilience in Asia. Asia's high hazard profile and the unequal and underdeveloped nature of UEC encouraged them to propose this study. Accordingly, they initiated the project called SECRA (Strengthening University-enterprise Collaboration for Resilient Communities in Asia) funded by the Erasmus Programme of the European Commission. The project aims to develop a framework for strengthening community disaster resilience through strengthening UEC. In order to develop the proposed framework, the study conducted an initial literature review to identify the factors that affected UEC. Then the study conducted a thematic analysis to identify key thematic areas based on their relatedness.

The study revealed more than forty different factors affecting the UEC. The factors are grouped into cultural, structural, relational, and material as thematic areas. In addition, the literature review also found several good practices adopted in several countries supporting their UECs. These findings will be utilised to develop a more systematic, institutionalised and monitored framework for strengthening UEC for countries in Asia towards disaster resilience.

#241 - Barriers to the Implementation of Work-Based Learning into Learning Engineering Programmes: A Review

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Keywords: Co-op education, Degree apprenticeship, employability, university education

Abstract

Over the years, the average age of the workforce in the engineering sector of the economy has been increasing. Literature indicates that low labour productivity and skills shortage could be attributed to the ageing workforce situation. Work-based learning programmes are designed to provide young people with the skills and knowledge required for industry job roles. However, there are barriers to the smooth implementation of work-based learning programmes in the engineering sector. Thus, the current study explored the findings in relevant studies through a systematic review to summarize the barriers to the implementation of work-based learning in engineering programmes. The study showed that finance is the most predominant barrier to the implementation of work-based learning. Case study is the most common research method used in previous studies on this topic. By synthesizing existing knowledge, this review provides insights into the barriers to the implementation of work-based learning. The study contributes to knowledge in various ways. First, it provides a comprehensive insight into the barriers to the implementation of work-based learning in engineering programmes. Second, it highlights trends and gaps in the current knowledge on barriers to the administration of work-based learning programmes. The information presented in the study could be used to develop strategies and policies for improving the process of running work-based learning for engineering programmes.

#181 - The progression of Awareness of Circular Economic Principles within Civil Engineering

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Keywords: Circular Civil Engineering, Circular Economy Awareness, Higher Education

Abstract

Circular Civil Engineering is applying the circular economic principles to civil engineering. The circular economy is a model of production and consumption, which results in absolute minimal waste. Some of the main challenges to its implementation include lack of policies, design for end of life, unclear circular economy framework, and lack of awareness. This research focuses on the awareness and knowledge on the subject within students and postgraduates in industry. The data for this project was collected through an online survey and resulted in most of respondents having a relation with the University of the West of England. The survey focused on how confident students and postgraduates are on their knowledge, as well as researching previous implementation of the circular economy in universities and the working industry. This research found that progression of awareness has been made over the years, but not on a large enough scale.

#227 - Inclusive exploration of sustainable goals and solutions through Minecraft

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Keywords: Minecraft, engineering engagement, accessibility, sustainability communication.

Abstract

Science Hunters has successfully used the computer game Minecraft to engage children with science since 2014, using a specific approach that promotes learning within the framework of defined topics, whilst encouraging exploration of the elements that most interest individuals. The main audience is children who may be experiencing barriers to accessing educational opportunities.

As an overarching endeavour, Science Hunters links to Sustainable Development Goals (SDGs) around inclusive education and lifelong learning opportunities (SDG 4: 'Quality Education'). This case study focuses on the Science Hunters engineering strand, Building to Break Barriers. The project worked with children from groups under-represented in engineering, specifically including girls and ensuring clear representation (60% of 15 recruited) of women within the participating engineer cohort; linking to the SDG of empowering all women and girls (SDG 5: 'Gender Equality').

Developed topics delivered opportunities to engage with engineering and environmental solutions to specific real-world problems. These linked, for example, to elements of the SDGs such as food security (SDG 2: 'Zero Hunger'), 'Sustainable Cities and Communities' (SDG11), 'Responsible Consumption and Production' (SDG 12) and 'Life on Land' (SDG 15) and embedded awareness of these issues through engaging with a familiar and popular medium. Feedback included that the project "made engineering accessible" for their children, and that it was "wonderful, especially for the girls, to see so many females in STEM roles."

#235 - Apprenticeships: how can they support sustainable organisational management?

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Keywords: apprenticeships, organisational management, skills, development.

Abstract

This paper will summarise the findings from an Engineering Doctoral project, spanning three years. The research is about degree apprenticeships in England, specifically the ones in civil engineering at Level 6, however this paper will take a broader view of the role of apprenticeships as a sustainable facet contributing to organisational management. The research will be relevant to organisations to gain a better understanding of how apprenticeship programmes could become integrated into business as usual with links to recruitment, retention, and skills development to name some. The research adopted an ethnographic methodology, gathering qualitative data from 2019 to early 2022 using questionnaires and focus groups. Software analyses was undertaken with the results from the apprentice questionnaires uncovering underlying constructs which were in turn used to structure the focus group prework and discussion questions. This paper will consider the data collected from the focus groups. The research will lead organisations to evaluate and consider where apprenticeships, and similar skills development frameworks can support long-term business visions and plans. This research will be added to early body of works in this subject area and will present examples of supporting activities that can promote longevity of skills development for employees.

#273 - Children's Perception of Space: The influence of Architecture in the Development of Creativity. Primary School

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Keywords: children, perception, creativity, architecture

Abstract

Architecture is a way of seeing and understanding space by children and adults. Exploring with architecture from an early age help us act on transforming the environment in a sustainable way.

Children's perception and creativity is a broad area to study, a trans-disciplinary one, as it includes pedagogical, psychological, medical, technical, ecological and many other fields. children 6-10 years old are deprived of an environment in which to develop their creativity and, at this age, they do not need just a table and a pen, they need to explore through all their senses with diverse materials and shapes.

A phenomenological approach is reached by understanding from authors like Bachelard and Pallasma that the perception and memory of a place are created by a unique landscape. From storytellers, from macro to meso and, last but not least, micro, from the territory, to the urban fabrics and to the intimacy of a home, our memories are created in our childhood by using our senses in these landscapes.

An empirical view may layout the experience of children with space according to their inherited perceptive nature. This are well presented through a series of case studies. Today's architecture cannot be separated, especially when it comes to vulnerable people, from several other subjects.

#124 - The current water and sanitation provision at rural schools KwaZulu-Natal: The Built Environment Professionals Perspective

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Keywords: Backlogs, Inequality, Infrastructure; Rural, Sanitation, South Africa, Water

Abstract

South Africa has made a substantial amount of progress with regards to basic service delivery since the end of apartheid in 1994, however, there still remains major disparities between the various provinces and municipalities within the country. Water and sanitation provisions particularly in schools in rural areas of South Africa, in many instances lack dignity for learners and teachers. This also undoubtedly raises health concerns for learners, teachers and administrative staff at the schools. Rural communities in particular, have access to far less, as a result of unequal development, poverty and the cost of providing bulk infrastructure services for water and sanitation, to distant rural areas of the country. This study adopted a quantitative research approach. Online questionnaires were purposively emailed to 120 built environment professionals who are involved in the provision of water and sanitation facilities to schools in KwaZulu-Natal. Fifty-two completed responses were received. The data was analysed, utilising descriptive statistics. It was found that the government has made a concerted effort to ensure that school going children have been provided with water and sanitation facilities. However, this paper highlights that once the provision was made, very little else was provided to advance the current situation. In many schools across the province, children are still subjected to unhygienic water and sanitation conditions at school which affects their health and learning experience.

Energy and Carbon

#197 - From consumer to prosumer, how the general public can aid the transition to Virtual Power Plants

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Keywords: Virtual power plants, decentralized grid, climate change, energy security.

Abstract

There is currently a shift in the power generation and distribution models from a top down centralised system to a network of decentralised grids making Virtual Power Plant (VPP) technology an opportunity for a different model of power supply. In this context, a VPP is a cloud-based power plant which connects multiple Distributed Energy Resource units such as renewable energy resources and energy storage systems and allows energy producers to buy and sell energy on the market. These distributed energy resources can be small scale residential sources such as solar panels, micro wind generation or combined heat and power units within the home with support of battery storage technology. Therefore, domestic consumers have the potential to be a major barrier in implementing VPP Technology throughout the UK, restricting the UK's progress towards sustainability targets to combat climate change.

Based on a review of literature on barriers to implementing VPP's, it was evident that domestic consumers can cause technical, social, political and financial barriers to implementing new technologies. The study surveyed 64 domestic consumers across the UK about adopting the technology. Based on the survey results, a further 6 respondents voluntarily undertook semi-structured interviews to provide more detailed understanding of their motivations. Analysis of the results showed that along with the barriers discovered in the literature review, two more themes including property barriers and a desire for flexible options were identified. The results indicate that domestic consumers can be a barrier to VPP implementation. Yet with funding via governments or VPP providers to support the upfront capital cost of the technologies and offering flexibility of involvement packages these barriers can be overcome. Allowing many who may not have been able to financially, to become prosumers, supplying the VPP with distributed energy resources to provide greater capacity and resilience to the network.

#134 - Considering Carbon as Another Criterion on Deciding the Optimum Material Mix: A Case Study Using AHP Technique

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Keywords: Analytical Hierarchy Process, Building Materials, Carbon, Multi Criteria Decision Making

Abstract

Embodied carbon (EC) of a building is directly proportional to its used materials and their quantities. Therefore, material selection is a crucial juncture of a building development that cannot be disregarded in attempting to reduce the EC share of whole building lifecycle carbon emissions. Irrespective of that fact, material related decision making still relies on the criteria such as cost, time to assemble, quality and durability. It stresses the necessity of taking carbon content of materials into account as another material selection criterion. If materials are to be chosen optimally considering several criteria, a multi criteria decision making method can be adopted. Of various methods that have been developed, Analytic Hierarchy Process (AHP) is one tool that has attracted the wide attention. In light of that, this paper adopted AHP technique to demonstrate how carbon can be included as another decision-making criterion when choosing an optimal material mix for a case study. Depending on the data availability, only material carbon and cost were considered as the selection criteria for the demonstration. Further, the material selection was confined to the building elements that create the structure of the building. The results indicated that the optimum material mix which was suggested for the building structure is less expensive and emits considerably low emissions compared to the material mix that had been originally chosen. Thus, this study informs the building designers and other relevant decision makers that the early consideration of carbon along with other criteria would facilitate an optimal selection of material mix for building performance, environmental impact, and occupant well-being. Also, the study provides a good insight into the use of AHP and a practical guide to make trade-off decisions.

#201 - Potential Strategies for Enhancing Solar Architectural Skins

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Keywords: Building-Integrated Photovoltaics, Solar Façades, Façade Design, Façade Technologies.

Abstract

As the climate crisis requires lowering carbon emissions on multiple fronts, building-integrated photovoltaics (BIPVs) can reduce buildings' reliance on energy from fossil fuels by supplying them with electricity generated from a renewable source. Integrating photovoltaics into the building envelope brings advantages such as onsite energy generation and economic savings, besides improving aesthetics compared to building applied photovoltaic (BAPV) solutions. Nonetheless, embedding photovoltaics into architectural skins entails a trade-off between appearance and efficient energy generation. While regulatory frameworks and dropping prices have facilitated the spread of first- and second-generation photovoltaics for architectural applications, less established photovoltaic-based technologies may have the potential to improve the efficiency and appearance of solar architectural skins. They may reduce the amount of photovoltaic material to be integrated into the building envelope while increasing its energy conversion efficiency. Through an interdisciplinary review of academic literature and design examples, this study explores the potential of less-established photovoltaic-based solutions for architectural façade applications. It relates advances in photovoltaics to existing façade designs, towards proposing a range of potential strategies for improving buildings' architectural image and electricity generation through façade-integrated solar technologies.

#224 - Design Lessons from Plants for Adaptive Solar Skins

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Keywords: Biomimetics, solar skin, building envelope, adaptation.

Abstract

Several systems have been developed to enhance buildings' environmental performance towards reducing their operational energy demand. However, there is still potential for improving methods for responsively controlling daylight and solar gain while facilitating renewable energy generation. Adaptation is a key aspect of the building envelope's design. Thus, looking at plants as natural organisms that adapt to different environmental conditions can be a reliable source of inspiration. In this paper, we present a review of climate-specific adaptation strategies found in plants and discuss their potential for application in the design of building skin systems with shading and energy generation functions. Building on field study observations, the work reviews the features and principles of selected plants in response to different climatic conditions to establish a systematic logic of light management strategies with potential for design applications. The paper proposes the groundwork towards establishing a more comprehensive framework of biomimetic strategies inspired by plants, towards facilitating the design of adaptive architectural skins that can manage light more efficiently and potentially generate energy from solar radiation.

#165 - The Wonderful Wizard of Decarbonisation: Lived–Experiences on the Green Brick Road

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Keywords: Net zero carbon, SMEs, Business support, Climate emergency

Abstract

Net zero carbon initiatives and decarbonisation are gaining popularity as approaches that hold a promise to mobilise government, business, and civic action towards addressing concerns over the climate emergency. The UK Government has set challenging targets in terms of carbon reduction and is pursuing wide–scale net zero interventions through local industrial strategies supported by the national and international funding programmes. SMEs are increasingly becoming a focus of funded business support towards decarbonisation. So how are the SMEs responding to decarbonisation interventions? What are the intended and un–intended consequences of decarbonisation in a small or medium size business context? This study sets out to ascertain, through a phenomenological lens, how SMEs are discovering what net zero carbon ambitions look like within their businesses, how they are approaching decarbonisation and what are the impacts of the decarbonisation initiatives undertaken. Six SMEs from a variety of sectors in the East Midlands (UK), in receipt of support from an on–going ERDF funded project, were interviewed for this study. Participants were asked to share experiences in terms of their initial perspective on what net zero business would look like and to consider the support they received. The decarbonisation journeys and the outcomes were explored with the emphasis on the practices and participants, and the planned and achieved carbon reduction outcomes. The decarbonisation journey through the project is examined in three phases: before, during and after the journey. The role of the external assistance in the journey to net zero was also explored as part of the study. Interpretative analysis of all the interview transcripts revealed three overarching themes: (i) Technology is a significant enabler of decarbonisation; (ii) Data is essential to enable positive change to happen; and (iii) Business support is important for the uptake of the decarbonisation initiatives. Therefore, based on this information, the study surmises that companies need external guidance to make the decarbonisation actions possible, which includes provision of data and a sounding board for ideas, plus extra funding and assistance are needed to achieve the targets set by the UK Government

#204 - Reducing Polar Ambient Temperatures by Implementing Orbital Solar Shielding

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Keywords: Sea-level rise, Solar shielding, clean electric propulsion, sustainable growth.

