

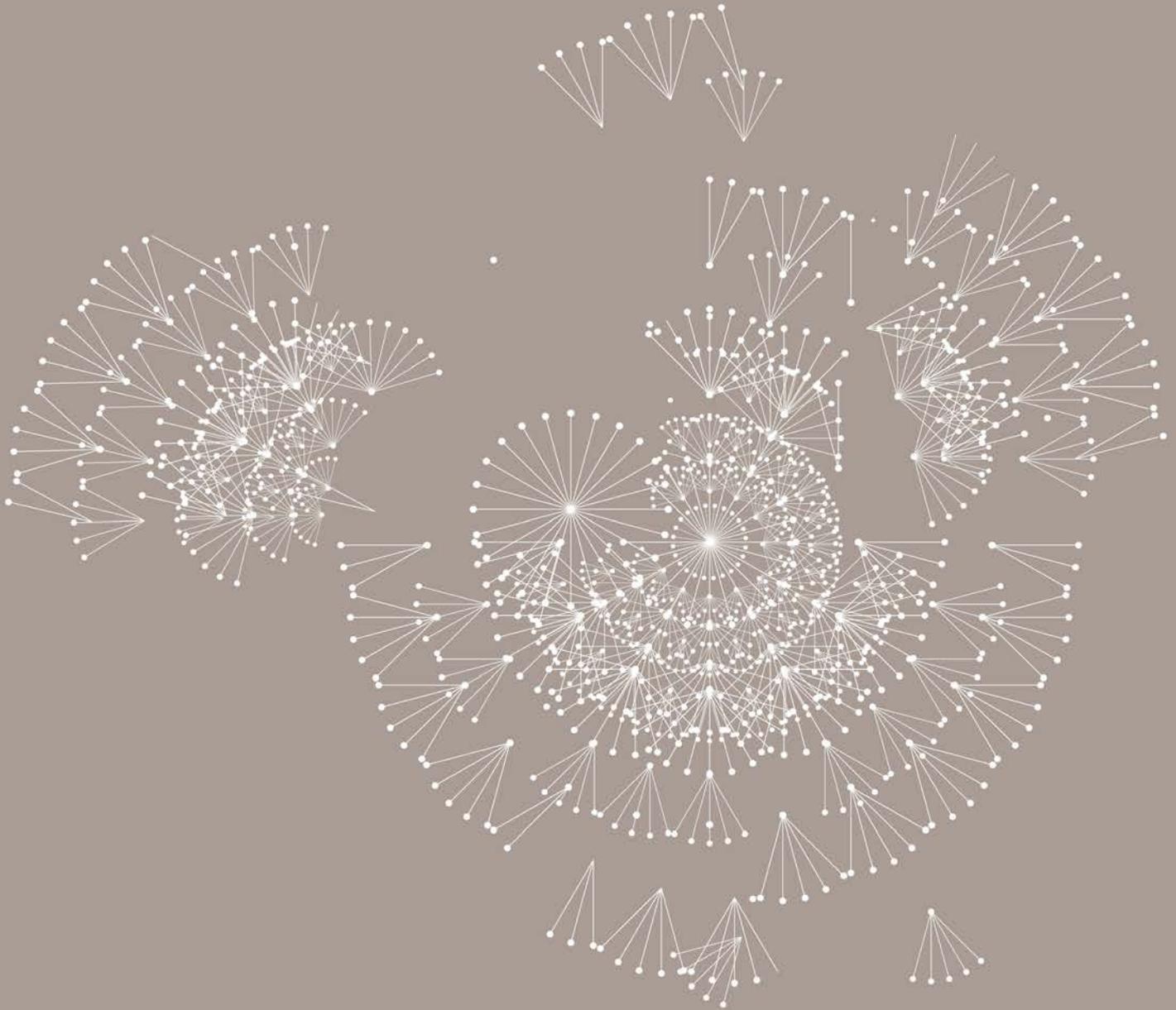
LEEDS SUSTAINABILITY INSTITUTE

# International Sustainable Ecological Engineering Design for Society (SEEDS) Conference 2017

Abstracts



Leeds Sustainability  
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**Sustainable Ecological Engineering Design for Society  
(SEEDS)**

International Conference

**2017**

September 13<sup>th</sup> and 14<sup>th</sup>

Leeds – Leeds Beckett University

United Kingdom

**ABSTRACTS**

**CITU**



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THE CHARTERED INSTITUTE OF BUILDING

## 2017 Conference Theme: **Healthy Environments, Buildings and Spaces**

The built environment has a greater impact on natural resources and produces more waste than any other industry. However, beyond the green rhetoric, research is being applied on the ground to address the balance between the built and natural environment. The International SEEDS Conference brings together experts from around the world focussing on the changes that are taking place and the benefits or consequences that are being predicted and measured regarding the built environment's impacts. As well as addressing technical issues, measuring energy efficiency and modelling energy performance, emphasis is placed on the health and wellbeing of the users of spaces occupied and enclosed. As guardians of nature and the environment, the Conference will also explore the areas we protect and preserve for greater natural environmental influence. Understanding how buildings and spaces are designed and nurtured to obtain the optimal outcome will be a focus of much discussion and debate. To embrace the knowledge, we also open up the conference for dialogue and research on education and training. This holistic approach draws together the research themes of energy, building performance and physics while placing health, wellbeing, ecology and education at the heart of the conference.

Through research and proven practice, the aim of the SEEDS Conference is to foster ideas on how to reduce negative impacts on the environment while providing for the health and wellbeing of the society. The professions and fields of research required to ensure buildings meet user demands and provide healthy enclosures are many and diverse. The SEEDS Conference addresses the interdependence of people, the built and natural environments, and recognises the interdisciplinary and international themes required to assemble the knowledge required for positive change.

### **The themes and topics covered by the papers include:**

Protecting nature and the natural environment	Planning and sculpturing positive change
Building and environment design	Reducing consumption and waste
Energy efficient modelling, simulation and BIM	Sustainability, ethics and responsibility
Integrating urban and natural environment	Behaviour change
Building performance, analysis and evaluation	Community building and masterplanning
Thermal comfort, air quality and overheating	Health benefits of alternative and natural materials
Green spaces, enclosures and buildings	Urban heat island and mitigation
Green technologies and IT	Building resilience
Energy flexibility	Sustainable cities
Energy behaviour and lifestyle	Zero energy and energy plus buildings
Dampness, water damage and flooding	Local producers and urban environments
Building surveys, thermography, building pathology	Trees and green city landscape
	Edible urban landscape
	Biomimicry and Biophilic Design
	Water and air quality Education & Training
	Renewable energy

**Conference Chair - Professor Christopher Gorse**

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## **Leeds Sustainability Institute**

The Leeds Sustainability Institute at Leeds Beckett university have hosted and supported this conference. Support has also been received from industrial partners, including **CITU** and the **Chartered Institute of Building** and we are grateful for this support.

The Leeds Sustainability Institute is a centre of research, informed and supported by business leaders, professional associations and community groups. Our research addresses the challenges of creating more sustainable places, communities and economies. Through the Institute a wealth of experience and skill is captured, with the potential to influence and shape the future via its networks and partners.

## **Welcome from Professor Chris Gorse – Director of the Leeds Sustainability Institute**

It's a pleasure to be able to welcome you again to the Sustainable, Ecological, Engineering, Design for Society Conference at Leeds Beckett University. This is the third year we have hosted the Conference and the quality and diversity of papers is as rich as ever. Next year the Conference will travel to Dublin, within the geographical reach of the British Isle's and ready to step to new continents in future years.

We are forming an international committee, with a new incoming Chair, Professor Lloyd Scott of the Dublin Institute of Technology. With the support of the committee we will see the conference travel, accumulate knowledge and improve accessibility. Each year it is gratifying to see the SEEDS community develop as it strives for joined-up thinking, challenging norms, and growing in its commitment for sustainability. Foremost, the community is moving forward, enjoying the connections between industry, academia and society and engaging in new perspectives and opportunities. While governments, worldwide, contemplate their position on sustainability, the United Nations Framework Convention on Climate Change remains firmly fixed on their commitment to reducing the anthropogenic impact. Notwithstanding the recent departure of the USA, the UNFCCC position has not been changed. From the strength, depth and quality of SEEDS papers and the posters submitted to the RISE awards, we are reassured that the academic and industrial sectors remain focused on a commitment to restore the balance. We look outward to expanding our knowledge of the global challenges.

Our international reach is important to SEEDS and Leeds Beckett University, as always we welcome our colleagues and partners from around the world. We extend a warm invitation to Leeds and hope that we develop relationships and knowledge that will take us forward with greater resilience as we tackle the pressing issues of sustainability. This year's conference received contributions from across the globe, including Australia, Finland, France, China, South Africa, Russia and Europe.

It is clear from the contributions that our research has advanced, the challenge of protecting the ecosystem and ensuring the world is a place where future generations can exist is now more demanding. We encourage everyone to share their thoughts, explore deeper and gain a better understanding of our world by listening and participating in SEEDS. We very much hope you enjoy our Yorkshire hospitality and we look forward to a rich and rewarding discussion.

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## **Healthy Environments: *Getting it more right this time*** **Guest Editorial Peter Skipworth**

Our built environment is the result of historical thinking. As thinking and knowledge develops we adapt the spaces we have, and think differently about the spaces we create. Our approaches mitigate the uncertainties of the future - this mitigation includes knowledge sharing and thought leadership.

### **The Contemporary Approach**

The contemporary approach to the creation of occupied space and facilities is to think first. Contemplating a range of different factors, this careful thinking is done on behalf of users and the environment at the very beginning of the development process.

The thinking takes in macro and micro considerations. Climate change, the need for sustainable energy use and minimum ecological impact influences the design of buildings. Along with this, there is the efficient utilisation of space and comfort of the users which influences how we arrange the internal space down to the chairs and the windows. We have a lot to think about.

Increased awareness of environmental issues has shifted the design of artificial environments to incorporate more, well-thought out 'green' and 'sustainable' practice. Environmental impact assessments have become wide-ranging, considering ecology and hydrology, through to air quality, noise and the impact on heritage assets to cite but a few.

When you consider the factors that have adverse impact to human health, the actual building design does not generally come to mind. As we are spending increasingly more time within artificial environments and engineered structures, health and wellbeing is being impacted. Human health is consequently becoming an important consideration in the thinking process behind design and development.

A broad definition of "healthy building" was first termed by Levin (1995) "*A healthy building is one that adversely affects neither the health of its occupants nor the larger environment.*" A building cannot be deemed healthy unless its impact on people and the surrounding environment are benign.

The contemporary, holistic, think-first approach to design stems from a more complete understanding of the requirements for 'healthy' building.

### **Historically**

However, this hasn't always been the case. Going back to the industrial revolution, the environment came a poor fourth behind profit, profit and profit - ranking alongside the wellbeing of workers.

Advances in the printing press, and the sharp increase in literacy increased education and learning. An understanding of the link between economic growth and the quality of people's lives developed, although this is now seen as lacking and has a closer correlation with the level of waste production than people's happiness.

Building safe, 'healthy' places must have been an aim for our early ancestors, creating shelter to protect themselves from the harshest of elements (Frumkin *et al.* 2012). This shelter not only played a key role in survival of humankind, but also in building and advancing civilisation. As we have developed better

materials and techniques, creating simple shelter transformed into creating buildings with specific functions, such as defence, worship and beauty.

As humans, we will always have a need for the built environment. Modern needs and deeper understanding has given way to a larger array of requirements, extending far beyond simply the need for shelter.

In an evolving technological world, sustainable design combined with innovative technology has the potential to help fulfil social, environmental and economic requirements (Loftness *et al.*2007). As we recognise the need for reducing our natural resource consumption and also how influential the built environment is upon our senses, it has become more important than ever to educate ourselves on the best approach to sustainably develop optimal artificial spaces.

### **Plotting a Course**

We know where we've been and know, or have opinions on, how we've arrived here. Naturally, we don't know fully where we're going. Even though we have a clear and present danger from climate change, and even though the printing press has been surpassed by much more efficient means of conveying information, we are still battling ignorance. And though we can have some cautious certainty that the combusting of fossil resources to service our energy needs will be largely a thing of the past by 2050, we still don't know exactly where we're heading or how to get there.

Good choices for the courses we take are better than course-corrections. People often talk about three industrial revolutions; the first using water and steam [fossil fuel] power to mechanise; the second using electricity [fossil fuel] to create mass production; the third using electronics and IT to automate production. The cleantech revolution is arguably correcting the errors of the first two revolutions. However, we didn't know what we didn't know back then, but we don't know what we don't know now.

As well as the environmental impacts of early industrialisation, the social impacts have begun to be better understood. Andre Norton (1983) thought the human race made a big mistake at the beginning of the industrial revolution, leaping for the mechanical things and missing that people need the use of their hands to feel creative. The "knowledge economy" addresses this with minds being substituted for hands in feeling creative.

### **Thought Leadership**

The future is uncertain and will likely be challenging, however with increasing technological advances and education there is chance to improve.

The uncertainty, the knowledge gaps, and the opportunity that we have to do it better this time underline the importance of thought leadership. Furthering understanding of the interdependence of people, the built and natural environments in the spaces we create and inhabit is made better sharing our intellects, experiences and learning.

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# **Healthy Behaviour, Safety and Wellbeing**

# INCENTIVISATION: HOW MOTIVATIONAL THEORY MIGHT REVEAL THE FLAWS IN CONTRACTING PRACTICE

**Bethany Piggott, John Heathcote and Peter Guy**

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**Keywords:** Procurement; Contracting; Incentivisation; Motivational Theory.

## **Abstract**

*Procurement and contracting is arguably a central component to the successful management of sustainable projects. The development of many contract strategies involve the management of the risk of the motivation of the contractor, through the mechanism of the performance clauses. Currently an assumption persists that these performance clauses will act to motivate the contracting partners to deliver a project to an expected level of performance in carrying out the work. That performance might be necessary for the project to achieve a sustainable outcome, (i.e. that the installed process will achieve a level of predicted output; or that the cost of installation on equipment will not exceed the business case estimates). This paper reports on research that utilised a focus group of experienced construction and engineering project managers, who were asked to examine this issue from their experiences in practice. The group presented a consensus that revealed that effective counter strategies existed in practice to negate the risk that client imposed performance clauses presented to the contracting body, thus challenging the efficacy of many project contract strategies; and consequently project performance in general. This paper examined contemporary motivational theories, and agency theory, to seek to explain the focus group's findings. Examining contract incentive clauses through the lens of motivational and agency theory allows for the inference that current approaches using performance clauses, aimed at the incentivisation of contractors, in construction and engineering practice, do not serve to incentivise/motivate the contractor and can act against the project's intention to create a sustainable project outcome. Projects that are specifically aimed at the utilisation of green technology and improved sustainability, (which often require a degree of careful feasibility evaluation), might be particularly vulnerable to this flaw in traditional procurement approaches. As all Projects should be seeking to create sustainable outcomes (HM Treasury 2013), this may be an issue of concern for the sustainability of all projects. Four hypotheses, for future testing, are proposed.*

# AN OVERVIEW OF FACTORS AFFECTING HOUSING ENERGY EFFICIENCY IMAGE

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**Keywords:** End-users' Perceptions, Architectural Principles and Physical Characteristic, Australian Housing; Energy Efficiency.

## Abstract

*The energy performance of the residential sector has a significant impact on the demand for energy in Australia. Given the developments in the construction industry, technology, and engineering, the main gap in enhancing the energy efficiency of the residential sector is the direction of housing development rooted in occupants' housing preferences. With respect to this critical role of occupants' preferences, the main question is how to deal with the diversity of occupants and their preferences, alongside their lack of attention to the environmental impacts of their housing choice behaviours. It is believed that explaining housing energy efficiency image as a collective conceptual picture of occupants' perception is a reliable methodology in developing a human-based action plan for improving the preferences. The main objective of this paper is, therefore, to address housing-related factors, which have the potential to represent the housing energy efficiency image as perceived by users. In responding to this aim, a literature survey was conducted of previous research works, categorising the environmental factors and the related physical characteristics based on their potential: to reflect end-users' perceptions; to impact energy efficiency; and finally to represent the environmental image. Eventually, a set of six categorical-based factors i.e. environmental quality, surface properties, elements, spatial layouts, formal cues, and architectural composition has been developed, consisting of 59 physical attributes.*

# UNDERSTANDING PERCEPTIONS OF ROAD NOISE POLLUTION IN THE URBAN ENVIRONMENT USING GIS ANALYSIS

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**Keywords:** GIS, Noise, Perceptions and Wellbeing.

## **Abstract**

*The aim of this research is to investigate what effects noise pollution and perceptions of noise (specifically road noise from busy transport hubs) have on the health and wellbeing of local people and communities. Access and use of quiet respite spaces will also be analysed, as well as the existing noise mitigation measures currently in place.*

*Noise pollution can have many impacts on an individual's physical health, mental health and their sense of wellbeing. This is particularly apparent within an urban setting, where factors including air and road traffic, trains and commercial work all contribute to increased noise levels. Effective management of these problems by local authorities can mitigate against future health impacts, and the effective use of green infrastructure can help to reduce the associated risks to both health and wellbeing.*

*The research methodology uses a wellbeing perspective, analysing an individual's perceptions of noise, as well as proximity and use of quiet spaces through the use of GIS analysis. Planning and management strategies associated with the worst affected areas will also be investigated, with a view to identify the policies that work, and those that don't.*

*A mixed methods approach is being adopted, using questionnaire surveys, GIS analysis, policy analysis and qualitative interviews. The research will utilise the Warwick Edinburgh Mental Wellbeing Scale (WEMBWS) as a measure of wellbeing, and this will be combined with specific noise related questions with an aim to obtain noise perspective information. The study area is based in East London, around the Poplar area and the A12, and participants are being selected using noise information from DEFRA, postcode and GIS analysis.*

## THE ROLE OF INTERIOR DESIGNERS IN CONSTRUCTION HEALTH AND SAFETY

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**Keywords:** Construction, Health and Safety, Interior Designers.

### **Abstract**

*Relative to other industries in South Africa and construction industries worldwide, the construction process generates a disproportionate number of fatalities, injuries, and disease, and both the direct and indirect costs contribute to the cumulative cost of construction.*

*Designers influence construction health and safety (H&S) directly and indirectly. The direct influence is because of design, details and method of fixing, and depending upon the type of procurement system, supervisory and administrative interventions. The indirect influence is because of the type of procurement system used, pre-qualification, project duration, partnering, and the facilitating of pre-planning.*

*The paper presents the results of a study conducted among interior designers in South Africa to determine their perceptions and practices relative to construction H&S. The following constitute the salient findings. Client satisfaction, quality, and time are more important to interior designers than construction H&S. A range of design related aspects impact on construction H&S. Construction H&S is considered frequently relative to 43% of occasions and 57% of design related occasions by interior designers. Experience predominates in terms of how H&S knowledge was acquired, and a range of aspects have the potential to contribute to an improvement in knowledge and the application of construction H&S.*

*The paper concludes that interior designers contribute to construction H&S, but that there is potential for and a clear need for enhanced contributions. Recommendations include the inclusion of construction H&S in interior designer tertiary education, and continuing professional development (CPD).*

# INTEGRATING CULTURAL ECOSYSTEM SERVICES (CUES) AND GREEN INFRASTRUCTURE (GI) DEVELOPMENT FOR ENABLING HEALTH AND WELL-BEING IN URBAN ENVIRONMENT

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**Key words:** Ecosystem Services, Green Infrastructure, Sustainability, Cities

## **Abstract**

*Several studies demonstrate that Cultural Ecosystem Services (CUES) derived from green infrastructure (GI) have direct and indirect impact and influence on peoples' well-being in cities. The lack of consideration of CUES in cities was reflected in the Millennium Ecosystem Assessment Report by United Nations which shows that the quality of CUES will be degraded by 2050 both in industrial and developing countries. In this context, the paper focuses on an innovative approach of integrating CUES in GI development to enable sustainable and healthy cities. Due to prolific urbanization, green infrastructure in cities are under immense pressure limiting their potential both in providing environmental sustainability and ecosystem services to urban communities. There is an urgent need for exploring innovative strategies for pressurized urban areas in effectively providing ecosystem services to promote health and well-being in cities. The paper examines the potential of largely neglected everyday loose spaces in urban environment that can be developed into a network of active green pockets. As the loose spaces are both inherently and implicitly connected to the everyday urban geographies, with appropriate planning and design, they can also become successful multifunctional social amenity spaces. Analysis and discussion are drawn from a review of creative projects of GI projects in cities and a renewed socio-spatial approach for integrating GI and CUES is presented. The paper will offer critical socio-spatial insights for architects, urban planners, engineers, urban designers and policy makers in developing GI in cities which not only focus on urban sustainability but also to enable health and wellbeing. The conclusions of the paper informs the ongoing research project in which the author investigates the innovative methods of improving socio-ecological resilience in Cambridge.*

## PERCEPTIONS OF DISABILITIES AND THE EFFECT IN THE DESIGN OF INCLUSIVE ENVIRONMENTS

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**Keywords:** Disability, Inclusive Design, Perceptions, Education.