Abstract

The aim of this study is to develop an engineering method to reduce the amount of solar radiation received at the poles, hence providing a mechanism to slow the rate of warming. There is an unprecedented continual rise in global sea-levels attributed to human-caused global warming (NASA 2021). The rise is caused by both melting ice-sheets and glaciers, and the sea-water expansion as it warms up. Polar icecaps are melting around 13% per decade. At this rate, the Arctic will be ice-free by 2040 (Worldwildlife 2022) and a minimum of 410 million people will be affected by sea-level flooding by 2100 (Hooijer et al. 2021). Potential methods of reducing sea-level rise have been proposed including placing in space a massive shield of 2,000 km span costing around \$10 trillion to manufacture (Early 1989). In contrast, this research proposes a sustainable method of orbital solar radiation management, utilising cost-effective small “nanosatellites” and solar sailing techniques. The aim is to produce a network in polar orbit of solar powered satellites, each containing a reflective solar shield/sail. The satellite swarm would have the appearance of a large shield of which each satellite is one pixel in the whole system. Such a network is easier and more cost effective to launch, moderate, control and maintain. It can be extended by adding satellites when costs permit; it operates even if there is a faulty satellite (which can be replaced); and each small sail is individually angled to moderate the Solar radiation shielding and its re-direction. Calculations are presented of local Polar surface temperature affected by varying altitude, orientation and light scattering efficiency. The performance of a shield deployment method is tested to indicate the key challenges and advantages of the design. Future developments such as storing solar energy or power beaming are identified.

#236 - Dock-to-Dock: Multimodal Freight Transportation in Coastal Regions: Challenges, Opportunities, and Benefits

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Keywords: Ammonia, Decarbonisation, Freight, Hydrogen, Ports and Transportation.

Abstract

The Dock to Dock (D2D) project defines the primary infrastructure for future electric freight transport solutions between coastal cities, in particular the energy infrastructure (battery charging/hydrogen refuelling) required for ground vehicles, and urban air mobility and autonomous vessels. We assess typical use cases against economic, environmental, and technological constraints. Our exploitation process involves end-users and stakeholders e.g seaports, airports, autonomous shipbuilders, and electric aircraft manufacturers. We demonstrate and assist in selecting the most promising use case for commercial exploitation.

#207 - Heat pumps and the UK's heat decarbonisation: Lessons from an Ofgem dataset of more than 2,000 domestic installations

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Keywords: Heat pumps, efficiency, performance

Abstract:

The decarbonisation of heat in the UK represents an urgent and colossal challenge. Heat pumps are cited as a crucial tool to lower CO₂e emissions, and the UK Government plans to boost installation rates from 30,000 per year to 600,000 by 2028. UK heat pump field trials completed in 2010 and 2015, however, reported disappointing results with many installations failing to deliver benchmark efficiencies. There is no evidence from more recent UK studies to show that performance has improved significantly.

To investigate actual heat pump performance, a dataset was obtained from the Office of Gas and Electricity Markets (Ofgem) for a sub-set of installations that are subject to strict monitoring under the Renewable Heat Incentive (RHI). A spreadsheet methodology was developed to interrogate the dataset and calculate the in-situ heat pump efficiencies and those actual results were compared to the installer forecast efficiencies that were included in the dataset.

The analysis found that more than one quarter of the main sample and 28% of Air Source Heat Pumps (ASHPs) were performing with an efficiency below the Seasonal Performance Factor (SPF) benchmark of 2.5. No correlation between the installer performance forecasts and the actual SPF results was found in the main samples examined. Additionally, the analysis found no improvement in performance after the UK installation standard was overhauled in 2017.

Overall, these results raise significant questions about installation design and execution and about the methodology used for consumer performance forecasts. It is concluded that information asymmetries may damage consumer confidence in heat pumps and that this may limit market growth.

#265 - Analysis of Climate Change and Carbon Emissions from Buildings in the Built Environment

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Keywords: Climate Change, Carbon Emissions, Buildings, Built Environment.

Abstract

Climate change has affected the earth, and its impact on the planet, such as increasing temperatures, can easily be observed. A new mission that aims not to exceed the increase in global warming of 1.5-Celsius has been initiated to keep the world safe. This goal can be achieved by decreasing the carbon emissions in the built environment since carbon emissions are the major contributors to the rise in global temperatures. Hence, this study aims to systematically analyze the studies about climate change and carbon emissions from buildings in the built environment. The Wos database was used to search the published papers between 2011 and 2021 related to climate change and carbon emissions from buildings in the built environment subjects. Thematic evaluations, changes in concepts, the trend keywords, key authors, the trend topics, applied methods and used tools in the studies are presented.

#186 - Examining the variation in residential electricity use in urban Indian households with and without air-conditioning

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Keywords: Residential, electricity, air conditioning, climate, seasons

Abstract

Residential electricity use (REC) in India is projected to increase five times by 2032 driven by urbanisation and climate change, yet there is paucity of data on residential electricity use and how it varies across space (climatic zones) and time (seasons). This paper empirically investigates the climatic and seasonal variation (summer, winter) of residential electricity use in India using statistical analyses of nationwide survey data of 4,877 urban households (single-family/multi-family, different income groups), which were located in 21 cities representing all five climates ranging from cold, composite, hot-dry, warm humid and temperate climates. The survey data were gathered as part of a national NEEM-CLASP study during 2018-2019, and included household characteristics, income group, socio-demographics, electricity use, ownership of air conditioning (AC) units and appliance usage data.

As expected, high income households (n: 1,084) reported the highest mean monthly summer electricity consumption at 280 kWh followed by middle income households (n: 1,058) at 229 kWh, while low income households (n: 2,984) experienced the lowest summer electricity consumption of 166 kWh. In AC households, mean monthly summer electricity consumption was 1.6 times more than winter consumption, while for non-AC households mean summer use was 1.4 times more than winter use, implying that seasonal variation was prevalent irrespective of presence of AC. Climate zone was found to influence seasonal electricity use. The highest mean monthly summer electricity use was observed for AC households (n: 561) at 307kWh in the composite zone, while the highest monthly winter electricity use was 210kWh in non-AC households (n: 308) located in the cold zone. Based on the Least Absolute Shrinkage and selection operator (LASSO) method, number of residents, number/usage of appliances and floor area (m²) were found to have the biggest impact on electricity consumption. To curtail the growth of REC in India, the seasonal and climatic variation in REC should be addressed through national energy policy.

Finance and Risk Management

#104 - Construction Projects in Saudi Arabia: risk analysis

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Keywords: Construction Project, COVID-19, Risks, Project Failure.

Abstract

Construction projects play a vital role in the development of any country. The output of the projects is measured in terms of deliverables. However, while executing projects, failures and delays are amid challenges that organizations face, due to the risks associated with the projects. This study aimed to analyze the risk factors related with construction projects of Saudi Arabia. A research model related to internal and external risk factors of project failure is proposed. A total of 76 Saudi's construction firms were studied. In order to determine the internal consistency of the variables, a reliability analysis technique is applied. The two measures CR and AVE are used for convergent tests. To examine the data suitability for factor analysis, we found a value of 0.888 with Bartlett test. In addition, the sphericity has the significance value of 0.00, which indicates that the data relationship is strong and well suited for factor analysis. A confirmatory factor analysis (CFA) was used to test the validity of the hypothesised constructs. Structural Equation Modelling (SEM) procedures were used to establish the interrelationships between the internal risk factors, external risk factors, and project failure scales and to interpret these scales with respect to their common underlying factors. SEM analysis was also used to examine the mediation impact of nature and COVID 19 on project failure. The results of this study suggest that internal risk factors have a direct, significant, and positive influence on the failure of construction projects in Saudi Arabia. SEM analysis was also used to examine the mediation impact of nature and COVID 19 on project failure. According to the findings of this study, nature and COVID 19 both significantly influence the relationships of internal and external risk factors on construction project failure in Saudi Arabia. The study ended by recommending that further research in this field be expanded outside the Saudi construction market.

#226 - Role of Financial Incentives in promoting Disaster Resilience of the housing sector

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Keywords: Financial incentives, Disaster resilience, the housing sector

Abstract

Investing in resilience demands massive funding, one of the critical causes for the current under-investment in resilience. The housing sector predominantly experiences destructive consequences in the face of natural hazards, initiating paramount losses in any region. Therefore, improving the disaster resilience of the housing sector has substantial importance in many aspects. Unfortunately, despite the continuous efforts to develop a resilient housing sector and a built environment where it belongs, losses are replicating with increased intensity and frequency. The resilient construction methodology's technical know-how has already been discussed broadly. However, encouraging communities to invest in disaster-resilient technologies remains challenging.

Accordingly, it is necessary to provide additional funding support via incentives and enablers to promote disaster resilience in the housing sector. Incentives are rewards for actions that exceed the minimum level of compliance and act as inducements for improved performance. Amidst the different incentives, financial incentives become significant as they reduce funding constraints for resilient investments. Accordingly, the paper presents the role of financial incentives in promoting disaster resilience in the housing sector. A desk review and semi-structured interviews were used to collect the relevant data. Finally, qualitative content analysis and thematic analysis have summarised the findings. The need and the role of financial incentives in embedding disaster resilience are established through this study by identifying the current practices, challenges, and prerequisites. The establishment of financial incentives for disaster resilience practices will be instrumental in developing a resilience pathway for the future.

#107 - Declining high street – Are local landlords a solution? – A study of Trowbridge, UK

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Keywords: Local landlords, high street, town centre retail, Trowbridge.

Abstract

Responses to high street decline need to encourage greater levels of stakeholder engagement. While many stakeholders are well researched, the prominence of local retail landlords in smaller towns is often overlooked. Through a generic case study of Trowbridge in Wiltshire, UK, this research critically investigates whether local landlords are able to meaningfully contribute to a solution to high street decline and whether they can keep pace with the challenges of maintaining healthy small-town centres. The primary qualitative data is gathered through inspection of the town centre and semi-structured interviews with local landlords. Secondary quantitative data gathered includes ownership, vacancy, and occupier type. Local landlords are shown to be of particular importance, despite largely engaging very infrequently with wider regeneration schemes. Interviews revealed their strong awareness of the causes of high street decline and issues specific to Trowbridge. Participants were also found to desire improvements to the current condition of the high street, for both philanthropic and business case reasons. This research demonstrates that local landlords are a significant group with credible potential to implement changes and informs further analyses of other towns struggling to reinvigorate their high streets. While the case study provides a rich picture and the results are partly generalisable, further research is needed to understand more about the role of local landlords across similar towns with respective idiosyncrasies.

#167 - Shockproofing UK Construction Supply Chains in Disrupted Environments

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Keywords: supply chain, procurement, disruption, resilience

Abstract

Two of the most impactful post-war events to UK construction supply chains occurred between three-and-a-half years of each other: the UK's national vote to leave the European Union (June 2016) and the COVID-19 global health crisis (first reported to the World Health Organisation in December 2019). While both very different, each exposed the vulnerabilities of existing supply models in construction, and a complacent over-reliance on extended international supply chains. Compounding this, the Grenfell Tower fire in west London (June 2017) further impacted UK supply chains with subsequent changes to building regulations and associated legislation.

This study investigates and reports on the experiences of construction supply chain contractors operating in the north-west of England, and their experiences of labour and material supply stability before, during, and after the disruptor impacts identified above. Reflections were made on the event outcomes, with recommendations from each of the participants as to methods and approaches of shockproofing their respective supply chains from future unknown events.

Exploratory qualitative data was collected through a purposive sample of eight semi-structured field interviews with senior management at UK and international supply chain contractors, comprising piling, concrete frames, facades, drylinings, kitchens, joinery, mechanical and electrical, and lifts. Operating regionally, nationally, and globally, the common factor, regardless of size and capacity, was each were dependent on unprotected supply chains for material and labour resources.

Results identify complex challenges in stabilising supply chains against disruptor events, with a one-size-fits-all unviable where consumption ranges from raw materials to semi-conductor components. Multiple suggestions are made to shorten and stabilise supply chains across the UK, Europe, and beyond. A mini framework is proposed here to assist the UK construction industry in creating sustainable and secure supply chains capable of withstanding future shock and disruption events.

#221 - Challenges of urban agglomeration when integrating pandemic preparedness and disaster risk reduction to protect economic assets and people in the 'new normal'

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Keywords: Pandemic, Urban agglomerations, Pandemic Preparedness

Abstract

The wide-ranging impacts of COVID-19 have prompted much reflection among decision makers and researchers regarding pandemic preparedness and links to wider disaster risk reduction efforts. These discussions were primarily focused on mitigation strategies, preventive measures and increasing the capacities of the health care and sanitation facilities. However, the implementation of the outcomes of these discussions were challenged by many factors especially in urban agglomerations. It is important to understand the specific challenges when contemplating pandemic preparedness to protect economic assets and people in the 'new normal' where practices during the pandemic that has become standard. This study addressed the question what are the challenges of urban agglomeration when integrating pandemic preparedness into disaster risk reduction? The is an account of a desk review across academic research, institutional reports, and policies. For academic studies, Emerald, SCOPUS, Science Direct, and Springer were searched. The World Health Organization and United Nations websites were used to identify and source relevant institutional and policy reports. A combination of the following keywords was used in the searches: pandemic preparedness, health preparedness, COVID-19, urban agglomerations, and urbanisation followed by a thematic analysis. The challenges identified by the review were classified into environmental, socio-economic, and management and governance. The environmental challenges include climate related, air quality and respiratory problems, which can affect pandemic preparedness measures. Population density, mental wellbeing, and economic loss were identified as the key socio-economic challenges, while overlapping bureaucracies and limited decentralisation are the key challenges related to governance and management. The findings of this desk study will inform further empirical studies on the urban agglomeration of Bandung in Indonesia, which will explore strategies to support the development of more effective pandemic preparedness planning in urban agglomerations and that can better protect economic assets and people in the 'new normal'.