### **Abstract**

*Individuals with a disability and/or impairment(s) have had a long history battling with acceptance in mainstream society, life as an individual with a disability has changed with time, for example; in the Babylon era births of children with congenial impairments were used to predict the future; in the Renaissance period in Europe physical beauty and perfection was revived, fast forward to today's time the United Kingdom hosted the Paralympic Games in 2012. What is deemed as acceptable and our understanding of the term "disability" has come a long way, important milestones have sometimes been achieved by way of protests and petitions resulting in legislation being passed.*

*Designing inclusive buildings and the environments surrounding them is largely directed by the designer's education, subconscious thoughts and ideas. In recent times the UK government and design bodies have hoped to direct inclusive design by introducing new, and fortifying existing legislation in conjunction with the Department of Work and Pensions rectifying and training professionals in understanding disability and to learn key skills when designing inclusive spaces.*

*A qualitative method has been used in the form of questionnaires distributed via social media inviting professionals of the architecture and construction industry to partake in the research.*

*The aim of this research is to explore perceptions within the architecture and construction industry and whether it has an affect when designing inclusive environments.*

*The questionnaires concluded that preconceptions of disabilities within the architecture and construction industry do exist and education plays a dominating factor in changing our thought process.*

*Moving forward it is recommended to carry out further investigations to establish how the preconceptions have formed and to evaluate the Built Environment Professional Education Project (BEPE) and its integration in higher education.*

# HOW ART POVERA CAN USE RECYCLED PACKAGING TO CREATE USABLE EVERY DAY PRODUCTS AND OBJECTS OF ART

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**Keywords:** Recycling, Plastic Packaging, Art Povera, Local Materials.

## Abstract

*The UK alone produces more than 170m tonnes of waste every year, much of it food packaging. While it has revolutionised the way we store and consume food, there is now so much of it that landfills can't cope. It can take 450 years for some types of plastic bottle to break down; one type, PET, while recyclable, doesn't biodegrade at all. And yet only a third of plastic packaging is recycled, (The Guardian, 2017).*

*Europe recycled 5.4million tonnes (35%) of plastic packaging in 2012, 35% was incinerated and used as heating and generating electricity, the balance going to landfill. (European Plastic Recovery Organisations, 2013).*

*However, more than a third of the waste paper and plastic collected by authorities and big business is being sent 8,000 miles and further for processing by other countries.*

*This paper explores how, by revisiting our past use of local materials and the application of Art Povera, much of landfill plastic can be made into usable objects of Art.*

# **Energy, Environment and Sustainability**

# ECONOMIC COMPARISON OF DOMESTIC RENEWABLE ENERGY TECHNOLOGIES

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**Keywords:** Whole life cycle model, PV and Wind turbine systems, domestic scale.

## Abstract

*Throughout the life of a building, operational costs can be significant and clients may require estimations of potential future outlay. Whole life cycle cost (WLCC) models can help forecast the operational and maintenance costs to give clearer client expectations and manage financial risk.*

*The EU drive to include renewable energy technologies in development, such as solar photovoltaic and wind turbines suggests that renewable energy technologies are beneficial for reducing energy costs for consumers and energy use for the host country. However, there are questions whether the financial performance over time meets levels of expectation.*

*The aim of this research was to develop a WLCC prototype to test the life cycle costs of renewable energy technologies, and carry out an initial comparison comparing costs of a limited number of domestic-sized solar photovoltaics and wind turbine systems, using field designs and operating costs.*

*To develop the WLCC prototype, a theoretical dwelling for comparison of the systems was defined, (located in South Yorkshire, UK) and the prototype tested and refined for the application of the two technologies. Cost data received from manufacturers and installers was used for the prototype input data, including assumptions and variables. The finished WLCC prototype was used for a comparable analysis using meter and bill data received from six property owners.*

*Gaps in performance between predicted and actual costs were recorded. Extrapolating the data over 50 years, including maintenance and running costs, resulted in predictions of some financial viability for PVs but not for smaller wind turbines.*

## **HUMAN IMPACT ON THE EARTH AND SUSTAINABILITY**

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### **Abstract**

Much of the current news about the future sustainability of our planet tends to focus largely on carbon dioxide and global warming, and this has been the situation for at least the past two decades. However, carbon dioxide emissions are not the only anthropogenic impact upon our world. For over 10,000 years – the Holocene era – the climate and weather conditions on our planet have been remarkably stable. This state of affairs is now beginning to change; so much so that Paul Crutzen suggests that we are entering the Anthropocene era.

Professor Johan Rockström, director of the Stockholm Resilience Centre, Paul Crutzen and others convened a group to look at this whole area of human impact. Their report was published in 2009, and in it they identified nine areas of concern, including carbon dioxide and global warming. The aim of this paper is quickly review these nine main areas of anthropogenic impact identified by the Stockholm Group, and to identify some of the connections between them. Hopefully, this will provide some helpful background for the papers presented at the 2017 SEEDS conference.

Recent literature is reviewed and put into context, including some more recent publications than those available to Rockström's group in 2009 and mentioned in their report. The paper shows that the areas of impact identified are indeed very important, many being linked intimately with carbon dioxide emissions and global warming. Engineers need an awareness of the impact of these various topics when making design decisions for buildings and infrastructure.

**Key words:** Global warming, biodiversity, toxic substances, water supplies, ocean acidification.

# LET THERE BE DARKNESS - LED SECURITY LIGHTS EFFECTS ON TREES AND GREEN CITY LANDSCAPE: HUMAN AND WILDLIFE CIRCADIAN RHYTHMS, MENTAL WELL-BEING, ROAD SAFETY AND THE VIEW OF OUR NIGHT SKY

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**Keywords:** blue-rich LEDs, HPS lamps, well-being, circadian rhythms.

## **Abstract**

*There is a growing trend for urban areas in the UK, USA and elsewhere to change over-roadway and residential lighting from high-pressure sodium [HPS] to blue-rich LEDs, often simply on the basis of saving energy, yet without health- or environmental-impact assessments. The views presented in this paper are from a historical perspective based on research conducted by the author in the City of Chicago. A literature review was also conducted of research that showed blue-rich LEDs' effect on human health and well-being, wildlife circadian rhythms, road safety and the view of our night sky. Studies also now provide evidence on a national scale of the relationship between the amount of artificial night-time light and budburst in woodland trees.*

*The purpose of this paper is to raise awareness of the potential impact on urban and rural areas of blue-rich LEDs to ensure that city designers and arbourists make informed decisions about the choice of street and road lighting. It is not a newly discovered problem that there are harmful effects of street lighting as botanists were made aware of the deleterious effects of incandescent street lighting on trees 81 years ago by Matske in 1936. Horticulturalists learned of such effects on both wild and domesticated plants from research by Cathey and Campbell in 1975.*

*Research in 1974 by the Chicago Audobon Society and District 14 Environmental Education Project was ignored. The City installed HPS lamps primarily based on the report of a consulting arbourist, and the HPS lamps were more energy efficient, yet 11% failed after 13 months. There were effects on young trees, with 60% of a group of saplings suffering death or damage to growth over their first spring and summer. The Chicago politicians installed the street lights to show residents the city was taking proactive steps to address our primal fear of darkness, and the idea that lighting systems would reduce crime was politically popular.*

*Research has shown that making choices about the kind of roadway lights we use, simply on the basis of energy consumption, is shortsighted. Energy-saving measures need to be linked to health and ecology considerations. Soybean farmers learned not to plant in fields adjacent to HPS roadway lighting. The night-time illumination can reduce crop yield by 20–40%.*

*In the UK, Public Health England recommend using CCT 2700K blue-rich LEDs to minimize glare and discomfort. Street lighting should be tested 'in situ' before a lighting scheme is rolled out to ensure it does not cause harm to human well-being, trees and wildlife. It is crucial that local communities be involved in deciding how streetscapes, including trees and lighting, are planned, managed and maintained.*

# **Analytics, Education and Sustainability**

# EXAMINING VIGNETTES IN AEC RESEARCH – HOW ARE THEY USED, AND WHAT ARE THEY GOOD FOR?

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**Keywords:** Research Methods, Sustainability, Vignettes.

## Abstract

*Prominent concerns of the SEEDS research community revolve around the intentions, ethics, behaviours and standards of designers, constructors and users of our built assets. One way of examining such ‘approaches’ is through the application of well-considered vignette type questions embedded within appropriate research instruments. The vignette technique presents research participants with a credibly constructed ‘hypothetical’ scenario that facilitates reflection, and can potentially reveal normative behaviours, specifically ‘how’ participants would react in such circumstances. An appraisal of the typical research methods used in the Architecture, Engineering and Construction (AEC) literature reveals an apparent underuse of such a data collection technique, and a systematic type literature review reveals several other uses of the term. The aims of this work are to explore the use of vignettes across the wider AEC literature, introduce the usefulness of vignettes as a data collection tool, and consider their suitability for the purposes of the agenda of the SEEDS community. The work concludes with the inclusion of an exemplar ‘ethical dilemma’ vignette to demonstrate the technique and a call for greater use of more ‘sustainability focused’ vignettes, in future empirical research work.*

# UNDERSTANDING THE FACTORS CONTRIBUTING TO THE ADOPTION OF SUSTAINABILITY IN SUB-SAHARAN AFRICA – A SCOPING STUDY REVIEW

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**Keywords:** Sustainability, Sub-Saharan Africa, Methodology, Grounded Theory.