Health and Safety

#143 - An Innovative Construction Site Safety Assessment Solution based on the Integration of Bayesian Network and Analytic Hierarchy Process

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Keywords: Bayesian Network, AHP, Construction safety and Risk assessment.

Abstract

The building construction industry is one of the industries with the highest accident rate and the highest number of fatalities among China's industries. Risk assessment plays an effective role in avoiding safety incidents and economic losses. Construction safety is also emphasized in the Sustainable Development Goals issued by United Nations. However, traditional methods have shortcomings in accident chain estimation, quantitative analysis, and handling with uncertainty. This paper proposes an innovative quantitative analysis method and the scoring standard to calculate the safety score on the construction site based on the Bayesian Network and Analytic Hierarchy Process solution. The most likely potential causes and the accident chain can be determined.

Consequently, the contribution rate of each risk factor to the accident could be calculated and quantify the degree of harm of various risks. Through this method, the real-time safety score can be calculated by inputting current risk factors that happened on the construction site. The risk factors in the site change dynamically during the construction progress. This solution shall help rapidly generate the security score to guide the decision making of the safety control. The safety incident reports during the construction period in China will be utilized as the data source for training, simulation, and verification. In future research, this method will establish a safety score curve providing the resource allocation suggestions to ensure the risks are controlled within an acceptable range.

#182 - Understanding pedestrian red-light violation: Exploration of the impact of traffic engineering and traffic conditions

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Keywords: Pedestrian behaviour, signalised junction, traffic engineering, traffic conditions.

Abstract

The design of the geometry and traffic controls at signalised junctions is often focused on the level of service offered to drivers and rarely takes into consideration the level of service offered to pedestrians. This results in pedestrian adopting illegal and unsafe behaviours – e.g. red light violation. This study aimed to identify the elements of signalised junction design that are critical in pedestrian safety by analysing how they affect pedestrian behaviour. Both traffic engineering design (e.g. junction geometry) and associated traffic conditions (e.g. traffic speed) were investigated. Over 6500 observations had been made at 10 signalised junctions in the city centre of Montreal, Canada. The 10 junctions were selected to ensure that a variety of environments, road users and junction designs were covered. Results show that the presence of a countdown display has the most significant and positive impact on pedestrian behaviour. Results also suggest that pedestrians cross at the red light when they feel confident about their ability to judge whether they can use the available traffic gaps to cross safely the street.

#255 - Health, Safety and Well-being Issues in Construction

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Keywords: construction, health, safety, wellbeing

Abstract

Construction occurs in the elements, is physically demanding, entails exposure to a range of hazards, and entails long working hours and working more than five days a week. These characteristics result in disease, illnesses, injuries, fatalities, and the experience of stress, which in turn result in absenteeism. Furthermore, mental health has been identified as the leading health and safety (H&S) issue in construction. The objectives of the study were to determine the: extent to which H&S hazards are experienced; extent to which diseases / illnesses / injuries are experienced; causes of stress, and causes of absenteeism. A quantitative study was conducted among civil engineers, site supervisors, and construction health and safety officers (CHSOs) using a self-administered questionnaire. The salient findings include: dusts, noise, and cement / plaster / screeds predominate in terms of the exposure of workers to occupational health (OH) hazards; headaches, pain and numbness in the wrist, and neck and back injuries predominate in terms of diseases / illnesses / injuries workers experience; unsatisfactory working conditions, demanding construction activities / tasks, poor remuneration, hazardous work, unhealthy and unsafe sites, long working hours, and poor career opportunities predominate in terms of factors contributing to workers experiencing stress; alcoholism, injuries (work related), and ill health predominate in terms of factors contributing to workers being absent, and manual handling, moving objects, and tripping predominate in terms of hazards workers are exposed to. Conclusions include: workers are exposed to a wide range of H&S hazards; experience stress and are absent due to a range of work-related and socio-economic factors, and experience a range of diseases / illnesses /injuries. Recommendations include: hazard identification and risk assessment should be enhanced; occupational health interventions such as training, and surveillance should be enhanced; working conditions and working hours should be interrogated, and health and well-being programmes should be implemented.

#256 - Construction Health and Safety Practices on a Roads Agency's Projects

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Keywords: construction, health and safety, multi-stakeholders, non-compliance, roads agency

Abstract

The South African construction industry contributes a disproportionate number of fatalities and injuries relative to other industrial sectors, and there is a high level of non-compliance with H&S legislation and regulations in the industry. The current study sought to determine the reasons for H&S non-compliance on a roads agency's projects. The quantitative method was adopted for the study, which entailed a self-administered questionnaire distributed to construction H&S agents, civil engineers, H&S consultants, design managers, construction project managers, depot managers, and resident engineers involved with the agency's projects. The salient findings include: respondents generally consider / refer to H&S during the six stages of projects and on eighteen occasions, and undertake nine H&S-related interventions on the roads agency's projects, and respondents rated themselves above average relative to twelve aspects. Conclusions include: respondents consider / refer to H&S during the six stages of projects and on eighteen occasions more so during the downstream and midstream stages than the upstream stages, and respondents' knowledge is more extensive with respect to non-designer-related aspects than designer-related aspects. Recommendations include: respondents should consider / refer to H&S more frequently during the first three stages of projects and upstream occasions; project managers should adopt a multi-stakeholder approach, and construction H&S should be embedded in all tertiary built environment.

Innovation in Architecture

#216 - Amphibious architecture: A review of the construction methods adopted in existing designs

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Keywords: Amphibious Buildings, Amphibious Architecture, Floating Structures and Flood Construction.

Abstract

Effective flood mitigation strategies at individual property level can be designed to limit damage and facilitate recovery by limiting water entry or enabling entry into occupied spaces in a controlled manner. Ideally these strategies will be robust to potential variations in flood depths and can be deployed rapidly and/or automatically at onset of flooding

The research considers amphibious architecture as part of a multi-dimensional approach to Property level Flood Resilience. The research defines an amphibious building as one which is fixed to a buoyant base that rests on the ground but is designed to float when flood waters rise. Amphibious architecture is also shown to meet the criteria of a robust flood mitigation strategy as it works in harmony with the natural cycle of a flood and is effective in areas with both low and high [flood] water depths.

Although there are many existing designs and a small number of constructed amphibious buildings., there is yet to be a comparative review of their design, rationale, and construction methods.

The research focuses on the collation and review of the construction methods of constructed amphibious buildings, highlighting their characteristics and unique design properties. A literature review is conducted to understand the similarities and differences between the construction methods adopted in these buildings, highlighting the design challenges posed by the construction methods adopted and possible areas for improvement in design of amphibious buildings.

#180 - Exploring Architectural Drivers, Barriers and Solutions for Urban Agriculture and Planting Interventions in the Interior Environment: a New Zealand case study

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Keywords: Urban Agriculture, Resilience, Indoor Environment, Wellbeing.

Abstract

This paper explores the integration of indoor green walls as a union of the built and natural which offers potential for improvements in urban food supply, air purification and contributions to occupant health. The aim is to identify areas which show potential of greatest contribution through further development. This paper considers the possibilities to transform urban building typologies and encourage resilience and shifts in how occupants inhabit urban spaces when combined with nature. Existing research indicates that the benefits from plants in the interiors could be extensive and research in this area is still developing. It is known that most indoor plants lead to an improved indoor air quality, which is especially relevant at the time of increased reliance on artificial ventilation which unavoidably requires ongoing operational energy consumption and often is built using materials high in embodied energy. This research discusses a range of possible innovative approaches using contemporary technologies, and focusing on the context of one local market, which is not especially large nor central globally: New Zealand. Rethinking the urban environment for a future of reduced carbon emissions and improved food sovereignty should include an active consideration of the beneficial role interiors and indoor environments can play. For urban buildings, improvements to housing through indoor urban agriculture interventions creates autonomy and security for a resilient future of the built environment.

Project Management

#139 - The Prevalence of Sustainable Development Goals Amongst Construction Industry Reporting

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Keywords: Social Value, Corporate Social Responsibility, Reporting, Communication.

Abstract

17 Sustainable Development Goals (SDG) were adopted by all United Nation member states in 2015, each with targets to achieve by the year 2030. It is now nearing the mid-point of the SDG delivery timeframe. If the SDGs are to be achieved arguably an awareness must already be in place to allow a focus on their delivery in the second half of this timeframe. A lack of SDG goal awareness could potentially result in targets being missed. However, organisations that currently have little SDG awareness still have time to contribute to SDG achievement with immediate action. As the construction industry is a major contributor to the UK economy, the greater engagement of construction industry organisations with the SDGs will inevitably increase the likelihood of SDG achievement. However, there is a gap in contemporary literature around current SDG engagement by UK construction industry organisations. This study aims to explore if major UK construction contractors are currently engaging with the SDGs directly and indirectly. Contractor engagement with a positive concept is usually followed by contractor communication. Therefore, a Qualitative Content Analysis (QCA) is undertaken of ten of the top twenty UK contractor's most recent sustainability reports to identify if the contractor makes direct or indirect reference to any SDG activity. The results indicate that for most SDGs all of the contractor reports analysed contain either direct references to an SDG or discuss activities that are closely to aligned to an SDG. However, there are some SDGs that are not addressed either directly or indirectly by contractor actions. Other SDGs are addressed, but not in a substantive or specific manner. Arguably, this reveals that contractors, if just from a reporting perspective, are actively engaging with most SDG's. This study contributes to literature with an understanding of SDG prevalence amongst major UK contractors and serves as a platform for further research.

#144 - Exploring the roles of knowledge management initiatives in the improvement of the different project management areas in the Nigerian construction sector

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Keywords: construction, improvement, knowledge, knowledge management, Nigeria

Abstract

The Nigerian construction sector is suffering from poor management, which initiates waste of time, cost, and material. Numerous tools and techniques have been formulated to enhance the project management process and deal with problems to meet stakeholders' expectations. In Nigeria, knowledge creation, capture, organization, storage, dissemination, and application can be considered an economical initiative which can be utilised in the management of projects at any stage during the project lifecycle. The aim of this study is to explore the actual status of applying project management knowledge areas in the construction industry sector in Nigeria, to investigate the real impact of adopting knowledge management initiatives in enhancing the application of project management knowledge areas, and to explore the real benefits that have been achieved from implementing knowledge management applications in project management. To achieve the research objectives, the researcher used the descriptive, analytical, and quantitative approach to get to suppositions. This study focused on the Nigerian construction sector and was limited to those who have direct or indirect experience of implementing knowledge management in project management, whether preparing drawings, details, estimating quantities, cost management, managing, and extracting the schedules. The research sample consisted of 106 respondents. It was concluded that implementing knowledge management in project management could ultimately enhance the project management process and encompass all areas of management unevenly. Many benefits are defined, such as enhanced knowledge base + Quickly decision making, enhanced efficiency, and enhanced project outcomes.

#190 - Talking clients into sustainability

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Keywords: carbon reduction, green consultancy, shared values, sustainable procurement.

Abstract

The need for sustainable practices has gained an unprecedented momentum in the construction sector in the past couple of decades. Understandably, sustainable practices can only be successful when key stakeholders (e.g., client, designer, main contractor, subcontractors, etc) are in support of achieving them as common goals and/or shared values. Construction projects are typically known for their complexity, and this makes collaboration and consent challenging. A common goal of improving sustainable practices can be embedded in all aspects of projects ranging from conception to completion and in operation phase through to refurbishment and deconstruction or re/upcycling. Clients often have limited knowledge of sustainability especially when it comes to construction processes. It is common practice for clients to employ consultants to guide them through the various phases of projects. This paper explores the various approaches that consultants adopt when 'encouraging' clients to buy into sustainable designs for large projects. The research examines the practices of construction projects teams and consultants as they work closely with clients to successfully implement sustainable options. Semi-structured interviews were collected from six (6) industry professionals ranging from Project Managers to Quantity Surveyors. All participants played roles with clients and contractors thereby giving the study a broad scope of data source. Themes being explored within the data included cost vs 'environmentally-conscientious' options, fundamental decisions for moving towards sustainable principles, and knowledge of long-term benefits of such choices. Furthermore, the study investigates the techniques that consultants and project teams adopt when clients are directly or indirectly against the concept of implementing such practices particularly when they believe them to be non-beneficial due to financial implications. The study sheds much-needed light on best practice methods adopted by firms operating in financially difficult environments, working to ensure green approaches are implemented in the construction sector. It is evident from this research that everyday subcontractors need further assistance through additional measures (e.g., training focusing on sustainability) if a holistic approach to achieving higher standards

of sustainability is to be realised. Finally, there is hope that incoming legislation may give the industry a much-needed jolt to further embrace sustainability.

#213 - Identifying the Challenges and Barriers Associated with the Adoption of Energy Efficient Innovative Technology in Warehousing Facilities in South Africa

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Keywords: Challenges, Energy efficiency, Innovative Technology, Warehousing Facilities.

Abstract

This research aims to identify the Challenges and Barriers Associated with the Adoption of Energy Efficient Innovative Technology in Warehousing Facilities in South Africa. Pandemic had a significant impact on the rapid increase in e-commerce activities which led to the need for many companies in South Africa to develop larger and more sophisticated warehousing facilities. However, due to the current condition of South Africa's energy supply, the warehousing industry faces many challenges as regular load-shedding interrupts operations. Furthermore, energy-efficient innovative technologies used to reduce energy consumption in warehousing facilities is not widely adopted in South Africa. It was discovered that energy costs contribute a high amount to warehouses operating budgets; therefore, the need for energy efficiencies in warehouses is essential. Certain technologies are readily available to be incorporated into South African warehouses to address the reduction of energy consumption. However, when implementing such innovative technologies, many challenges and barriers will be faced. This research attempted to identify the challenges and barriers through a constructivist paradigm. The research was conducted using interviews with professionals in the industry who had vast knowledge and experience in the warehousing industry. The data collection took the form of semi-structured interviews, where a qualitative data approach was adopted. Nvivo was used to generate underlying emerging themes. It was found that only a select few energy-efficient innovative technologies are adopted in South African warehouses and that implementing energy-efficient innovative technologies provided numerous advantages and disadvantages. Most importantly, the findings revealed a significant number of challenges and barriers to the implementation of such technologies.