## Abstract

*Sustainability in the built environment is a key topic of discussion due to the adverse impact buildings have on the environment. This has propelled many countries to put in place sustainable development measures. This has however, been met with challenges in developing countries, primarily in Sub-Saharan Africa (SSA). SSA has a history of endemic energy crisis, despite its abundance of renewable energy resources. Reflecting this is the heavy reliance of fossil fuels for power generation in SSA countries. The findings reported in this paper form part of a wider study on the perceived barriers to sustainability by built environment professionals in SSA, with specific focus to use of renewable energy source (RES) for power generation in buildings. This paper focuses on the identification of a suitable methodology, which takes into consideration the distinctive characteristics of the SSA context for enquiry through the adoption of a scoping study review. The study addresses the concerns of methodology selection and application by reviewing strategies and methods adopted by past and current enquiry in SSA, which have primarily been aligned with theories, frameworks and research in developed countries. This is of importance due to the impact contextual, subjective and other factors can have on the outcome of enquiry as evidenced by previous research in literature.*

*The purpose of this scoping study review was to provide a comprehensive overview of the available relevant research on barriers to sustainability in SSA, which focused on study designs with empirical evidence, which would aid in informing the selection of a methodology suited for studies specific to the context of SSA. The scoping review is underpinned by Arksey and O'malley five-stage framework. The results indicate that there is a need to view SSA as a distinctive case based on its context and other characteristics, which will influence its research outcomes. Based on the review, it is suggested that grounded theory method is a suitable approach because it will take into consideration the wider context.*

# EXAMINING THE EFFICACY OF AGILE METHODOLOGIES FOR PRODUCT DEVELOPMENT

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**Keywords:** Project Management, Agile, Product Development, Innovation.

## **Abstract**

*Project Management as a profession has developed a plethora of 'Agile' approaches to project development and implementation. These tend to involve an iterative development using a phased set of prototypes and tend to enjoy uptake in Information Technology projects, new product development and are utilised in business change projects where benefit outcomes might be less tangible. There is much debate in professional project management circles about the value of 'Agile' project methodologies, and a significant amount of this is bias promotion. This study sought to determine whether Agile methodologies could offer any identifiable advantage over 'waterfall' methods. ('Waterfall' methodologies are so termed to identify them as separate, distinct and preceding, class of project methods. Waterfall is characterised by a linear stepped approach, with the project being developed in stepped phases).*

*The study utilised a single case study organisation and looked at a set of product development projects where an 'Agile' methodology had been recently introduced. This allowed the researchers to examine how the 'Agile' approach had influenced the perception of new product development projects. Structured interviews were used in conjunction with a semi-structured questionnaire, this allowing the researchers to reach a wide group of project managers.*

*The research demonstrates the variability and key factors that might be associated with 'Agile' and reveals to an extent issues with its adoption. Within the case study the Agile concept appears beneficial, but what might be revealed is that the iterative, recursive and flexibility of thinking across the organisation is what is important, in respect of project development, rather than the Agile methodology itself.*

# **Building Performance, Assessment and Evaluation**

# LIFE CYCLE COSTS ASSOCIATED WITH BUILDING FAILURE IN COASTAL AREAS

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**Keywords:** Building Failure, Building Performance, Coastal Areas, Life Cycle Costs.

## Abstract

*This study builds on the ongoing discourse centred on enhancing building performance within the context of the natural environment. This is against the backdrop of the contextual nature of Life Cycle Costing, which poses difficulties in applying the evidence provided in different studies, to provide generalizable financial justification to clients, of the need to invest adequate funds at the front-end of project cycles. This study provides an interpretation of life cycle cost analysis, directly applicable to building construction in coastal areas located in a tropical wet humid setting. The study highlights possible failure patterns, using Bonny, an archetypal coastal town which lies along the Nigerian Atlantic coast line, as the study area. A survey of fifty buildings based on physical observation, reveals problems of rain penetration, rising damp, metal work corrosion and biological attack on wood work. The fundamental environmental triggers and design optimisation technicalities, necessary to forestall the manifestations of failure are identified. Further to this, a comparative initial construction cost and life cycle cost analysis is computed for two alternative building schemes with identical floor plans for the construction of a 4-bedroom bungalow. Scheme A using sound construction and detailing to guard against future maintenance problems, and scheme B adopting the typical designs evident in the area. The result of the analysis shows that in the long run scheme A is financially more favourable than B, as the increased initial costs are entirely offset by reduced running costs. The outcome of the analysis provides sound financial justification for developers, reinforcing the argument that adequate financial provision should be made during budgeting, to cater for relevant preventative measures in the specification of material requirement, suitable to the wet humid conditions of the region.*

# COMMUNITY ENERGY STRATEGIES FOR REGISTERED SOCIAL LANDLORDS IN WALES: AN INTRODUCTION TO THE RESEARCH

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**Keywords:** Community energy, housing associations, organisational change, sustainable regeneration.

## Abstract

*In Wales, registered social landlords (RSLs) are key to the Welsh Government's agenda for the sustainable regeneration of communities, including meeting the Wellbeing of Future Generations (Wales) Act (2015). This paper sets out the first author's Professional Doctorate in Sustainable Built Environment (D.SBE) project, undertaken at his employer: Coastal Housing Group (CHG), Swansea. CHG manages over 5000 residential properties and develops 120+ dwellings annually for rent/low-cost sale, and urban located commercial units. In addition, CHG also contributes to community development and regeneration through targeted recruitment and training placements in its procurement. Since the uncertain political and economic climate in the UK could continue for the foreseeable future with BREXIT negotiations and political cycles in the UK and throughout Europe, there is pressure for RSLs to deliver greater services to ensure that sustainable development is a priority, ensuring communities are able to weather the coming years' unpredictability.*

*The D.SBE project is investigating and evaluating the barriers to change within CHG to establish initiatives for social responsibility, such as community energy generation and storage schemes. The research methodology includes a systematic literature review to identify the 'gap in practice' and the challenges facing organisations, such as RSLs wishing to engage with community energy. The findings will be used to develop a community energy strategy for CHG and action research will be adopted to pilot and test within the organisation and with stakeholders; and to apply to case studies of new and existing communities. Part of the evaluation will include embedding of new learning and ways of working to enable CHG to become more flexible and adaptable in the future, and thrive in order to continue serving its communities in the years to come.*

*This paper will be of interest to those involved in the affordable housing sector moving towards more resilient sustainable communities, and becoming more autonomous in their operation. The outcomes could be transferable to other UK RSLs.*

# USING CONVENTIONAL REMOTE CONTROLS TO PROMOTE HOME AUTOMATION

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**Keywords:** Home Automation, Usability, Conventional Remote Control, Energy Efficiency.

## Abstract

*Building automation (BA) is an important field of research not only due to the services it provides to residents (e.g. security, convenience and comfort) but also to the sustainability benefits it can create across three pillars of sustainable development: environmental, economic, and social. These technologies enable residential and commercial building to improve energy and resource efficiency. In doing this, they can significantly contribute to saving costs, reducing CO<sub>2</sub> emissions and providing enhanced living and working environments. In spite of these benefits and that different technologies have been available for many years, home automation (HA) has not been widely adopted. A major barrier to this adoption is the complexity and lack of usability of today systems' user interfaces (UI). The aim of this study is to enhance usability of home automation systems (HAS), thus contributing to a better adoption of HA, based on the inclusion of conventional remote controls into systems that are usable only via web-user interfaces or smartphone applications. In the first place, questionnaires are conducted with the purpose of discovering if users tend to control their home appliances and technical devices typically with conventional remote controls or more advanced techniques. Subsequently, a current HAS is implemented in such a way that it can be controlled by conventional remote controls, in addition to their typical UIs. In the end, the usability of the system is assessed using heuristic evaluation and usability testing methods. The results show that conventional remote controls do improve the usability of HAS, at least for simple daily tasks.*

# IMPROVING HEATING EFFICIENCY OF RESIDENTIAL BUILDING AUTOMATION SYSTEM THROUGH SMARTPHONES - GERMAN USE CASE

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**Keywords:** Building Automation System, Smartphone, Heating Efficiency, User Context.

## Abstract

*The residential sector represents a big part of the energy consumption. In Europe, households represented 25% of the total energy consumption in 2014. Furthermore, the International Energy Agency in 2013 established a goal of 77% reduction of the carbon footprint when compared to 2050. One approach for saving energy is by introducing Building Automation Systems (BAS) which can reduce the residential carbon footprint by 38% in the German scenario. User-context detection can help to improve the overall carbon savings from BASs, and smartphones can be used for user context detection. In this paper, a smartphone was integrated to a BAS, in order to explore its benefits by increasing heating efficiency in residential BAS. Besides that, lights, and some appliances in the house were also controlled by the use of smartphone sensors such as: GPS, infrared, light, accelerometer and gyroscope. The following user contexts were identified: user presence, sleeping, awakening, and partying. In order to compare the heating efficiency of the current system, the heater response was simulated for three scenarios: fixed schedules, presence detection by motion sensor and exit button, and absence of controllers. Results show that the introduction of smartphones in BASs can be up to 50% more efficient when compared to other scenarios.*

# AN ASSESSMENT OF THE QUB METHOD FOR PREDICTING THE WHOLE BUILDING THERMAL PERFORMANCE UNDER ACTUAL OPERATING CONDITIONS

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**Keywords:** QUB method, Heat Loss Coefficient, in situ measurements.

## Abstract

*The performance gap between the design and the as-built thermal performance of buildings is an issue of high importance for the construction industry and reducing this gap has been the subject of significant research. Assessing the design of thermal performance is straightforward; however estimating the as-built performance of a building presents several technical challenges that often restrict its wider implementation. One of the most common challenges is the time required to perform such testing. The QUB method is a transient method developed to estimate the Heat Loss Coefficient (HLC) in a single night without occupancy. The ability of the method to provide reliable results was demonstrated experimentally in a climate chamber with controlled conditions in a previous work.*

*The work presented in this paper reports on the findings from a long-term field study conducted in order to assess the applicability of the QUB method under actual operating conditions and to identify key parameters that may affect its performance. A series of tests were performed during the whole heating period in a detached house located in the University Park campus, University of Nottingham considering two distinct conditions: as-built and with increased air tightness. The results suggest that the QUB method was able to estimate the HLC of the house with reasonable repeatability in both cases. The reliance of the results to the experimental conditions that may affect the test is also discussed in order to improve the robustness of the method.*

# THE THERMAL ASSESSMENT OF HISTORIC SASH WINDOWS: A CASE STUDY OF A HISTORIC BUILDING IN THE NORTH OF ENGLAND

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**Keywords:** air leakage, draughts, historic windows, thermal performance, thermography

## Abstract

*Windows represent one of the largest contributors to heat loss in historic buildings. This study evaluated the thermal performance of sash windows in an historic Educational building in north of England, using a thermal camera, hotwire anemometer, heat flux plates and temperature sensors. A case study building was selected where the test sample improvement options to the sash windows were already installed. The installation of the upgraded windows made it possible to observe, as well as measure, the windows' in situ performance under normal operational conditions. Four trial sample window options were used, which included: secondary glazing, draught proofing, double glazing and solar film in addition to the trial control window to which no intervention was undertaken.*

*Surveying and measurement tools were used to examine thermal performance and air leakage. Supported with the use of a blower door, to create a pressure difference, thermography made it possible to identify the cold air entering through the windows. The anemometer was useful in determining the presence of the draft, but was not accurate in measuring the velocity of the draft. The in situ U-values taken using flux plates which provided comparative information on how the window performed, with heat flow measures being undertaken simultaneously. These heatflux data were used as an indicative measure across the windows that were monitored; however, due to the limited period available to monitor the windows (between room occupation), the heat flux measures were not accurate enough to obtain what would be considered reliable U or R values. Thermography was found to be the most useful method to assess windows, since it gave more information about the distribution of temperature around the window surface area, and also helped to locate draughts around the frame edges.*

# VIABLE OPTIONS FOR PROVIDING LOW CARBON HEATING AND HOT WATER IN NEW HOUSING

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## **Abstract**

*Although the heat-loss in new dwellings in the United Kingdom is small in comparison to older properties, there is still a significant energy requirement for heating and hot-water. In order to meet the government's Carbon reduction targets for 2020 and beyond robust low-carbon solutions are required for provision of heating and hot-water in new housing stock. This paper looks at the viable options for this.*

*The prospective energy requirements for heating and hot-water have been modelled for sample house types built to current Building Regulations and to Passivhaus standards and the results used to analyse the input energy and associated carbon emissions for a range of heating and hot-water options.*

*The study reviews community heating system solutions as well as systems suited to individual dwellings and includes those with renewable energy content such as heat pumps and biomass. Available data from energy monitoring has also been used to take into account the performance gap on systems in the real-world. The study concludes that investment is needed to develop and manufacture solutions for social and private housing that are both effective and affordable.*

# ENERGY ASPECTS OF DEFAULT HEATING PROGRAMMER SETTINGS

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**Keywords:** heating controls, performance gap, programmable thermostat, default settings.

## **Abstract**

*It is widely observed that there is a difference between the actual energy consumption of domestic buildings as measured in use compared to that predicted at the design stage. This is generally known as the 'performance gap'. This discrepancy is a concern for those involved in low energy building design as it means that targets set at the concept stage of a development on aspects such as reduced CO<sub>2</sub> emission rates are not realised in practice. A number of factors are involved in creating this difference in performance. Two key areas are variations in build quality compared to design intentions especially in the area of insulation and air tightness and also differences in the way that occupants interact with their buildings on aspects that affect energy performance. It is this latter aspect that is the focus of the research presented here. It involves a survey of the central heating programmers currently available on the market and in particular the default programmes that are factory set in to these devices. Whilst these settings should be reconfigured during installation and commissioning in conjunction with the requirements of the homeowner, it is possible that they will be the basis for operation for many years following installation. The default settings are looked at here and the information given will be of use to those involved in thermal modelling of building energy consumption and issues of human interaction with building services.*

# **Design, Planning and Urban Heat Islands**

# MAPPING SOCIO-ECONOMIC BARRIERS TO THE IMPLEMENTATION OF ENERGY EFFICIENCY POLICIES IN THE UK BUILDING SECTOR

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**Keywords:** energy efficiency, barriers, energy policy

## Abstract

*In 2015 the UK building sector accounted for 43% (29% domestic, 14% commercial) of the national energy consumption, thereby positioning this sector as critical in meeting national energy efficiency targets. However, barriers to energy efficiency are vast and complex, and overcoming them is a key challenge for effective implementation of energy efficiency policies. This paper describes the findings from a review of literature and an expert survey to map and assess the key social, cultural, educational, economic and institutional barriers (in terms of small, medium and high impact) to implementing energy efficiency policies across the UK building sector.*

*Overall the barriers are found to be strongly linked with consumer behaviour. They are often highly complex with multiple inter-relations. The barriers with the highest impact comprise the undervaluing of energy efficiency, lack of motivation and inertia within consumers/end users, infrastructural and planning barriers to medium sized energy projects as well as practical and construction-related barriers such as a lack of skills and adequate standards. Economic barriers such as upfront/capital costs and the lack of adequate or misaligned financial incentives also appear to be significant. Surveys of experts showed that the top two most important barriers in the building sector to overcome were the socio-economic status of building users (11.7% of experts) and lack of funds or access to finance (10% of experts). Although there are several UK policies that aim to target some of these barriers, a number of the UK's energy policies (Green Deal, Zero Carbon Homes) have recently been scrapped, and consultation is out on how to proceed in terms of the UK national energy efficiency policy within this sector.*

# **Green Digital Infrastructure, Networks and Technology**

## GRID METRICS FOR MONITORING GREEN NETWORK

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**Keywords** : Smart Grid Metrics, Green Networking, MIB, Sustainable IT Network, Network Management.

### **Abstract**

*Current modeling designers of large-scale complex network systems are becoming more concerned with the energy consumed by the network infrastructure. Such concerns conceived technologies like Energywise with its management information base (MIB). However, while research efforts are relatively recent in IT network research, energy consumption patterns have been heavily studied in the area of power generation in the electric grid. Recently, the electric grid has integrated intelligent ICT based monitoring and control capabilities which forms today's Smart Grid technology. This convergence enabled clear visibility, control, and monitoring of the energy use and provides real time information and data for energy consumers. Smart Grid research induces metrics that are used for data collection such as the real-time energy cost, latency, reliability, cybersecurity, renewable energy, and CO2 emissions.*

*This paper proposes to identify and implement smart grid metrics into the architecture and design process of communication networks in order to achieve higher sustainability and efficiency. To date, Energywise MIB designed by Cisco gathers information for monitoring and controlling energy in communication network infrastructure. However, energy is not the unique indicator to be considered for greening a network. Thus, the objective of this paper is to propose an extension of Energywise MIB that includes other metrics covering all the facets of sustainable development directly available from smart grids.*

# AN SDN PERSPECTIVE TO MITIGATE THE ENERGY CONSUMPTION OF CORE NETWORKS – GÉANT2

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**Keywords:** Software Defined Networks, Energy Efficiency, Network Control, Core Network, GÉANT Network, Energy-aware routing.

## Abstract

*The dense usage of networks in peak times forced network designers to over-provision resources to satisfy the needs during these specific times. Resources such as bandwidth, processing power, and memory are prepared oversized to handle high traffic loads, however, most of these devices are underutilized during the non-peak times and this unlocks the potential to optimize the energy consumption of the resources proportionally to its actual traffic utilization. Due to the vertical integration of the control and data plane in the conventional network, managing the network is challenging. The Software Defined Networking (SDN) is a novel networking approach, which provides a programmable and logically centralized control plane, separating the network control from the forwarding devices. Thanks to the features introduced by SDN, the decisions for the network such as routing and forwarding are made globally. In this paper, considering GÉANT network, we proposed a method by which we can remove up to 41% of the link during the peak time traffic and save energy consumption consequently.*

# ENERGY CONSUMPTION IN SMARTPHONES: AN INVESTIGATION OF BATTERY AND ENERGY CONSUMPTION OF MEDIA RELATED APPLICATIONS ON ANDROID SMARTPHONES

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**Keywords:** Smartphones, Energy Consumption, Battery

## Abstract

*Modern smartphones have become indispensable for many people around the world as they continue to evolve and introduce newer functions and operations. Battery capacity has however failed to keep up with the rate at which smartphones have evolved in recent years, which has led to rapid battery drain and the need for users to discard and replace them very frequently. This inevitably leads to increased greenhouse gas emissions and harmful consequences the world over due to poor disposal and reuse practices among users.*

*Using the Samsung Galaxy Note as an android platform for experimentation, the factors most responsible for energy consumption and battery drain in smartphones are identified as the network, the device specifications, the applications on the device, and the common practices by the smartphone user. Interviews conducted with varied respondents further reveal that user practices impact energy consumption in smartphones more significantly than perhaps all the other factors.*

*It is recommended that information be better conveyed to smartphone owners, while smartphone manufacturers should improve their design specifications in keeping with the Green Code. Further study is also suggested to distinctly clarify the impact of the stated factors on smartphone battery drain.*

# PROMOTING GREEN TRANSPORTATION VIA PERSUASIVE GAMES

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**Keywords:** Persuasive Design, Transportation Mode Detection, Serious Games, Sustainable Behaviour

## **Abstract**

*It is now widely accepted that human behaviour accounts for a large portion of total global emissions, and thus influences climate change to a large extent (IPCC, 2014). Changing human behaviour when it comes to mode of transportation is one component which could make a difference in the long term. In order to achieve behavioural change, we investigate the use of a persuasive multiplayer game. Transportation mode recognition is used within the game to provide bonuses and penalties to users based on their daily choices regarding transportation. Preliminary results from testers of the game indicate that using games may be successful in causing positive change in user behaviour.*

# DEVELOPING A MODEL FOR EVALUATION OF SUSTAINABILITY PERSPECTIVES AND EFFECTS IN ICT PROJECTS

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**Keywords:** Sustainability perspectives, Evaluation model, ICT projects, PERCCOM programme

## Abstract

*Today's world has a new important agenda: tackling environmental issues and adopting environmentally sound practices in all industries. However, achieving sustainability is challenging because, it needs significant changes in legislations, business models, processes and human behaviour across the whole world. In this context, ICT arises as an important enabler to interconnect these elements through software-intensive systems and deliver up to 15% of total world emissions savings by its enabling effect on other industries. This paper evaluates the focus and effects of various ICT projects on sustainability. For this purpose, different perceptions of sustainability are studied and a model is proposed for evaluating different dimensions in existing ICT projects. In this study, a literature based model is applied to analyze the thesis projects of the first year students in an ongoing Erasmus Mundus Master programme focused on pervasive computing and communications for sustainable development. The outcome of this model-based analysis will provide better understanding of the sustainability perceptions within the selected ICT projects.*

# GAMIFIED PARTICIPATORY SENSING FOR SUSTAINABILITY: AN ICT TOOL FOR LAKES MONITORING

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**Keywords:** Participatory Sensing, Gamification, Public Engagement, Motivation, Water Observation

## Abstract

*Participatory sensing is the concept or practice whereby individuals or publics using information and communication technologies (ICTs), such as mobile phones, contribute to data collection, analysis and sharing of knowledge. In this paper, a gamified mobile application aimed to involve citizens to monitor lakes is presented. This application represents an example of ICT for greening, which addresses an environmental issue by actively boosting citizen stewardship via embedded gamification mechanics such as challenges, achievement, storytelling and feedback.*

# GREENMED: A SUSTAINABLE PHYSICAL ACTIVITY TRACKING APPLICATION

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**Keywords:** Physical Activity Tracking Application, Android Fitness APIs, Animal Representations.