#266 - Mind the Gap - Project Management and Lean Tools application for Process Flow Optimisation Across Interfaces in a Construction Component Manufacturing Facility

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Keywords: Lean Manufacturing, Seven Wastes, Interfaces, Communication.

Abstract

In the last decade the development of offsite manufacturing of components has aided in the construction sector's reduction of the seven fundamental wastes, yet offsite manufacturing poses its own issues with regards to waste. The identification of the seven types of waste (transport issues, excess inventory, unnecessary motion, waiting times, overprocessing, overproduction and defects) has led to the introduction of lean manufacturing practices in construction. As a result, the reduction / prevention of waste in the construction sector has been discussed in the literature but there is very little evidence of research being carried out into waste in the construction component manufacturing sector. The aim of this case study was address this gap through examining waste identification, monitoring and minimisation in a construction component manufacturing facility, focusing particularly on the process flow from design, manufacturing through to installation on site, as issues at these interfaces cause the majority of waste .

Six lean manufacturing based methods- process mapping, project management tools for planning and scheduling, decision making, key performance indicators, and communication systems formed the basic focal points of the investigation into waste at the process interfaces. They informed the design, execution and delivery of seven semi-structured interviews and the development / administration of a questionnaire to participants selected from staff members who met specific selection criteria. Due to COVID-19, the research was conducted through on-line vehicles MS Teams (Interviews) and MS Forms (questionnaire admin and data capture from the Interviews).

The findings show that 100% of participants were aware the implementation of a range of lean manufacturing tools such as non-conformance reports into the process to effectively reduce waste in projects due to issues at process interfaces. Despite the use of lean tools, participants cited examples of waste primarily due to poor communication across interfaces.. More emphasis on the effective transfer of information relevant to a project across the

interfaces, in particular at the client → design interface, was needed to prevent waste from creeping into the projects.

#200 - Improving decision-making in smaller local authorities to facilitate Net Zero Delivery - Practitioner insights

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Keywords: Local authorities, Net Zero, Decision-making, Renewable Energy

Abstract

Local authorities in the UK face significant challenges to meet Net Zero targets since they are endeavouring to take on a diversity of roles including being investors in Renewable Energy (RE). They must work within defined legal, constitutional and democratic decision-making structures but without a unifying Central Government regulatory or policy mandate. 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 structure where most investment will be needed to tackle Net Zero. This paper tries to provide a smaller local authority perspective to Net Zero, with specific attention on RE investment decision-making, drawing on 25 semi-structured interviews with local authority staff involved in Net Zero policy and delivery across the East of England. The research reveals insights highlighting the impact on how RE decisions are made because of political decision-takers' understanding of the Climate Change and Net Zero, different staffing levels and functional approaches to managing Net Zero activity, and complex and time-consuming decision-making processes recognizing the importance of upholding democratic principles of transparency and accountability. Some councils in the study area have managed to streamline their decision-making processes by creating more effective and coherent investment and delivery mechanisms. Recommendations are made in the paper to help smaller local authorities improve their effectiveness at investment decision-making as part of RE delivery with wider implications for central government Net Zero policy and delivery at local level.

#248 - Know the Way, Go the Way, and Show the Way: Leadership Styles for Project Success in the Irish Construction Industry

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Keywords: Communication, Ireland, Leadership Style, Site Management.

Abstract

In Ireland, research has shown that when it comes to management styles across all industries, Irish managers are among the most easy-going in Europe. The laidback culture of the Irish people has positioned them to be effective and supportive leaders, encouraging collaboration and teamwork. However, the dynamic and complex nature of the construction industry makes management and leadership much more difficult compared to other industries, where relationships between the workforce are more fluid, and various leadership styles are used. Therefore, this study aims to identify and analyse leadership styles used in the Irish construction industry, and document which styles, if any, are the most successful to implement in practice on-site. This pilot study encompasses a qualitative research method, incorporating seven semi-structured individual interviews with construction professionals in various management and leadership roles on projects across Ireland. The data is qualitatively assessed using thematic analysis, where emerging themes are identified for discussion. The results are centred around four key themes: the characteristics of effective leaders; how leaders create a vision; how leaders motivate the workforce; and how leadership is used as a success factor on construction projects. Although based on a small sample size, the findings indicate that there are three main leadership styles being used in the Irish construction industry: transformational, transactional, and laissez-faire. Moreover, results show that the respondents sometimes use all three styles simultaneously or in an ad hoc manner, depending on the situation. Overall, the key contribution of this research illustrates that there are three main leadership styles being utilised in the Irish construction industry, but due to the impromptu and spontaneous nature of the construction industry, there is no one-size-fits-all approach. Nevertheless, this research encourages a more formalised and strategic approach to delivering leadership on-site and ensuring project success on construction sites in Ireland.

#159 - Sustainable Event Mobility: A Case Study of Large Event Activities in Mega-City; Nigeria

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Keywords: Sustainable transport, Transport modes, Urban mobility, Significant events.

Abstract

Striving towards sustainable event mobility in a developing country like Nigeria comes with challenges of existing transport problems, one of the threats to Nigeria's population and commercial hubs. Its significance to the quality of life and well-being cannot be overstated as it affects Lagos residents. Lagos is a driver of diverse event audiences, rural-urban migration, and changes in urban mobility patterns. The path to delivering a sustainable event has contributed to domestic tourism and environmental pollution congestion. This study investigates large events and recommends sustainable mobility solutions for congested-free events in a megacity, Nigeria. The study draws on an explanatory sequential mixed method research design and adopts a descriptive analysis to achieve the aim of the study. The finding revealed that large events in Lagos, Nigeria, are the most significant factor influencing the environment and road networks within the renowned cities during the event's season. A colossal deficit is spotted between transport demand and supply due to low public transport coverage to reduce car dependency within the states. The study suggests that event organizers rely on informal transport modes (mini-busses, tricycles, and motorcycles) that are available and cover the city's interconnected street roads. The interplay between formal and informal transport modes provides an organized, coexistent, and collaborative transport system. The findings of this study could assist transport planners, urban planners, and policymakers in Nigeria in identifying host areas with large events and proffering solutions to improve road usage and accessibility.

#178 - How Does UK Corporate Management Select and Measure Innovation in the Construction Industry?

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Keywords: Corporate Innovation, Idea Selection, Measurement, UK Construction

Abstract

Speed and quality of innovation has become crucial to surviving in highly competitive markets. Indeed, some argue that innovation should be embedded within corporate culture, rather than being delivered within a process of ad-hoc events. Furthermore, the organization's ability to innovate is increasingly recognized as a key factor for sustainability, competitiveness, economic success, well-being, and the development of society. However, without the ability to observe, measure and reflect on the management of innovation, the ability to implement good corporate strategy is limited. The work reported will gain direct insight to the practices and methods used to capture and measure corporate innovation operations in UK construction, with the aim of developing a framework that captures and defines a practical process for measuring and valuing innovation. A systematic review of literature has been undertaken to identify the key attributes of corporate innovation that may be measured, interviews will be undertaken to identify literature outside of the academic field that might inform the work. It is expected that case studies will follow to collect rich strategic data that provides a unique and valuable contribution to knowledge. Following a study and analysis of the data, methods will be presented for better understanding of those metrics and measures used when assessing the value of innovation at a corporate level. This stage also includes a review of the literature and initial interviews in the field of innovation operation measurements outside of academia. Early results suggest innovation is far too important to be managed without accurate measurements. Metrics drive behaviour and "what gets measured gets done." Innovation indicators should be selected, and their metrics should be designed and used to manage company's evolution, to achieve better alignment with business strategies and nourish a culture of entrepreneurship that results in improved corporate success.

#155 - Back To the Future – North Arm Cove Initiative - implementing Circular Economy principles in creating sustainable, resilient, innovative precincts

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Keywords: Sustainability, Collaborative Planning, Circular Economy, Heritage

Abstract

There are two main areas of our research – past and future. Investigating one of the forgotten pearls of Australia’s planning past and conceptualizing its sustainable, regenerative future. This paper describes the ongoing project of “recycling” the plans prepared by Walter Burley Griffin a century ago, and creating an innovative precinct, based on Circular Economy (CE), through innovative, collaborative ways of doing urban planning. The paper presents the current state of the project and the results as of April 2022. Identification and analysis phases were conducted through the PESTEL analysis. Proof of concept phase was completed in collaboration with university/research institutions as well as various industry entities through the North Arm Cove Initiative.

Thus far, our research includes a proposed framework for achieving sustainable goals:

- *sustainable, regenerative precinct for a resilient, smart community*
- *meaningful community participation in planning and governance*
- *circular supply chain for an urban community*
- *measurable performance and controlled impact of the community on the environment*
- *opportunities for implementing research in real life – innovation precinct*

Key aspects of future planning and delivery of the precinct should be collaborative, comprising inclusive planning and governance, in line with a transition to Circular Economy. The new framework proposes continuous collaboration between research, industry, and community through the Sustainability Research Centre hub, that would define and govern the delivery of measurable outcomes on three bottom lines – social, environmental and economic – but also innovation/technology and aesthetics. The project is developed by the DESIM-R&D team for the community of landowners of North Arm Cove (NAC), heritage “paper subdivision” in New South Wales (NSW), Australia.

Social Value

#174 - Heritage-led Urban Regeneration & the UN Sustainable Development Goals (SDGs)

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Keywords: Sustainable development Goals (SDGs), World Heritage Cities, Heritage-led Urban Regeneration, United Nations (UN).

Abstract

Heritage-led urban regeneration is expected to be closely linked to the UN 2030 agenda for Sustainable Development Goals (SDGs) as highlighted in (SDG-11.4). However, gentrification, excessive tourism, social exclusion, and others tend to take place in World Heritage Cities and contradict many aspects of urban sustainability in general and the SDGs. This is due to the shortcoming of SDGs in addressing cultural and social sustainability as equally important pillars to environmental and economic sustainability as well as the lack of their clear visibility and integration within WH cities' policies and practices.

This paper first investigates and positions heritage and culture within the UN Sustainable development Goals (SDGs) for 2030 -namely SDGs 8, 11 and 17- in order to identify the current shortcomings of SDGs in addressing social and cultural sustainability. The case study of the recently inscribed city of As-Salt on the World Heritage List is used to illustrate the need for rebalancing the conflicting priorities of different stakeholders and the consequences of the SDGs' shortcomings particularly with regards to intangible heritage and the local communities as the carrier of that heritage. Second, the paper investigates other UN initiatives for Sustainable Development, namely the Historical Urban Landscape recommendations (HUL) and the New Urban Agenda (NUA) and suggests how these could be integrated in a timely manner under the umbrella of the SDGs targets. This is done in order to rebalance cultural and social sustainability in the urban regeneration scenarios and processes within World Heritage Cities.

#140 - Construction Social Value: contractors prefer pretty parrots over ugly ones

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Keywords: Social Value, Corporate Social Responsibility, Reporting, Communication.

Abstract

Social Value (SV) activities are all intended to rectify the harmful impacts of business operations and promote positive social change. Arguably the focus of such activities should be upon those most in need and where companies can make the most positive differences. However, there has been no research considering the relevance and appropriateness of the intended recipients of such activities undertaken by construction contractors. The problem therefore exists that it is not known if current SV efforts are focussed on the areas in society that would most benefit from SV. Previous studies have revealed that parrot species perceived as beautiful by humans were more prevalent in conservation populations, even if such breeds were not in need of conservation. Parrots deemed ugly, despite being endangered, were less likely to be conserved. The construction industry is an ideal context to explore why certain SV recipients are selected over others as increasing stakeholder scrutiny and public sector procurement requirements have resulted in high levels of SV engagement. This aim of this research is to understand which recipients' construction contractors focus upon with their SV efforts. A Qualitative Content Analysis (QCA) of 10 contractor SV reports categorised the SV practices undertaken. The QCA codes derived from the UK Government's SV Model as this arguably represents the areas the UK government view as SV priorities. The findings reveal that contractor SV practices are primarily aimed towards a select group of recipients and activities, such as addressing economic inequality and tackling climate change (the pretty parrots). However, Covid-19 recovery and bridging the disability employment gap (the ugly parrots) are government SV requirements that are not addressed as effectively by construction contractors despite their national significance. This paper contributes to a previously under explored area in the literature of which areas of SV contractors primarily focus on and which they do not.

#231 - Mapping knowledge domains of research on Corporate Social Responsibility in the built Environment

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Keywords: “Corporate Social Responsibility”, “Construction Industry”, “Corporate social Responsibilities (CSR)”, “Sustainable Development”, “Built Environment”

Abstract

Over the years Corporate Social Responsibility (CSR) has been studied and implemented as an essential practice in many organizations being reflective of a growing corporate environmental, economic, and social conscience. In addition to the acknowledged benefits of increased company performance and its use as a strategic marketing approach (Albus and Ro, 2016). As such, it has become a critical subject in the literature from a strategic perspective due to its benefits. . However, it's application in the built environment is unknown and this study seeks to fill that gap by assessing the current state of research into CSR, along with a detailed analysis identifying the areas of study that have been exhausted and those that require further investigation. This study will attempt to expose what is missing from current research to effectively guide future research of CSR within the built environment. The study adopted a quantitative strategy using a bibliometric approach to identify and analyse papers in the field of CSR in the built environment using Scopus abstract and citation databases from 1957 to 2022. The findings revealed a limited endeavour by academics to understand CRS within the built environment until the early 2000's where it began to grow in popularity as a research area. . . This suggests CRS is still at a nescient stage which provides opportunity for further investigation in the areas identified The implications of this research are that areas of Corporate Social Responsibility of the built environment that have not been sufficiently studied can be identified and suggestions made for further investigation.

#239 - A Study on Driving Factors for Green Building Occupancy

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Keywords: Drivers; Green Building; Sustainability; Tanzania.

Abstract

In recent years Green building (GB) technologies has increasingly gained popularity across many countries as one among the strategies towards achieving sustainability. Despite their growing popularity still there is little knowledge on GB technology, similarly, it is not clearly known what motivates tenants to buy/rent GBs in Sub-Saharan African countries like Tanzania. Therefore, the purpose of this study is to identify the factors that drive the occupancy of green certified buildings in Tanzania. A total of 272 questionnaires were distributed to occupants of the identified green certified residential buildings. Data was analyzed through descriptive statistics and inferential statistics. Based on the findings, the top three ranked driving factors included; Beautiful appearance of the building and design; Building location and Building amenities. The findings further revealed that the occupants of GBs were not influenced by the green certification status of their GBs. The results imply that there is little knowledge on GB. Therefore, this study will foster better understanding of the drivers and also the consciousness of this information such as the drivers will contribute towards improving the awareness of green building technology to community members so as to enhance achievement of sustainability.

#240 - Do Job Advertisements Promote Gender Inequality in the Construction Sector?

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Keywords: construction sector, gender inequality, job advertisement, text mining

Abstract

The poor performance of construction projects remains a topical issue in the academic field of construction management. Across the globe, statistical data indicates that the construction sector is male dominated. The observed inequality is linked to conflicts, which is one of the main reasons for the poor performance of construction projects. The current study aims to explore the differences between job adverts for male [construction manager] and female [social worker] dominated sectors of the economy by comparing word usage. Text mining was used to unearth the differences in the content of the job advertisements for these two roles. The findings indicate that masculine words [such as leader] are the most commonly used words in the job adverts for construction manager roles. The findings suggest that the content of job adverts seem to promote gender stereotypes associated with employment in the construction sector. Such gender cues may contribute to the gender differences in the construction workforce. Taken together, these findings suggest that there is a need to embed gender-neutral words in job adverts placed by construction sector.

Sustainable Architecture

#220 - Fragmented Concepts of Sustainability in the translations of Knowledge – to – Object – to - Knowledge of Subject

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Keywords: Deleuze, invention in Architecture, Sustainable, Marketing.

Abstract

This paper draws from Deleuze's Francis Bacon; The Logic of Sensation to understand how sustainability operates as a concept and how the marketing strategies of the company can be viewed in the context of relationality between parts and the impact of knowledge and its locality.

With this theoretical lens I argue that the concepts which operate as part of the sustainable agenda should be considered as local because of their capacity to draw energies from their context specific to any microclimate and physical conditions in a passive way. The infrastructures that a sustainable initiative draws from should be considered in the same, partial and local way. The specific case that this paper is investigating is that of Carapace slate and how the concept of sustainability figures in their marketing strategies and guides their inventive directions. Here I discuss the strategy of introducing an architectural element capable of reducing carbon emissions and generating sustainable streams of energy into the market.

The paper looks at channels and strategies which the company uses to initiate the inventive process, sustain its operation issue information.

The element's presence in a free market context, as a new solution and without an independent, established infrastructure, is also permeated with difficulties in disseminating knowledge about them, creating hurdles in the implementation of a more sustainable approach. The impairment to the impact of the initiative that limit its potential is that of existing and cultural infrastructures, economic generalities, chains of supply and the issue of greenwashing that, in the context of contemporary mistrust in communication streams – weary of fake facts and misconstrued concepts – disallows the effective dissemination instalment. In doing so the range of the influence and propagation of the technology becomes circumscribed and not reaching its full potential.

#108 - Sustainable daylighting strategies: a study on the Types of Daylighting Strategies and Energy Efficiency with focus on the Built-Up Environment in Hot and Humid Climate Regions

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Keywords: Daylighting, Natural Daylighting, Sustainable Design

Abstract

The built-up environment forms one of the three vital needs of a human being: food, clothes and shelter. For the built environment to be efficient and effective, one of the most important factors is Lighting. Lighting in the form of Natural Light helps in creating healthier, brighter, happier and safer spaces. Architecturally speaking Natural Daylighting helps in the reduction of energy, reduces carbon footprint and helps in the overall sustainability of the building. This paper focuses on the need for natural daylighting in the built-up environment and discusses the various types of daylighting strategies that can be used to enhance daylighting and reduce energy consumption. Special emphasis is laid on Hot and Humid Climate and the need to reduce energy usage while also increasing occupancy comfort and passive strategies that can help enhance and improve reading conditions with natural daylight. The strategies are illustrated by comparing the savings in energy consumption with the help of both active and passive daylighting strategies with the help of simple tools available to the general public.

#115 - Defining Regenerative Design: The Foundation to Systemic Understanding, Adoption, and Practice

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Keywords: Regenerative Design, Sustainability, Systematic Review, Built Environment

Abstract

Extant literature research largely concludes that human activities contribute to global warming. Vulnerable communities have experienced ecosystem-related crises since the early 90s. Moreover, based on current global temperature and environmental projections, a permanent population displacements of 200 million is anticipated by 2050.

Current sustainable practices—and sustainability as a notion, are no longer sufficient to affect the fundamental shift required with the urgency necessary to positively impact resources. Thus in 2019 the United Nations' Seventy-third Session on sustainable development was a call-to-action in response to the anticipated irreversible damage from climate change. The construction industry as one of the world's worst carbon polluters is disproportionality problematic in Australia in ratio to its population. The World Green Building Council's vision to decarbonise the sector by 2050, however, represents immense opportunity for a paradigm industry shift from sustainable modes of operation to those of regeneration.

Through principle and practice, built environment professionals must persuade systemic change as achieving net positive ecologies requires aiming beyond mere impact minimisation through sustainability, but eliciting net positive dividends through regenerative design. Accordingly, the purpose of this study is to identify levels of understanding and cohesive application of the term at a practice, national, and international level, and understand some of the systemic impediments, specifically in relation to (1) practical implementation and application, (2) research, and (3) benchmarking.

This research undertook a systematic literature review of published scholarly literature on the topic. Supporting the notion of inconsistent awareness, understanding, and application surrounding regenerative design, the review was cross-validated with a post-hoc purposive survey of built-environment industry professionals. From this, the study highlights the critical juncture vis-à-vis the existing interdisciplinary body of knowledge for education, design,

construction, planning, urban development, and policy and provides evidence to support the need for a consensus surrounding the definition of regenerative design.

#284 - Physical Comfort in our Homes: An Architectural Perspective

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Keywords: Home, Well-being, Physical Comfort, Human Needs.

Abstract

The current paper investigates the relationship between the physical comfort in homes (warmth, light, and ventilation) and inhabitants' psychological well-being. In particular, the paper looks at users' perception of home, and the role of satisfaction with levels of physical comfort on overall satisfaction with the residence. The research uses a mixed methods approach with a quantitative survey questionnaire (n=101) followed by qualitative interviews (n=13). The findings of the research demonstrate a direct correlation between satisfaction with the physical conditions of the residence and general satisfaction with life. Furthermore, the findings show that the perceived association with home is increased when physical comfort is achieved.

#257 - Mini-Eco-House Design: International Application

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Keywords: Mini house, off-grid, affordable housing, minimalist living.

Abstract

The United States has an ever-growing population. Communities across the United States are restricting new construction due to the limited nature of life-sustaining resources such as clean water, electricity, and building materials. The current trend of resource management is not sustainable (i.e., gas, electricity, and waste management). In addition to these issues, housing prices are soaring beyond what the average wage earner can afford. This paper has documented the research, design, and fabrication of possible solutions that address these issues relative to housing. This solution is a Mini house that is ecologically friendly, designed with suitability in mind, and affordable. It provides an opportunity for home ownership and security to those who otherwise could not afford such necessities. In this paper, we discuss the research that went into the design. The research areas introduced are code restrictions, off-grid solar systems, high-efficiency appliances, unique space-saving design, self-contained composting sewer systems, and grey water filtration systems. The Mini-Eco-House design will be built and completed this summer, 2022. Design adjustments will be made as required and documented. The lessons learned, construction drawings, instructions, and bill of materials will be used to document the project. These documents will be used next year by several schools across Utah. The documents will also be used by a nonprofit organization working with the Democratic Republic of the Congo. This solution does not fit highly populated areas of the world. Still, it is a possible solution to sites similar to rural Utah and regions in the Democratic Republic of the Congo. This design helps conserve life-sustaining resources in growing communities. This paper aims to document the lessons learned and share them with those that might benefit from this experience.

Sustainable Construction

#130 - Assessment of time delay and cost overrun factors influencing the building construction project control practices in Nigeria

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Keywords: Cost overrun, Construction, Nigeria, Project control practices, Time delay

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 aims to analyse the significant factors that influence construction project control mechanisms in Nigeria, using infrastructural projects as a baseline. Data were collected through a questionnaire survey with 200 construction actors with project control experience. The respondents' retort was analysed based on the procedures for Smart PLS-SEM version 3 software. The measurement model entailed formative, and reflective quality assessments before the structure model was examined to identify the significant relationship among the variables. The study further deployed the importance-performance matrix analysis (IPMA) to unravel the indicators with priority to the target construct. Hence, these indicators form the basis and attention for management decisions. The results revealed that both cost overrun (COF) and time delay (TDF) factors were positive and significant predictors of the project control practices. Likewise, IPMA showed that the COF construct has more importance and performed better than the TDF. Furthermore, 'Unstable government policies' from the TDF and COF indicators should be prioritised by the stakeholders in construction firms in the study area. This is followed by the 'Design changes', culminating in the project cost overrun in the construction environment. It is therefore essential that government policies should be the one that could last longer than usual, and this would involve adequate planning and commitment from the path of the leaders in the country. Also, clients and user involvement should be taken seriously from the inception to avoid change in the design at the handover stage of the project.

#211 - A Life-Cycle Cost Analysis of developing High-rise Sustainable, Innovative, Affordable Housing (SIAH) in South Africa

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Keywords: High-rise affordable house, Life-Cycle Cost, Low-rise affordable house, Sustainable Innovative Affordable House.

Abstract

This research aims to determine the life cycle cost (LCC) associated with developing inner city, high-rise, sustainable, innovative, affordable housing (SIAH) and compare that to the LCC of conventional, low-rise affordable housing (AH) in South Africa. Whilst much research exists to quantify the extent of the housing backlog and the evident need for a more effective housing framework in developing countries, limited research exists regarding the feasibility of alternative AH designs. In this light, little is understood about the costs involved in developing SIAH designs, location, and the associated benefits to society. However, the growing housing backlog, increasing urbanisation, need for sustainability, rising land prices, and other critical factors make it more important than ever to understand better how alternative affordable housing can be of great benefit. On this basis, this study seeks to grow the knowledge surrounding this topic by providing insight into the potential life cycle costs of an inner-city, high-rise SIAH design and whether there are cost savings that can be achieved by implementing such a design comparison to conventional affordable housing over an expected 50-year life span of houses. The data collected was analysed using input into the LCC model and then further interpreted. The study's findings resulted in four different cost items related directly to an LCC analysis of affordable housing: development costs, operating costs, maintenance costs, and social costs. This research found that inner-city, high-rise SIAH housing has a 99% lower LCC than conventional, low-rise AH in peripheral urban areas. The fundamental reason for this is the significant social cost savings for households due to better-located housing. The study's conclusions reveal that alternative housing designs, particularly in the form of SIAH, offer substantial benefits in terms of LCC reductions over the lifespan of the building compared to conventional, low-rise AH designs.

#218 - Provincial perspectives on the adoption of wood construction for sustainable built development

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Keywords: Built Development, Provinces, South Africa, Wood Construction.

Abstract

Emerging advocacy for the built environment to integrate sustainable infrastructure development can be achieved when project stakeholders within the AEC sector and country representatives participate in decision-making. However, few studies have evaluated the perspectives of provinces as imperative in integrating alternative sustainable development methods in the traditional construction approach. Hence, this study purports to investigate the perspectives of South African provinces in driving sustainable development approaches with a specific focus on wood construction. This study presents preliminary findings from a pilot study of postgraduate students working in provinces selected by convenience sampling using a questionnaire survey. The study avails state of provincial considerations and disposition towards wood construction. The study's findings will aid the drive for the implementation of sustainable development in the built sector and inform key policy decisions on perspectives from provincial stakeholders on the use of wood construction in sustainable built environment infrastructure delivery.

#214 - Study the impact of Internal and External key Influencers on the level of adoption of technological Innovation in Affordable Housing Projects

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Keywords: Affordable housing, Internal and external influences, Level of adoption, Sustainability, Technological innovation.

Abstract

The availability of various technological innovations in the construction industry is able to enhance the sustainability of affordable housing and promote the development of sustainable, innovative, affordable houses (SIAH). However, the existing studies do not provide practical knowledge on the impact of key internal and external influencers on the level of adoption of these technological innovations in affordable housing in the global south. Therefore, the current study scrutinises the impact of the key internal and external influencers on the level of adaptation of technological innovation in South African affordable housing projects. The initial findings were utilised to develop SIAH causal model. The SIAH casual model and the nexus between the constructs/sub-constructs were validated through a structured questionnaire survey returning 517 completed questionnaires by registered home developers in South Africa with structural equation modelling as the analysis method. The study found a low positive impact of internal influences and moderate negative impact of external influences on the level of adoption of technological innovation by home developers in South African affordable housing projects. Moreover, the research proved the high negative mediating impact of external influences on the association between internal influences and technological innovation adoption level. The study deduces that the external influencers are the main drivers of adopting technological innovation in affordable housing. By addressing the external influences, the level of adoption will significantly improve. This is because of both direct and mediating adverse effects of external influencers on the level of adoption of technological innovation in affordable housing projects. The validated casual model can use as a robust framework to reduce the challenges of adaptation to technological innovations in SIAH.

#102 - A Systematic Review of Responsible Sourcing Literature Across the Architecture, Engineering and Construction (AEC) Sector of the UK

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Keywords: Responsible Sourcing, BES6001, Green Supply Chain Management, Sustainable Construction.