## Abstract

*Evidence suggests that physical activity brings substantial health benefits while its absence causes several health issues. As people become more aware of negative health outcomes associated with physical inactivity, the shift from sedentary lifestyles to healthier ones occurs, and physical activity tracking apps may help in this regard. While mobile applications for tracking physical activity are abundant, most of them fail to deliver evidence-based recommendations. This is a major drawback especially when these apps are designed to guide users towards healthy lifestyles. This paper presents a prototype application that could provide evidence-based recommendations about how much physical activity adults should do to stay healthy according to user's current activity level. A new visualization approach which uses animal representations for activity levels is also introduced to enhance user experience, increase motivation and create a good base for further integration of gamification principles. Early testing showed that users found the prototype very useful and expressed great interest towards the animal representations.*

# FRONT-END DEVELOPMENT FOR HOME AUTOMATION SYSTEMS - A DESIGN APPROACH USING JAVASCRIPT FRAMEWORKS

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**Keywords:** Home Automation, User Interface Design, Web Application development, User-Centered Design.

## Abstract

*Automation technologies are widely acclaimed to have the potential to significantly reduce energy consumption and energy-related costs in buildings. The energy consumption of buildings represents in average a total of 41% of the energy usage in the European Union (EU) and from this lot, residential buildings accounts for 65.9% of the total energy usage of EU buildings and 27% of the total energy consumption in the EU.*

*However, despite the abundance of commercially available technologies, automation in domestic environments keeps on meeting commercial failures. The main reason for this is the development process that is used to build the automation front-ends, which tend to focus more on technical aspects rather than on the users' needs.*

*On the other hand, developing a usable and interactive interface is a complicated task for developers due to the heterogeneity of technologies that exist in the system architecture of a Home/Building Automation System.*

*In this paper we recommend the ISO 9241-11 (Guidance on usability, ISO/IEC 1998) standardized User Centered Design (UCD) approach as a design method for developing a user interface that meets user-, usability- and system requirements. Based on this approach a set of design guidelines are proposed to help developers solving the multi-disciplinary design challenges that are involved in this development process. A home energy management functionality for a Web-based home automation front-end has been developed as a proof-of-concept for this approach.*

*In addition, due to a lack of recommendations to assist developers in making an informed decision about the selection of a suitable JavaScript development framework to support the development of the front-end, a list of selection criteria is given. Finally, a user evaluation of the interface is proposed to assess the suitability of the User-Centered Design method for producing more usable and satisfying interfaces.*

# HOW MODERN MICROCONTROLLERS CAN AID THE HEATING OF REMOTE RURAL DWELLINGS, USING SUSTAINABLE RESOURCES

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**Keywords:** Microcontroller, Heating, Renewable, Fuel Poverty.

## **Abstract**

*The remote location of many households in the countryside, mean that they are reliant on deliveries of LPG or fuel oil to heat their homes. This is expensive, driving many residents into fuel poverty, as well as detrimental to the environment, for example one tonne of fuel oil produces 3.23 tonnes of CO<sub>2</sub> (DEFRA, 2017). The financial and environmental cost of production and transportation of both LPG and fuel oil is also great.*

*One solution is to use both local and renewable resources, for example many rural areas have access to forest or other renewable fuel sources. Other established ideas are the use of solar energy to heat both domestic water and a Trombe walls (Torcellini and Pless, 2004) for heat energy storage to circulate warm air around a building.*

*All of these systems are reliant on how current microcontrollers can optimise the control of operation. For example a stock wood central heating system can burn both wood and many other renewable fuels for up to 26 hours in one loading (PEREKO, 2014). This is achieved by using a proportional–integral–derivative controller (PID) algorithm within the microcontroller that optimizes the operation of the boiler and directly affects lower fuel consumption; the estimated savings reach approx. 30%.*

*This paper explores how microcontrollers can now be applied to both wood, solar water heating and Trombe wall heating systems, in order to optimise the use of renewable energy.*

# **Managing Water and Waste**

# ENHANCING UK FLOOD MITIGATION MEASURES THROUGH LOCAL COMMUNITIES' FLOOD KNOWLEDGE

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**Keywords:** Flood Risk, Vulnerability, Resilience, Flood mitigation, Community participation.

## **Abstract**

*Flooding is becoming a frequent and persistent problem throughout communities across the UK, causing an estimated 1.1 billion pounds worth of damage annually. Recent research has established patterns in rainfall trends strongly suggesting the magnitude and intensity of flood is set to get significantly worse. In response to these findings, Government bodies and the Environment Agency have expended millions of pounds to build physical flood defences in the most affected communities across the UK. However, such measures have not always proven to be effective in times of crisis, leading to a gradual transition from flood defence to flood risk management. This shift has encouraged local communities and individuals to work holistically towards the development of more community adept flood mitigation measures.*

*The paper aims to investigate how community engagement and implementation of local flood knowledge leads to the improved development of community flood mitigation measures. The paper is based on primary and secondary research including a review of literature surrounding the subject area, and interviews with flood action groups and senior members of the local council affected by flooding. The research is focused primarily on those areas that have been hit most recently by several flood events - Calderdale and Yorkshire - where local communities have lost power, water and telecoms commination during the flooding.*

*The study shows that the Environment Agency is trying to use different approaches for flood mitigation measures that focus on improving the local community engagement. Further, the City of York set a good example of local community engagement, however, officials expressed the need to work with communities before, during and after a flood event and there is a need to improve the community risk awareness for an effective flood preparation in the United Kingdom.*

# THE BARRIERS AND OPPORTUNITIES TO THE RETROFIT OF SUSTAINABLE URBAN DRAINAGE SYSTEMS (SUDS) TOWARDS IMPROVING FLOOD RISK MITIGATION IN URBAN AREAS IN THE UK

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**Keywords:** Flooding, systematic review, retrofit SuDS, Benefits, barriers.

## Abstract

*In the UK, about 5.2 million properties, accounting for about one-sixth of all properties, are in areas at risk of flooding. A chronic shortage of housing, a growing population, and increased rainfall are likely to exacerbate this situation. Sustainable Urban Drainage Systems (SuDS) have been successfully applied in cities worldwide and have proven to be a cost-effective solution to manage flood risk whilst also delivering a range of other benefits. Despite these benefits, there has been a relatively low uptake of SuDS in new developments and even less so in the opportunities for retrofitting SuDS in existing buildings.*

*The aim of this study is to examine the barriers and opportunities in the retrofit of SuDS in a bid to appraise their effectiveness in the mitigation of flood risk. A systematic search of the available literature is employed to identify key sources of evidence. An examination of the search results reveals a range of multiple benefits from retrofitting of SuDS including enhancement of air quality, health improvements, and towards **conducting** a whole life costing methodology, among others. Furthermore, there exists a number of potential barriers to their uptake including, for example, the lack of experience and trust in such schemes, and that SuDS tend to be undervalued by stakeholders owing to the complexity of the monetisation and quantification of their wider benefits. Further research is therefore recommended to help develop a fuller appreciation of the true costs and the wider monetary and non-monetary benefits towards addressing some of the apparent barriers to the retrofit of SUDS. This will help to increase the uptake of SuDS retrofit as a valid approach within an integrated flood risk management strategy.*

# STAKEHOLDERS' STRUCTURAL FACTORS AFFECTING THE IMPLEMENTATION OF RAINWATER SYSTEMS IN THE AMAZON. THE CASE OF BELEM

Dr Pedro Pablo Cardoso<sup>1</sup>; Dr Andrew Swan<sup>2</sup> and Prof Dr Ronaldo Mendes<sup>3</sup>

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**Key Words:** Rooftop Rainwater Harvesting; Stakeholder Analysis; Social Network Analysis.

## Abstract

**Purpose:** *This paper analyses the structural features of stakeholders that influence the implementation of rainwater systems in Belem (Brazil).*

**Methodological approach:** *The paper presents an explorative research based on the application of Social Network Analysis (SNA). Interviews were made with experts in the field and the data was coded and analyzed. A stakeholder's map was made to summarize the information collected and visualize the identified factors.*

**Findings:** *The key finding is based on the identification of key players and issues in the implementation of rainwater systems; the absence of interaction with some of them and the canalization of decision-making powers in few agencies.*

**Research limitations:** *The scope of the study is limited to the region analyzed and consequently is context specific. Due to the limitations of the data collection in the field, the full potential of SNA could not be explored in this analysis.*

**Implications:** *The paper makes evident some of the redundancies in the management of water in the region. Also, it makes evident issues related to lack of inclusion in the decision-making process and planning for the implementation of rainwater systems in the region. In this sense, the paper can inform policy for the planning of the further expansion in the implementation of this source of clean water.*

**Originality and value:** *This study is the first of its kind in the region. The use of methods to map stakeholders and visualize the relations of influence, as well as the identification of previously unseen key actors is a contribution of great value for the planning of further expansion in the implementation of rainwater systems in the region.*

# THE LONG TERM LIFE OF RECYCLED PLASTIC IN CONSTRUCTION PROJECTS REPRESENTS A MORE BENEFICIAL USE OF A VALUABLE RESOURCE THAN EITHER THE ORIGINAL PRODUCT OR CLOSED-LOOP RECYCLING

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**Keywords:** Blended recycled plastic, Civil Engineering, Infrastructure, Built Environment.

## Abstract

*Emphasis within plastic recycling is centred on closed-loop recycling - using waste plastic to produce a new item similar to the original – especially new bottles from old. However recent reports indicate that 44% of the 35 million plastic bottles used each day in the UK are not recycled. Using industrial case studies, supported by academic research, this paper will demonstrate the potential for use of waste plastic products in the Construction Industry and propose that construction represents a more beneficial, and sustainable use of a valuable resource than either the original application or the product from closed-loop Recycling.*

*The use of recycled plastic to replace wood or concrete in outdoor construction projects is becoming more widespread due to recognition of the advantages from the rot-proof, maintenance-free material. Proprietary blends of waste plastic have now replaced wood or steel in the construction of civil engineering projects as far apart as Canada and Australia.*

*Progressing from a plastic lumber substitute in outdoor furnishing, the advantages of the utilisation of blended recycled plastic in construction projects is demonstrated in three case studies; an 'Ecocrib' retaining structure at Centre Parcs, a 'Woonerf' (living street) in Montreal, and a 'biofilter' flooring system in Farington that represents many such floor systems now built around the world. Each case shows how blended recycled plastic can be created in bespoke shapes and configurations, and to strict specifications for the engineering strength, stiffness, flexibility, durability and low-unit weight, allowing the material to easily suit a variety of design needs. The chemically inert nature of the material prevents it from interacting with surrounding chemical or biological agents in even the most challenging of environments. The paper concludes with a discussion of how a general consideration of the engineering properties of the material should lead to the development of the next generation of blended recycled plastic structures that designers will be able to incorporate into future sustainable construction projects within the built environment.*

# **Planning for Sustainability**

# NEIGHBOURHOOD PLANNING AND SUSTAINABILITY: THE NEW NORMAL OR THE PLACE OF PLACE

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**Keywords:** Place-making, neighbourhood planning, sustainability

## **Abstract**

*Spatial planning has a long-founded concern with place-making and planners are increasingly urged to balance the requirements of capital accumulation with the goals of environmental sustainability and human wellbeing. The legislative and policy framework for spatial planning is concerned, therefore, to define how the attachments of place can be represented in land use and development plans and to calculate their appropriate weighting in relation to economic growth. This paper explores the normalisation of place attachment in planning policy through a study of neighbourhood planning in England. The aim of the paper is to evidence the process through which the intelligibility of place is established in relation to the market imperatives of development. The paper is concerned with the construction of norms, the variations on those norms, and the point at which those variations become characterised as deviant. The paper charts the exclusions and exceptions through which the intelligibility of place is negotiated in neighbourhood planning policy and concludes with an assessment of the impact of neighbourhood plans on sustainable placemaking.*

# HOW WELL DOES OUR ACUTE NHS HOSPITAL ESTATE PERFORM – AND WHAT CAN WE LEARN FROM THAT?

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**Keywords:** Estates, estates analysis and NHS

## **Abstract**

*The National Health Service (NHS) in the UK represents a significant challenge both in terms of scale and increasing pressures on the estate. The NHS is the fifth biggest employer in the world with 1.5 million staff (NHS Choices 2016), costing £139 billion per year (Harker 2017). The supporting estate is ageing, covering around 26 million m<sup>2</sup> (Naylor Report 2017) with running costs of over £8 billion per year (Carter Report 2016). As well as managing the performance of the estate, the NHS, as with most world healthcare economies, is dealing with the challenges of an ageing population, increasing demand and increasing cost against a backdrop of constrained funding. So how can we assess the performance of the estate against the backdrop of these increasing pressures.*

*This review considered whether a performance based analysis of NHS estate data provides useful indicators regarding the efficiency of existing assets for future uses.*

*The results identify significant cost in running the estate and significant variations in both running cost and space utilisation between hospital sites, indicating the potential saving with small percentage improvement to key indicators. While there are differences between small, medium, large and teaching hospitals and the age of the estate, the complexity of factors does not indicate an ideal performing type of hospital or age of the estate. Neither does the review show an increased cost of running older estates, though the results do show more inefficient space utilisation. The review indicates the need for more research and illustrates the potential for predictive analytics.*

# PROPOSED FRAMEWORK FOR GREEN BUILDING CONSTRUCTION PROJECTS DELIVERY USING BIM TOOLKIT WITHIN DIGITAL PLAN OF WORK

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**Keywords:** BIM, digital plan of work, Environmental assessment methods, Green buildings and Supply chain.

## Abstract

*Professionals in architecture, engineering and construction (AEC) start to recognize the importance of the synergy of Building Information Modeling (BIM) and green building to the construction industry. As the owner is demanding a high energy efficient building with lower cost, faster delivery and improved export. Implementing BIM in green project delivery allows the project team to meet the owners' expectations. In fact the current state of green BIM practices are immature and unsystematic, results from the lack of integrated process in design and execution. The obstacles may include: difficulty in differentiating the roles and responsibilities of team members, determining appropriate BIM execution strategies and standardizing information exchange (IE). BIM tool kit is one of the new methods in the BIM industry that defines the tasks, roles and deliverables needed for each stage in the project in a digital work plan. This research aims to address how to overcome problems in the Environmental Assessment Method (EAM) workflow by integrating the EAM requirements in the project stages using BIM tool kit for more efficient project handling and delivery. This will lead to a reduction in the cost and time spent, caused by the variations and lack of coordination. Therefore, the selected methodology in this research is held to study the functionality of BIM toolkit to be used in projects targeting green certificates and what is the potential of developing a guidance on BIM implementation in Green building projects, and this is held through observations and reviews of experts in the industry.*

# **Retrofitting for Sustainability**

# ENERGY RETROFIT APPROACH TOWARDS A MULTI-PERFORMANCE RENOVATION OF EXISTING BUILDINGS

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**Keywords:** Building Sustainability, Envelope Retrofit and Integrated Renovation.

## **Abstract**

*The increasing concerns over population growth, depletion of natural resources and global warming as well as catastrophic natural events is leading the international scientific community to envisage sustainability as a crucial goal. The built environment plays a key role on the triple bottom line of the sustainable development - Planet, People, Profit - because of several environmental, social and economic impacts produced by the construction sector. The acknowledged need to promote a sustainable building market is an international high-priority issue as underlined by the 2030 Agenda for Sustainable Development. Indeed one of its strategic objectives is to make cities and human settlement inclusive, safe, resilient and sustainable. In line with the 2020 Europe Strategy and the European 2050 Roadmap, energy efficiency and CO<sub>2</sub> savings towards a low-carbon economy are regarded as ambitious objectives to be achieved for both new and existing buildings. Thus energy retrofit becomes a fundamental and growing research area to be investigated.*

*This study aims to investigate the opportunity to develop sustainable integrated renovations that can improve energy and structural performance and at the same time provide economic and social benefits. A brief overview on the main characteristics and criticalities of the EU existing residential building stock is introduced. The work emphasizes the possibility to use envelope retrofit practice based on prefabricated modules as a potential measure to optimize the energy performance and increase occupants' comfort and economic property value. The benefits of the investigated solutions are evaluated according to a multi-performance life-cycle oriented approach. Finally, a discussion on the possibility of applying the proposed methodology to residential high rise buildings in Leeds is exposed.*

# DEVELOPING A TAXONOMY FOR DISCONTINUITIES IN INTERNAL WALL INSULATION

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**Keywords:** building efficiency, building performance, internal wall insulation.

## **Abstract**

*Adopting a fabric first approach and installing thermal insulation in existing buildings is one of the most effective methods of improving energy efficiency. The use of internal wall insulation (IWI) has been shown to offer an effective thermal solution, especially where other methods of insulation are unsuitable. However, fitting internal wall insulation is not without risk as discontinuities (gaps) are often found in the insulation layer for a variety of reasons. This can lead to increased flow of heat from the interior to the exterior causing reduced local surface temperatures, which can lead to condensation or mould growth.*

*Currently there is little or no consistency in the terminology used to discuss such discontinuities in IWI and as such categorising specific types of discontinuities and their relative magnitude and rate of recurrence in practice is difficult. This paper seeks to address the lack of consistency by proposing a taxonomy that practitioners and researchers can use when describing discontinuities in IWI.*

*This paper brings together the findings from building performance research, part of which involved field studies forensically observing IWI installations. Alongside the site visits, a literature review of IWI research was undertaken to identify the types of discontinuities observed and the terminology used to describe the occurrence and characteristics. From this a taxonomy has been developed to standardise and characterise discontinuities. It is hoped this will improve the understanding of and appreciation for the importance and scale of discontinuities in the industry, in so doing setting out a route for reducing their occurrence. It is also proposed that this taxonomy could be adapted for use in discussion of other insulation types.*

# **Sustainability and Control**

# LOW CARBON BUILDING: IMPLEMENTATION STRATEGIES UTILISED IN SOUTH AFRICA

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**Keywords:** Carbon emission, Climate change, Low carbon Building and South Africa.

## **Abstract**

*Carbon emission has established itself as a major issue, which requires a coordinated response. Buildings account for a high proportion of carbon emissions. These emissions can be traced back to heating, cooling, and lighting systems, although emissions from embodied materials are also significant. This problem has prompted the development of new strategies to reduce the amount of carbon dissipated by buildings. Hence the need for this study in South Africa to check what has been done in this regard. The study followed a case study research strategy and mixed method data collection techniques. This paper outlines strategies utilized in South Africa regarding the adoption of education, training on living sustainably, regenerative drives, geothermal ground loops, Intelligent Building Management System, purchasing carbon credits and offsetting through the kariba red project and power-generating gym equipment.*

# SSS.INFRA: BEYOND THE TRADITIONAL - A NEW QUANTITATIVE APPROACH FOR ASSESSING SUSTAINABLE INFRASTRUCTURE DESIGN

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**Keywords:** sustainability, infrastructure, design, quantitative assessment