Abstract

The UK's strategy for sustainable construction has raised concerns over the plethora of negative environmental impacts related to the architecture, engineering, and construction (AEC) sector. The introduction of policy-documents (including the Construction Playbook) provides challenging targets for the AEC sector in relation to climate change, carbon impact and social value. Thus, construction and its associated processes, in order to respond, must transform to meet with expectations. Several tools are proposed in support of this change, which include green supply chain management (GSCM) and responsible sourcing (RS). The aim of this study is to provide a systematic review of literature and research with a focus on the UK's AEC sector to identify the benefits and barriers to these practices and highlight opportunities for uptake. The PRISMA review process was used to identify, screen, and select (n=50) articles included in the review. Comprehensive document analysis reveals the most frequently reported benefits relating to the uptake of responsible sourcing were: (i) stakeholder value (44%); (ii) improved supply chain performance (42%) and (iii) competitive advantage (34%); whereas the most frequently reported barriers were: (i) cost (46%); (ii) lack of awareness (28%); and (iii) industry constraints (22%). To surmise, responsible sourcing clearly aligns with UK policies and AEC sector targets. However, the barriers remain an issue that must be addressed to effectively convert construction towards a sustainable future. It is, therefore, recommended that further investigation into the adoption of sustainable behaviours is undertaken. It is also recommended that support be provided by frameworks and public spending to allow tangible case studies proving the relevance and effectiveness of RS and GSCM.

#150 - Achieving supply chain resilience within the offsite construction sector: A review of success factors

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Key words: Offsite Construction (OC), Supply chain resilience (SCR), Supply chain capabilities (SCC), Supply chain vulnerabilities (SCV).

Abstract

The modern construction supply chains (SCs) are extended over hundreds and thousands of miles, making them overexposed to various risks with distinct levels of probabilities and magnitudes. The modern trend of offsite construction has been highlighted as the panacea for some of the illnesses currently faced by industry, including the environmental emergency, fragmentation of the industry, high uncertainty within construction markets, and the continuous need for uplifting performance of the built assets. Focusing on the offsite construction industry (OC), this paper aims to review the available literature in order to investigate how supply chain resilience (SCR) is an essential concept to adopt by the entities operating within the sector, highlighting the different factors affecting this adoption. The results revealed 96 critical factors that affect the degree of adoption and successful application of SCR for entities operating within the OC sector. On the one hand, these factors are categorised under six constructs of SCR failure: Environmental, Financial, Procedural, Project Organizational factors, Supplier/customer and Technological. On the other hand, 12 constructs of SCR success factors: Adaptability, Anticipation, Capacity, Collaboration, Dispersion, Efficiency, Financial, Flexibility, Market position, Recovery, Security, Visibility. This paper is beneficial in introducing prior knowledge on SCs to the OC sector by identifying and promoting success and failure factors in a collective manner. This knowledge provides guidance to industry practitioners on how to assess the levels of their criticality, seek improvements, and identify the most suitable ways to properly integrate them into supply chain processes in the OC industry.

#188 - Naturalness and atypicality of mycelium bio-composites as influencers of preference

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Keywords: Mycelium bio-composites, perception, naturalness, atypicality

Abstract

The biodegradable and regenerative nature of mycelium bio-composites provide architecture a novel solution for achieving more responsible productions (SDG12) and circular innovation (SDG9). This paper identifies the need for integrated, holistic issues of mycelium bio-composites to be addressed before their high-level adoption in architectural construction, and reports on results from a series of mixed-method investigations. The dimensional stability and aesthetic irregularities of mycelium bio-composites provide opportunities and challenges to mycelium bio-composites' market diffusion. Completed preliminary user studies indicate that these senso-aesthetic qualities could provide psycho-physiological affects which could support endeavours to increase well-being in places of work, study, and recovery (SDG3). The results indicate the roles emotions and perceptions play in consumer decisions, despite these factors often being disregarded by market diffusion research that focuses on logic and reason. Uptake for temporal, novel materials such as these requires the architectural industry to observe the full holistic potential of our materials and review our desire for permanence we've ingrained in practices and standards.

#269 - Pilot Study to Investigate the Extent to which Off-Site Construction can Help Promote Social Housing in Ireland

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Keywords: construction materials, Irish housing crisis, residential building and construction.

Abstract

Ireland is currently amidst the worst social housing crisis the country has ever known. A review of the literature reveals there's very little research on how off-site construction can be used to promote residential construction, specifically in Ireland. The purpose of this pilot research was to investigate the extent to which off-site construction can help promote housing and address the social housing crisis in Ireland. This was achieved using structured interviews with eight off-site construction workers from across the country and a scoring system to evaluate the different off-site construction materials. The pilot research highlighted the ability of off-site construction to produce fast, high-quality housing units. Nevertheless, it found the Irish construction industry to be slow in adopting it for residential social housing due to the prevalence of traditional construction methods. To speed this up, there's a need to revise the Irish government's annual new housing targets and develop a standardised housing design that takes advantage of the benefits of off-site construction. This and other similar research projects should help increase the adoption of off-site construction practices for social housing within Ireland, which should improve in the long run how housing is built in Ireland and lessen the existing social housing crisis. Future research should focus on reaching out to a larger sample of professionals from across the country and on investigating many of the barriers and solutions to off-site construction proposed in this paper in detail.

#276 - Designing a Net-Zero House: Some reflections

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Keywords: Experiential learning; Education for sustainable development; Net-zero; Renewable Energy Transitions

Abstract

Higher Education for Sustainable Development is a major concern in academia. Using the approach to the Experiential Learning (Backman et al 2019) this paper analyses the concept of learning landscapes in terms of finding solutions to the contemporary challenges such as Net-zero Homes. Governments around the world have committed their policies and planning practices towards achieving net-zero objectives mainly related to decarbonising the various sectors. Using the case of Renewable Energy Transitions, we discuss to what extent the Net-Zero remains a fluid concept? We particularly refer to our empirical experiences of working in academia, especially for designing and engineering solutions for a sustainable built environment. The case study work refers to working with international cohorts of university students and young professionals in architecture and engineering related disciplines and practices with aims to better understand the contemporary housing needs and growing demands for sustainable living. In addition, the attention towards net-zero, mainly driven by the UN Agenda for Sustainable Development in the form of SDGs, has been contextualised. A programme of virtual lectures and workshops was developed to build capacity of the participants. We analyse and discuss the process along with the feedback from the programme participants. In conclusion, we discuss the appropriateness and alternative conceptualisations of the discourse in higher education for sustainable development in variable institutional settings to determine the key influences on learners and the need to better conceptualise the experiential learning approaches.

Sustainable Construction (Off Site Construction)

#168 - Adoption of Offsite Manufacturing in Housing Sector: Challenges, Benefits and Future Opportunities

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Keywords: Modular, offsite construction, prefabrication and construction.

Abstract

Over several years, reliance on traditional onsite 'brick and mortar' construction, which is slow and prone to errors, has failed to address the growing issue of housing shortfall. Building houses is in high demand all across the world. To tackle the housing shortfall, the sector is adopting modern construction methods like as offsite manufacturing. Offsite manufacturing has been proposed as a suitable method for building new homes in various countries by academics and practitioners. They thoroughly documented the benefits in terms of building cost, speed, and quality. Although this technology has several important advantages, its present utilisation in the building sector is limited. The definitions, history, and terms used in different countries about the technology are presented. To find the reasons and fill the gap, the current study aims to investigate and explore the barriers to adopting offsite manufacturing in the housing sector and also, the benefits of utilizing offsite manufacturing. An expert questionnaire survey was designed for the findings in the literature review and sent to the stakeholders, there were 25 responses. The responses are statistically analysed. The results identified the barriers to the wider adoption as lack of design flexibility, negative image, lack of manufacturers, and previous experience and advantages in terms of scheduling, cost, time, productivity, reduction in construction waste, and increase in health and safety. Furthermore, the research explored how to improve the better use of offsite manufacturing in the housing sector. A theoretical framework was presented for better outputs by implementing offsite manufacturing in the housing sector.

#103 - Increasing the prevalence of offsite construction in the UK housing association developments: conceptual and pragmatic advantages and challenges

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Keywords: Social and Affordable Housing, Offsite Construction Methods, Literature Review

Abstract

Offsite construction is increasingly being presented as a way to increase housing delivery and reduce the global housing crisis. Social and Affordable housing providers play a pivotal role in the delivery of affordable homes and therefore offsite construction could be beneficial in alleviating the crisis. For offsite construction uptake to increase, the conceptual and pragmatic advantages and challenges surrounding offsite housing in relation to evolving social domestic needs to be explored and better understood. The purpose of this paper is to review the viability of offsite construction as not only a full-service solution to social housing provision, but an integral strategic partner for meeting the range of specialised fabrication needs for these new properties. A critical review of the existing evidence was conducted to explore the conceptual and pragmatic advantages and challenges encountered by UK Housing Associations (HAs) adopting offsite construction methods. The paper highlighted that whilst individual case studies and example homes offer one mode of justification for HAs to move forward, it is the cumulative effect of cost savings, sustainability, specialised skill sets, labour reduction, structural innovation, and rate of construction that should be weighed and incorporated into this consideration-making process. The adoption of offsite construction methods has the potential to increase social housing delivery and reduce the housing crisis. For uptake to increase, the perceptions of those building homes need to be better understood. While this paper adds value to the wider UK offsite construction literature, there is an urgent need to carry out empirical research into the perceptions of Social and Affordable housing providers towards the adoption of offsite construction solutions both nationally and internationally.

Sustainable Construction (Novel Materials)

#285 - Geotechnical Insights into the Experimental Use of *Proteus mirabilis* for Calcite Precipitation of Lateritic Clay Soils

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Keywords: Ground engineering, Foundations, Soil barrier, Sustainable construction

Abstract

*The uptake and use of microbial–induced calcite precipitation (MICP) for soil improvement has significantly increased since its application was discovered two decades ago. Most research and fieldwork focus more on its application in sandy soil improvement because soils with smaller pore sizes inhibit the movement of bacteria. The effects of *Proteus mirabilis* on the geotechnical properties of a lateritic clay was investigated. The index properties, compaction characteristics, strength characteristics, and chemical and morphological properties of the lateritic clay were determined. The soil is classified as a sandy clay (CL) based on the Unified Soil Classification System (USCS) and as an A–7–6 soil based on the American Association of State Highway and Transportation Officials (AASHTO) classification system. The soil was then treated with 0, 1.5×10^8 , 6.0×10^8 , 1.2×10^9 , 1.8×10^9 , and 2.4×10^9 cells/ml *Proteus mirabilis* suspension density. Comparing maximum dry density (MDD) and unconfined compressive strength (UCS) of the natural soil and soil treated with 2.4×10^9 cells/ml bacteria suspension, the MDD of the natural soil increased from 1648 kg/m^3 to 1768 kg/m^3 while the UCS of the soil increased from 129.09 kN/m^2 to 172.7 kN/m^2 , respectively. Micrographs of the treated soils showed a reduction in pore spaces due to the precipitation of calcites in the pores. With a 33.8% increase in the UCS of the natural soil due to calcite precipitation, this study shows the prospect of using *Proteus mirabilis* as an environment–friendly means of improving the geotechnical strength of soils.*

#282 - Rethinking living matter: Animate behaviours of fungal composites

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Keywords: biosensing, fungi, sustainability, electrical activity.

Abstract

*Smart materials integrating conventional soft electronics e.g. sensors and actuators, are widely used in the building and wearable industries, contributing to the depletion of natural resources and having a vast environmental impact. In this paper, a novel method using living fungi for the development of responsive materials for smart architectural and wearable skins is discussed. Living fungi composites exhibit remarkable self-sustainable properties: self-growth, self-repair and self-assembly. They present responsive capabilities to environmental, chemical and mechanical stimuli, allowing the implementation of sensorial fusion and decision making. We inoculated hemp mat substrates with the fungus *Pleurotus ostreatus* and cultured until a coating of white mycelial growth was observed. We performed a series of laboratory experiments on the fungal composites, exposing them to various environmental, chemical and mechanical stimuli and we explored their communication protocols and smart capabilities. We found that living fungi composites employ precise responsive mechanisms by generating distinct electrical potential impulses in the form of spike events, presenting a promising alternative to conventional smart materials. The results open up new possibilities for the development of the next generation of smart materials for the building and wearable industries, allowing large scale implementation and production.*

#193 - Can bamboo become a sustainable building material in Australia?

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Keywords: sustainability, carbon reduction, design, construction methodologies

Abstract

Bamboo grows rapidly, maturing within 5 to 9 years to a hard, timber-like material that can regenerate within the lifespan of most building products. It therefore has the potential to be a renewable resource for use in the construction industry.

This paper discusses the benefits of bamboo in construction and land restoration, its role in the circular economy, and its contribution in carbon reduction. There is an International Organisation of Standardisation Standard for the design of bamboo structures made from natural round-form bamboo, which is supported by other standards in the grading and test methods for bamboo. A number of countries, including Columbia, Ecuador, and Peru have also included the natural-round form bamboo in their Building Codes. In addition, China and India have developed codes and standards for natural round-form and engineered bamboo, and ASTM International have now added laminated veneer bamboo to their specification for the evaluation of structural composite lumber products. Those countries that have used bamboo for structural purposes have developed suitable trade skills and construction methodologies. At the same time, the use of bamboo for construction use is not well known in Australia.

This paper identifies the underlying factors with respect to why bamboo is not often considered as a building material suitable for permanent structures. It is based on a literature review and research of the bamboo industry in Australia. Based on the research, it can be concluded that using bamboo as a building material is mainly dependent on a number of factors, such as the experience of previous generations, evaluation of its performance during disasters, intuition of builders, and from the practices use its treatment and preservation. This paper also outlines a strategy and further research required to better establish bamboo as a viable design and construction material for permanent structures.

#272 - 'SMARTIFYING' CONSTRUCTION FOR CIRCULAR AND ZERO-CARBON BIOBASED BUILDINGS (SmartBioC)

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Keywords: Modern Methods of Construction, Biobased Construction, Serious Game, Life Cycle Assessment

Abstract

SmartBioC focuses on creating a user-friendly digital tool that allows users to select and specify biobased materials and building components for a modular housing unit based on a set of performance indicators including carbon footprint, thermal performance, cost, social value, health and wellbeing and strength. The ultimate aim of the tool is to speed up the uptake of circular biobased materials to provide zero-carbon, healthy and socially and economically viable solutions for the construction industry. Smart construction, integrating the use of digital technologies and Modern Methods of Construction (MMC) has the potential to improve the affordability, efficiency, and sustainability of new buildings. Aligned to a circular economic model, opportunities exist to optimise the use, reuse, and disposal of biobased materials within the expanding MMC housing market, thereby improving carbon sequestration and mitigating climate change. Together with industry partners, SmartBioC's research team is using the Design Council's Double Diamond Framework of discover, define, develop, deliver, to facilitate a collaborative and iterative process where the end-user is at the centre and determines the final outcome. To date SmartBioC has undertaken an exploratory review of the literature, an early concept modelling using Autodesk Revit, and an outline performance specification for the biobased products defined. A BIM Object library of MMC category 2 components with alternative biobased material configurations is under development for exporting to gaming platform Unity. Rapid prototyping and testing in Unity will ensure that a web-based tool (html) is distributed to users for feedback and development purposes. User-friendly digital tools like SmartBioC gives end-users, designers, decision-makers and specifiers, the ability to easily select circular biobased materials whilst visualising their design in 3D, along with information about the environmental, economic and social impacts of their choices. The adoption by the construction industry of zero-carbon, healthy and socially and economically viable biobased building solutions is imperative if the catastrophic impacts of predicted global warming are to be averted.

#274 - Can mycelium shape the future of architecture?

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Keywords: Mycelium, mycotecture, formal analysis.

Abstract

As the construction industry struggles to deal with its impact on the climate, researchers are looking for alternative materials to build with. A material that is the subject of recent research in the field of construction is Mycelium. Mycelium - the fibrous network that exists underneath a fungus - is a natural material with a zero-carbon footprint, is biodegradable and compostable. Already being used as a substitute for leather or as packaging material, Mycelium is making its way in construction also.

Combined with a substrate made of waste sources that are cellulose-rich (like sawdust, ground wood, straw, and various agricultural residues), it can be moulded to produce various products. When dry, it becomes very durable and resistant to water, mould and fire. In brick form, it is one of the most promising new materials currently being researched. It can also be used as a "living material". Researchers are currently exploring the idea of a smart material by adding nanoparticles and polymers to the substrate, obtaining a material that is able to self-grow, build and repair itself.

Through bibliographic research and comparative analysis, we will find out the current state of the research of this material and maybe find new possibilities to use it in architecture. The goal of this article is to explore the potential of this new material to help reduce carbon footprint, as well as the impact of its use on architecture. Can the Mycelium change the "modus operandi" of building materials, especially ecological materials?

#205 - Analysis of Modular Construction adoption in the UK housing sector

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Keywords: Housing, modular construction, Modern methods of construction, MMC.

Abstract:

The aim of the research was to analyse the development and adoption of modular construction within the UK housing sector. This was achieved through primary and secondary research. The primary research adopted quantitative and qualitative measures through a questionnaire survey of fifty-eight housebuilding professionals, as well as interviews with five industry professionals.

The key findings of this data found that the perception of the public and those working within industry needs to improve in order for modular construction to be widely adopted on a mass scale in this sector. Topics such as the skills shortage were researched and found to be an issue, but the requirement for a large labour force is apparently reduced with the adoption of factory produced modular units. A modern method of construction (MMC) target of one in four publicly funded units was introduced by the government in 2004. This was addressed within this study, but the data collected suggests this has not been achieved.

While there are still some reservations regarding the uptake of modular housing construction, there are also various positives highlighted within this study. These include increased energy efficiency and sustainability, agreed by the majority of the respondents as major drivers, alongside the increased speed of build and quality improvement compared to the traditional method. Overall, this study provides a good insight into the current state of attitudes and perceptions within the industry regarding modular construction and analysis of quantities of modular dwellings being built in the UK.

As a result of the analysis of the development and adoption of modular construction, the author recommends the introduction of more specific training, financial incentives, and improved communication regarding the benefits of modular built homes to attract more house buyers.

Urban Design Planning

#105 - Public space in Rzeszów as a modernist vision of green areas within the city

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Keywords: landscape architecture of Rzeszów, Polish architecture of the 20th century, modernist housing estates

Abstract

Over the past few decades, there have been various appraisals of the quality of modernist public space in Rzeszów, a city in southeast Poland. In the late 1980s, public open spaces located between residential buildings were often criticized, but in the 21st-century, following the experiences of dense urban dex

velopment, the advantages of the modernist vision of greenery in cities are increasingly appreciated. Rzeszów, whose development has been carefully planned in accordance with modern ideas since the 1930s, seems to be a perfect example of a city where public green spaces play a key role within urban space. The observations of the Athens Charter, access to natural light and fresh air were at the core of the vision of the future of cities, could be fully realized in the urban space of Rzeszów, the planning and implementation of which followed this vision until the 1980s.

#116 - Co-design and virtual reality for post-disaster infrastructure in Ecuador

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Keywords: Co-design, Earthquake, Post-disaster infrastructure, Sustainable development.

Abstract

According to UN Sustainable Development Goal 3 and 11, post-disaster resettlements should have conceived and developed considering the long term social, spatial and environmental impacts they can have on inhabitants. However, many are the cases where the long term implications have not been at the heart of decisions, especially in emergency context, such as in the aftermath of disasters, as testified by the NOVA VIDA project. The NOVAVIDA Research project, indeed, has analysed the Ecuadorian housing reconstruction developed after the 7.8 magnitude 2016 earthquake, taking as case study four cities located in the strongly affected province of Manabí. The research demonstrated, through qualitative empirical research, the spatial and social impacts of the post-earthquake resettlements deployed in Manabi. Clear are the set of necessary stepping stones that must be considered to avoid segregation and distress: involve local communities at all stages of reconstruction and adopt design solutions at the urban and housing unit level, which are strongly connected to the local geographic and cultural context. Looking at the buildings, the adoption of standardised building, arranged in infinite replicated rows, showed lack of flexibility, (in)capacity to accommodate future families growth and evident thermal discomfort. This paper aims to present: a. the co-design proposal for future post-disaster scenarios in the city of Portoviejo, discussing the approach, the analysis of the built environment, the project of the new resettlement, and the feedback obtained after the workshop with local experts and inhabitants; and b. the contribution provided by virtual reality in the analysis of the proposed future scenarios.

#233 - Enhancing the resilience of smart cities through housing provisions

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Keywords: Housing, Planning, Resilience, Smart City.

Abstract

The housing problem has long been associated with rapid urbanisation. Not all people migrating to cities can be adequately accommodated. A city at its maximum or excess capacity leaves people with no choice but to compete over the limited and scarce resources including lands/houses. The increased demand for houses escalates further challenges like exposed informal settlements and poorly planned urban developments that create disaster risks. Smart Cities were developed as a solution to different complex urban challenges including the housing problem. Housing in a Smart City can be viewed through different aspects of a Smart City, such as its socio-technological paradigm, risk-informed urban planning, zoning and development initiatives, improved human habitat comfort, innovations, etc. While innovative Smart Cities solutions keep growing, attention is now being paid to resilience building within Smart Cities, given disasters are inescapable. Therefore, housing in a Smart City should be systematised, complementing its disaster resilience efforts. To understand the housing requirements in a Smart City and evaluate the extent they acknowledge and complement resilience efforts, this study conducts a systematic literature review using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) technique. How housing provisions complement resilience efforts is mapped against 5 attributes: settlement models/planning structures in a Smart City, risk-informed and energy-efficient residential buildings in a Smart City, the use of science-based innovative systems (digitisation and integrated infrastructure), housing mix, and the affordability of houses in a Smart City. The research findings thereby advise capitalising on the potential of resilient housing for disaster resilient Smart Cities while minimising the negative impacts of urbanisation on housing.

#203 - Land, air and water: Reclaiming the Anthropocene through Bristol's infrastructural megastructures

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Keywords: Anthropocene, infrastructure, architectural representation, media

Abstract

The paper will present work developed across a series of architectural design studios at the Department of Architecture and the Built in Environment at UWE Bristol. Over the course of three years, the design briefs developed by Matthew Hynam and Sophia Banou have framed a discussion of social and environmental sustainability from a design perspective that proposes intervening within existing infrastructural megastructures as sites of latent possibility for the rehabilitation of the relationship between nature and the built environment. Framed by the discourse pertaining to the Anthropocene (Turpin, 2013) as a geological period within which manmade intervention has registered itself in the composition of our planet, the design approach developed in the context of this studios embraces the appropriation of the built by the natural to propose new considerations of site within architectural practice.

The paper will present and discuss student work that concerns design interventions within large-scale manmade constructs such as the Bristol Floating Harbour, Bristol Temple Meads Railway Station, Portbury Docks, Filton Airfield and the M32 motorway. In doing so it will address, firstly, how the built has unequivocally and permanently conditioned the natural and, secondly, how a design approach based on a process of survey and modelling, can allow for the study and intervention in such sites towards the pursuit of social and environmental sustainability. Through a series of techniques of 'expanded drawing' (Banou, 2020) and mapping, enriched by media such as film and installation, the brief and works presented propose an extended understanding of landscape and the capability of urban and suburban sites to act as representational registers of the negotiation between the built and the natural. The representational processes of survey examined through this body of work, are proposed here as a way of bringing into the "field of visibility" (Evans, 1997) of the architect a range of technological and scientific data on a level playing field with the social and cultural significance of the technological sites they examine.

#155 – Back to the Future – North Arm Cove Initiative - Can we revive and learn from a century old city plan? - An Australian Story

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Keywords: Sustainability, Collaborative Planning, Circular Economy, Heritage

Abstract

There are two main areas of our research – past and future. Investigating one of the forgotten pearls of Australia’s planning past and conceptualizing its sustainable, regenerative future. This paper describes the ongoing project of “recycling” the plans prepared by Walter Burley Griffin a century ago, and creating an innovative precinct, based on Circular Economy (CE), through innovative, collaborative ways of doing urban planning. The paper presents the current state of the project and the results as of April 2022. Identification and analysis phases were conducted through the PESTEL analysis. Proof of concept phase was completed in collaboration with university/research institutions as well as various industry entities through the North Arm Cove Initiative.

Thus far, our research includes a proposed framework for achieving sustainable goals:

- *sustainable, regenerative precinct for a resilient, smart community*
- *meaningful community participation in planning and governance*
- *circular supply chain for an urban community*
- *measurable performance and controlled impact of the community on the environment*
- *opportunities for implementing research in real life – innovation precinct*

Key aspects of future planning and delivery of the precinct should be collaborative, comprising inclusive planning and governance, in line with a transition to Circular Economy. The new framework proposes continuous collaboration between research, industry, and community through the Sustainability Research Centre hub, that would define and govern the delivery of measurable outcomes on three bottom lines – social, environmental and economic – but also innovation/technology and aesthetics. The project is developed by the DESIM-R&D team for the community of landowners of North Arm Cove (NAC), heritage “paper subdivision” in New South Wales (NSW), Australia.

Urban Environments

#106 - Critical Infrastructures (CIs) and Extreme Weather Events (EWEs); 'Cascading Criticality' in Urban Indian Context

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Keywords: Critical Infrastructure, Extreme Weather Events, Cascading Criticality, Interdependencies

Abstract

The past few years have seen a growing number of extreme weather events (EWEs) and associated critical infrastructures (CIs) losses. in India. Thus, research into CIs as essential for the upkeep of vital societal functions is vital since contemporary cities were not designed with climate change in mind. The main purpose of this research is to assess the 'criticality' of CIs as interdependent systems and assess cascading impact of climate change linked extreme weather events on the system of CIs. The study first identifies CIs and EWEs in Indian context by analysing data on Government spending on infrastructure, and metrological data on EWEs which have occurred in the past 3 years (2017-2019). In the second step, 2 interdependencies matrices are categorized based on driving power and dependence on of CIs application of cross-impact matrix multiplication into four quadrants - Quadrant 4 Independent (disruption will cause the maximum cascading impact on other CIs), Quadrant 3 Linkage (considered unusable CIs), Quadrant 2 Autonomous (relatively disconnected, can function without support), and Quadrant 1 Dependant (highly dependent on support infrastructure). To develop the matrices, a focus-group workshop was undertaken in which 27 experts participated. 18 identified CIs are assessed for their dependency and driving power and are again assessed for their driving power against 10 EWEs. Findings show that in the first matrix there are 4 Independent, 3 Linkage, 4 Dependant, and 7 Autonomous CIs. In the second matrix when EWEs are introduced, there are 5 Independent, 0 Linkage, 6 Dependant, and 5 Autonomous CIs, and two CIs are classified by a term coined by the authors 'cascading criticality' wherein dependency and driving power are equal: Urban Infrastructure and Education. The entry of education as both dependent and driver for smooth functioning of complex CI systems is a

novel concept that requires focused research because it offers a long-term sustainable solution for enhancing resilience of cities.

#152 - Influencing factors assessment and spatial design strategies for the sustainable development of rural heritage communities

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Keywords: rural heritage communities; sustainable development; influencing factors; spatial design strategies

Abstract

The rapid urbanisation and regional homogenisation of rural heritage communities is increasingly a challenge in rural heritage communities. On the one hand, rural heritage communities need to grow to be viable; on the other hand, indiscriminate growth could negatively affect heritage, cultural and architectural identity. Precedent research in this area is limited, lacking residents' perspectives and focusing on either assessing heritage status or applying existing strategies. Therefore, this study aims to synthesise the cultural ecology and anthropological approaches to investigate the factors affecting the sustainable development of rural heritage communities. The findings will propose a rational and sustainable spatial development strategy. This paper presents the first step of the research; a systematic literature review. The research resulted in a conceptual framework evaluated through a case study focused on the Chinese village of Baojing. The results show that the factors influencing the spatial development of rural heritage communities include the natural, social and economic environment, spatial evolution, public participation, and cultural driving. Therefore, the sustainable development of rural heritage communities can be enhanced by combining local conditions and improving these six factors in an integrated manner. However, further research is needed to determine the relevance of each influencing factor as a precursor to proposing a comprehensive assessment system for rural heritage communities.

#109 - A study on Sustainable Urban Blocks: Understanding sustainability at city level from successful models

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Keywords: Sustainable Urban Block, Adaptive Reuse, Tactical Urbanism, Retrofitting and Rehabilitation.

Abstract

A city's morphology depends on the urban blocks that make up the city's DNA. Historically urban blocks were designed for the people to live and create community spaces and these have since evolved over time and thus are sustainable in the way they grow and are reused, rehabilitated, and renewed. This study helps us understand what makes an urban block sustainable and how it can be designed to be sustainable through the examples of London (evolutionary adaptive reuse), Amsterdam (grassroots planning), and Barcelona (Superblocks with tactical urbanism). The study is substantiated by data collected with the help of surveys and comprehensive studies done on these major cities. A list of parameters of factors that make a city block sustainable has been collated to assist the design of future urban blocks that works sustainably from the designing stage to the way it works as an urban environment.

#132 - Evaluating the Urban Heat Island Mitigation Potential in the foothills of Uttarakhand, India through Green Roofing Systems

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Keywords: Urban Heat Island Mitigation, Building Sector, Green Roofs, Himalayan Foothills.

Abstract

Globalization has accelerated the rate of urbanisation at the cost of environmental degradation and making cities vulnerable to the impacts of climate change. Increased urbanization has contributed to the Urban Heat Island Effect and it is important for the sustainable urban development to mitigate UHI, especially among the nations of growing economies i.e. India. Additionally the commercial, industrial, transportation and building sectors emit a large quantity of global house gases in the environment adding to UHI in the urban areas. Of all these sectors, the building is one of the largest contributors mainly due to carbon emissions, reduced natural landscapes and long wave solar radiation reflecting back from hard roof surfaces. Therefore mitigating UHI caused by the building sector is imperative with green roofs having been identified as one of the best practices.

In northern India the Himalayan belt is experiencing tremendous urban growth for various reasons from religious destinations to natural forest cover for tourism . Both land use and land cover of the Himalayan foothills are changing rapidly from being green (vegetation) to grey (concrete roofs) and thus increasing the Urban heat island intensity. This meta study examines the Urban Heat Island phenomenon in Dehradun based on LANDSAT data of the last decade. The study identifies hot spots and evaluates the potential of installing a green roofing system on existing roofs.. The results of this study may be recognised as best practices to be carried forward for other similar regions in the Himalayas.

Waste Management

#164 - An Experimental Conversion of Wasted Facemasks to Eco-Composites

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Keywords: Composites, Flax, Polypropylene, Recycling.

Abstract:

The severe increase in the pollution caused by the discarded face masks during COVID-19 cannot be overstated. This research provides an innovative engineering solution to this issue by recycling polypropylene, the primary plastic found in the facemasks to manufacture eco-composite by reinforcing it with natural flax fibres. This research highlights the environmental pillar of sustainability from an engineering perspective. Flax fibres were chosen as the most suitable natural fibre for polypropylene reinforcement due to their favourable mechanical properties, and their abundance as a plant in Northern Europe also reducing the carbon footprint of the product. The mechanical properties of the 'Flax fibre reinforced polypropylene composite material', named FlaxPP, were analysed using software simulations and mathematical calculations. FlaxPP composite materials were found to have more favourable vibrational damping properties than GlassPP composites, while GlassPP showed significantly superior strength and stiffness properties during tensile testing. FlaxPP manufactured using face masks had lower mechanical properties than Flax/vPP, highlighting the influence of additives, chemicals, and coloured dye on the mechanical properties of the face masks.

#114 - The 5Rs for Waste Management of Abandoned Infrastructure in Nigeria

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Keywords: Abandoned Infrastructure, Sustainable Development, Waste Management, Refurbishment.

Abstract

This paper focused on how the 5Rs concepts can be adopted to resuscitate abandoned infrastructure in Nigeria while curbing the challenges faced in the Nigerian environment. Sustainable development is intended to meet present needs without compromising the needs of the generations to come. However, the innumerable number of incomplete and abandoned infrastructure projects in Nigeria brings into question the government's aspirations toward sustainable development in Nigeria. Abandoned infrastructure harms the economy, society and the environment. These infrastructures cluttered the entire environment of Nigeria, and many authors tagged the country as the world's junkyard for abandoned infrastructure, full of hide-outs for nefarious activities. The menace constituted by this abandonment also includes a threat to public health, creating an abode for pests, and a waste of useful, scarce, economic and material resources. The initial concept of the R system of sustainability was 3Rs: reduce, reuse and recycle, which are alternatives for waste management that progressively gained attention in the 1970s.

Nevertheless, a new concept of dealing with waste includes multiple 5Rs systems consisting of a rethink, reduce, reuse, refurbish, and regulation. These new concept attempts to promote waste management required to be done effectively. This paper illustrated how the Rs concept could sustainably address the waste generated by abandoned infrastructure in Nigeria through semi-structured interviews. Eight (8) construction professionals, including architects, Project Managers, Engineers, Quantity Surveyors and Contractors, participated in the interview. The interviews were transcribed and analysed through qualitative content analysis. The findings revealed the need for the government to rethink how best these structures can be put to use, reduce the development of excess infrastructure and salvage projects by refurbishing and reusing them. The possible implication of the findings initiated a paradigm shift in sustainable development that is not just for Nigeria only, but globally.

#267 - A Qualitative investigation into the Cause and Effect of Non-Physical Waste on UK and Irish Construction Sites

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Keywords: Project Overrun, Non-Value Adding Activities, Waste.

Abstract

The construction industry has developed rapidly, on a local, national, and international level. This rapid development has resulted in increased levels of both physical and non-physical waste produced within the construction sector. To date, the causes, and effects of physical waste are well documented; however, non-physical waste within Ireland and the UK requires further attention. The aim of this research paper is to investigate the causes, activities, impact, and proposed solutions to non-physical waste on construction sites within the United Kingdom (UK) and Ireland. A qualitative research method is used to address the aim proposed. Semi-structured interviews are conducted to gather information from professionals within the industry with a minimum of two years' experience. 15 interviewees from 10 different companies participate in the study, with focus on the causes, effects, and solutions to non-physical waste in the construction industry. In total, 26 causes are identified, all of which are grouped into five categories, as follows: Design, Planning, Poor Sub-Contractor Choice, Brexit, and Staff Retention. The respective activities of each category are identified and discussed further. The findings of this research paper will help construction companies to avoid and reduce the levels of non-physical waste throughout the life cycle of a project. Furthermore, the paper makes some suggestions for further solutions to reducing the levels of non-physical waste in the sector, while proposing further research on the topic.

#198 - Towards Circular Economy: The Role of Informal Waste Workers in Construction and Demolition Waste Management in Nigeria

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Keywords: Circular economy, Construction waste management, Reuse, Informal economy.

Abstract:

The circular economy is a concept that integrates material reduction, reuse, and recycling. The reuse of building components has potential that as yet has not been fully explored. To date, the Nigerian construction industry has not made documented attempts to apply circular economy. In Nigeria, huge amount of construction and demolition waste are produced and abandoned on roadsides, waterways, etc. The formal construction and demolition waste (CDW) system has failed in dealing with these wastes. Most of the attempts that have been made have been by the informal waste workers but unfortunately these attempts over the years, have gone unnoticed by the policy makers. Though not acknowledged by policy makers, the ubiquitous informal economy fortuitously remains active in construction and demolition waste collection, reuse, and recycling. Studies of this nature have previously not been undertaken in the context of Nigerian cultural and economic environment. Recognising the contributions of the informal waste workers in construction waste reuse will promote sustainable construction in Nigeria.

The aim of this paper is to explore the role of informal waste workers in reuse and recycling of CDW in Nigeria and challenges the lack of formal recognition of their roles by Nigerian policy makers. The study employs qualitative interviewing and proxy ethnography for data collection. The study focuses on the city of Aba waste workers and provides new insights into the role of informal waste workers in Nigeria. The focus in the case study has been metal wastes. The paper revealed that Circular economy of CDW in Nigeria happens through informal waste workers. Aba is an example of this process working well; however, the amount and type of reuse/recycling is undocumented and unrecognised. Building on the existing informal waste collection process in Nigeria may be more beneficial than trying to adopt the formal processes used in some other countries.

Waste Management and Circular Economy

#268 - Reducing Paper Waste within the Construction Industry using the Internet of Things

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Keywords : Construction Sites, Management Strategies, Quick Response Codes.

Abstract

Sustainable construction is pushing for the reduction of waste throughout the industry. One such waste is paper use, with the construction industry remaining largely manual and paper-based, despite the advancement of digital technologies such as the Internet of Things. This research aimed to investigate paper use within the construction industry and how the Internet of Things can be applied to reduce that usage. The literature review showed the construction sector lagged behind other sectors, such as healthcare, when it came to reducing paper use through the Internet of Things, costing construction companies annually in printing and managing paperwork. This research used a mixed-method approach, relying on a short survey of over 30 management professionals, and interviews with six people in high-level management positions in the province of Munster, Republic of Ireland. Results confirmed the overuse of paper on all sites that survey and interview respondents worked on, with 56% of survey respondents preferring hard copies of construction documentation over digital copies. Approximately, 57% of survey respondents had strategies in place (e.g., print policies, paperless meetings) to reduce that usage, with only 34% of all respondents believing those strategies were effective. All of those interviewed believed the use of quick response codes as part of an overall management strategy involving the Internet of Things can effectively reduce paper use on site. This is because quick response codes are easy to generate, can be linked to digital files and easily used to modify those files. Future research should focus on investigating the effect of each of these technologies and management strategies on paper use in construction.

#271 - Circular economy within the built environment: Clustering the strategies for new buildings and existing building stock

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Keywords: Built Environment, Circular Economy, Existing Building Stock, Material Passport.

Abstract

The increase in construction and demolition activities causes adverse environmental problems due to a decrease in natural resources and rapid growth in waste generation. Increment in these problems has encouraged researchers, producers, and policymakers to develop and apply innovative and sustainable solutions. This pursuit has led to the implementation of resource-efficient, zero-emission, and carbon-neutral strategies adopted by many industries. Within the last decade, the circular economy (CE) concept has gained importance as a sustainable innovative paradigm due to enabling resource conservation and sustainable waste management. After the European Commission (EC) released its first CE action plan in 2015, the transition to CE has started to be on the agenda of many industries, and the industries have focused on adapting this concept to their economic processes by setting up CE strategies. Furthermore, the circular economy (CE) concept has gained momentum as a new economic paradigm and become popular in the architecture, engineering, and construction (AEC) industry with its strategies applied from design and construction to deconstruction and end-of-life (EoL). Although there is a growing interest in exploring and implementing CE strategies, the articles pointing to specific CE strategies in the construction industry are still underexplored. Within this framework, this study aims to interrogate the various CE strategies related to the construction industry discussed in the literature. It evaluates the CE strategies obtained through a systematic literature review by clustering them for new buildings/existing building stock and meso/macro scale. Finally, the key strategies regarding the construction industry are listed and classified as design-construction-operation-refurbish-End-of-Life strategies for future studies. It is anticipated that CE strategies, both enhancing new kinds of designs for new buildings and evaluating material potentials of existing buildings, will enable minimizing construction-based environmental damage and encourage more sustainable construction.

#154 - Circularity in apartment building retrofit: exploring the potential of circular economy adoption through sustainable building rating systems

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Keywords: circular economy, apartment building, retrofit, sustainability rating systems

Abstract

Circular Economy (CE) is an emerging sustainability concept that is gaining traction for its potential to decarbonise sectors and adapt to climate change impacts. As the pressure to decarbonise by 2050 grows, the application of CE to buildings attracts increasing interest as the building sector accounts for 37% of global emissions annually, 20% of which is attributable to residential buildings. Retrofitting apartment buildings has been considered a key strategy to reduce the environmental impact of buildings, however, little is known about the potential application of CE in retrofitting existing apartment building stock. Sustainable Building Rating Systems (SBRS) has played a key role in introducing sustainability principles across industries in the building sector and have demonstrated influence in sustainable building design and practices. Recognising the relevance of SBRS, this research aims to understand how adoption of circular economy approach to apartment building retrofit can be enabled through existing SBRS in Australia. The research seeks to provide a preliminary assessment of the alignment of established SBRS applicable to apartment buildings with the prominent CE framework, the ReSOLVE framework. The results demonstrated the varying levels at which each of the ReSOLVE principles are covered by the indicators of the selected SBRS. The research also revealed important gaps in the ReSOLVE framework, corroborating the critique of circular economy's weak social dimension. The research suggests that in applying CE and the ReSOLVE framework in apartment buildings, the retrofit process and the participative nature it entails can strengthen CE's social pillar and consequently promote its wider adoption.

#252 - Improving the performance of recycled concrete for structural applications

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Keywords: recycled concrete, recycled aggregates, structural applications

Abstract

Concrete is the most widely used construction material in the world, and its use is projected to increase even more in the future. However, the production and use of concrete in the construction industry generates huge amounts of CO₂ emissions with currently used technology. The construction of concrete structures will also be made more difficult in the future because the aggregate traditionally used to make concrete is becoming increasingly difficult to obtain. Aggregate is a non-renewable raw material, its supplies are depleting and its extraction is increasingly energy-intensive and environmentally damaging.

Because existing concrete structures deteriorate over time, they will inevitably have to be demolished and end up as demolition waste. The disposal of concrete waste has also become a significant environmental problem, with the amount of concrete waste from the construction industry going to landfill increasing every year. For these reasons, a solution for the proper treatment and recycling of construction concrete waste is of increasing importance to society and the technological process of solving this problem should become a standard undertaking for the civil engineering profession.

For a wide range of industrial applications of recycled concrete, it is necessary to increase the performance of concrete products made from recycled ingredients. This not only concerns strength properties but also other characteristics such as durability and workability. To optimize the manufacturing process, it is necessary to improve the preparation and testing methodology prior to the concrete mix design. Based on the measurable properties of a given concrete waste raw material, even in the pre-processing stage, the composition of the recycled concrete mix can be optimized for specific applications.

This paper describes the applied testing and design methodology for a case study in Hungary and shows the potential structural applications of the recycled concrete produced.



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