## Abstract

*The function of all infrastructure in organised societies, especially civil infrastructure, is to provide for personal security, establish a basis for public health and institutionalise a quality of life equal to the expectations of those it serves. SSS.Infra is a research project to develop a quantitative approach to sustainability, endorsing a numerical evaluation of the performance achieved by a system to promote a holistic and design oriented technical approach. It is an evolution, not revolution of the three pillars of sustainability using cross-cutting technical performance criteria (41 Performance Criteria under 15 Credits across the 3 Parameters of the three "S's" SSS.Infra (Safe Performance, Suitable Integration and Source Control (responsible use of resources)). The Paper presents the system and how sustainability goals are reached through the design stages. One of the most important findings of SSS.infra is the analytical approach implemented with the purpose of providing a reliable and objective evaluation of infrastructure performance. Overtaking subjectivity, in other words, has been fixed as one of the mandatory requirements to consider for the development of the guideline. Secondly, that adoption of widely used industry design stages is a requirement to consider in order to make clear roles and responsibilities. For instance, the RIBA Plan of Work 2013 has been selected for a first attempt, considering Concept Design, Developed Design and Technical Design stages. The third key finding is that by using cross-cutting technical performance criteria, a rich network of connections become established between different credits, which has the result of promoting advantages for more integrated design implementation. Thanks to this structure, contributions coming from different technical specialties are more effectively coordinated to improve the final quality of the project.*

# DO DISPLAY ENERGY CERTIFICATES (DECS) WORK?

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**Keywords:** Advisory Report (AR); Display Energy Certificate (DEC); UK Central Government

## Abstract

*This paper is part of a D.Eng. research into DEC and Advisory Report (AR) compliance of UK Government buildings. Summary statistics are produced on the lodgement, energy efficient ratings, and energy saving priority recommendations of the UK Central Government cohort of buildings for 2008 to 2017. This is the first independent synthesis of these data of its kind, which provides evidence on the success of DECs in raising awareness of the energy efficiency of UK Central Government buildings.*

*Guidance was adopted and adapted by this paper for its quantitative analysis methodology and methods protocol, which was non-experimental. Its literature review and analysis of UK Central Government DECs and ARs from the Non-Domestic Energy Performance Certificate (NDEPC) Register have so far made some significant findings. The headline findings include that: no UK Central Government buildings achieved a DEC 'A' rating; only around 6% have a 'B' rating; 14% are 'C' rated; 23% are 'D' rated; 23% are 'E' rated; 11% are 'F' rated; and 24% are 'G' rated. This is significant, as it underlines difficulties that may be faced should minimum energy performance standards be introduced at a future date. Other headline findings are that only around 42% of 104 UK Central Government buildings will likely meet a 2018 target for DECs to have all buildings scoring 'A' to 'D' ratings. Significantly, this research found that non-compliance with DEC requirements was endemic, with 80% of DECs and ARs not being lodged for UK Central Government buildings. The implication is that the DEC and AR are not well enforced energy efficiency tools.*

*This research also found 36 AR recommendations it determined to be priorities because of their frequency of occurrence, and potential for improvements of UK Central Government buildings with DEC 'G' ratings. However, they rarely followed the 'Fabric First' principle because only three (around 8%) of them addressed building fabric issues. It is not known why this is the case or if AR recommendations are influential in energy management circles across the UK Central Government estate.*

*Future work will include creation of a qualitative analysis methodology and methods protocol to investigate why there is low compliance and lodgement of DECs and ARs by focusing on: the underlying reasons why buildings received particularly low ratings; and understanding the appropriateness and uptake of AR recommendations.*

# DEVELOPMENT OF A VALUES-BASED FRAMEWORK FOR PREDICTING PROJECT SUSTAINABILITY PERFORMANCE

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**Keywords:** construction project, organizational values, personal values, sustainability performance.

## Abstract

*Construction projects are subject to scrutiny in terms of sustainability performance, for example, on environmental issues and social matters. However, the reasons which underpin why one project outperforms another do not seem to be well-articulated in literature – possibly because projects are deemed to be unique and hence incomparable. For instance, decisions which lead to better or worse sustainability performance are arguably determined by the individual values of actors, as played out in a project context. If values are a predictor of attitudes and behaviours of individuals, then it is feasible that they also guide behaviour at the organizational (and project) level. Drawing on values theory, a preliminary framework has been developed to capture and assess individuals' personal values, within a project (organizational) context, to understand the likely implications on sustainability performance. The framework, developed from a literature review, aims to create a means by which it is possible to predict the sustainability performance of a project, and improve this through approaches that are more empathetic to individuals' values (for example, by configuring and managing teams differently). By so doing, this could help project teams to achieve higher standards of environmental and social performance in practice.*

# **Sustainability and Project Management**

# **‘VALUE MANAGEMENT’: THE IMPORTANCE OF WHOLE TEAM REPRESENTATION, STAKEHOLDER POSITIONING AND FACILITATION, TO SUCCESSFUL VALUE WORKSHOP OUTCOMES**

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**Keywords:** Business Case; Value management; Value Engineering Facilitation; Team working.

## **Abstract**

*This paper reports on a value management study workshop that was conducted to examine a long standing challenge to performance improvement in a chemical manufacturer in the U.K. Even taking into account Hofstader's law, and Gray and Flvybjerg's warnings about benefit exaggeration, the solution arrived at, offered notable gains in: energy savings; health and safety enhancements; operational speed (in a performance bottleneck process) and most significantly in the potential for future increased sales to a market that has a demand gap.*

*While reports on the potential for 'value management workshops' are not new, the testing of what might be significant factors that influence those successes is largely theoretical and would arguably benefit from the examination of the theory in practice.*

*The inferences possible from this field work suggest that some component factors in the preparation of the workshop need particular attention. These factors include: wide stakeholder engagement; careful prepositioning and preparation of team members that includes a focus on the benefit-value concept that includes sustainable thinking; a whole portfolio perspective; and independent workshop facilitation. The outcome of this study supports the theoretical promise of value management studies.*

*Projects that seek to improve sustainable outcomes in society and business, as well as in greener technology application, appear to raise the level of challenge for: the development of better project choices; for the management of projects in general; and for projects specifically aimed at sustainability improvements in particular. The paper recommends the habitual use of approaches and the mindset purported by 'value management' in the development of projects.*

# A STUDENT PERSPECTIVE OF PRIORITIES IN DEVELOPING A SUSTAINABILITY STRATEGY

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**Key Words:** Sustainability Strategy, Triple Bottom Line, Student Perception

## **Abstract**

*The study focuses on the understanding of priority areas when developing an organizational sustainability strategy. The paper reports on findings from an in-class survey with final year students on interprofessional studies project module. The module provides the opportunity for students to explore some of the complex challenges which face built environment professionals. It aims to broaden students' appreciation of these problems in the context of the rapidly changing commercial, political and ethical climate of the built environment. As part of the project output, students are expected to address sustainability issues. In order to kick-start the sustainability conversation, the module team sort to provide students with a broad sustainability context. Considering that sustainability is seen as a key employability skill, it is important that graduates are provided with a balanced sustainability context. The module team considered that a strategic context for enhancing sustainability understanding was useful. A questionnaire was developed based on a review of literature which identified potential priority areas from three sustainability dimensions including environmental, social and economic sustainability. A review of literature suggests that students perceptions towards sustainability tends to be environmental focused and less on social and economic sustainability. The differences in perception between the cohorts on the module are analysed. The exercise also provided an opportunity to demonstrate the difference in outcome between individual and group thinking as the survey was repeated based on a group perception as opposed to individual perceptions. The initial individual perceptions indicated that students generally have an environ-centric view of sustainable construction. However when they discuss sustainability in groups, their perceptions, while still environ-centric, tended to take a more holistic view consistent with previous studies that have demonstrated the impact of sustainability training on sustainability inclinations. It is therefore important that sustainability education should take a holistic approach that take into consideration environmental, economic and social sustainability.*

# DEVELOPING AN END-USER DATA CAPTURE METHODOLOGY

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**Keywords:** BIM, knowledge management, sustainability performance, communication, stakeholders, user need specifications, the 'voice of the customer'.

## **Abstract**

*The aim of this research is to establish the extent to which end user requirements are communicated throughout the construction process. The method of inquiry is purely literature based. This research indicates that the perspectives of those involved in construction projects are widening. Whole life considerations are now requiring those with operational expertise and knowledge to be involved in decision making processes. In particular, design build and operate schemes, such as PFI developments, require facilities management involvement at an early stage to allow their operational knowledge to influence design and component decisions based on long term operational efficiencies.*

*The increased use of BIM in such developments also compliments a collaborative approach by endorsing the involvement of those with specialist skills and sharing rich information in timely ways throughout the development project, from inception to operation.*

*The process of arriving at 'informed decisions' is clearly complex due to the interactions of components relating to data, information and knowledge. This paper illustrates the need for effective communication of user requirements throughout the construction process. It demonstrates that provision for the capture of tangible data is reaching levels of maturity through the adoption of property asset management systems, platforms and tools. However, the paper raises awareness of the need for further research into how less tangible user requirements are obtained to ensure the 'voice of the customer' is heard, interpreted and communicated appropriately by construction specialists throughout the development phases.*

# MEASURING THE IMPACT OF KEY PLANNING PRINCIPLES ON 'GROSS MARGIN'

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**Keywords:** Project Management. Planning and Scheduling. Supply Chain Management.

## **Abstract**

*Project Management includes, in its key tenets, a structured approach to planning and scheduling. Work by students on the MSc Project Management course at Leeds Beckett University found that basic errors in Gantt chart Work Breakdown structures (WBs) as well as incomplete logic linking (Referred to as 'hanging tasks') were prevalent in over 60 contract programme plans examined in 2015.*

*This research sought to examine whether the presence of: a WBs that functioned to reduce the complexity of the project plan; and a complete set of logic links (this is crucial because it allows a 'Critical Path' to be modelled) had any correlation on project 'Gross Margin\*' (\*Used as a surrogate for project success).*

*The research method looked at n=90 projects, all of which were customised factory built fabrications, selected at random from a single organisation (thereby offering some commonality). The efficacy of each sampled project plan's WBs and the project plan's logic links were examined for correlation with the 'gross margin' (adjusted for bid forecast) arrived at for each.*

*The research also revealed that the use of the suitably visualised planning model, that allowed the Project Manager to see and to create opportunities for efficiency, in delivery, appeared to be the positive determinant arising from the use of the plan model.*

*The research indicates how; the presence of a linked logic 'model' of the project, and attempts in the planning phase to reduce the plan complexity, are indicators that the project manager is exploiting the potential offered by a system approach to project management. This allows for the hypothesis that: 'Consideration of the planning principles of WBs and logic linked critical path modelling facilitated better management of the projects, resulting in a measurably improvement over the sample examined'. A statistical treatment of the data is employed to test the hypothesis. The hypothesis was found to be correct. (n=90, p=<0.05).*

# TESTING 'VALUE MANAGEMENT': TEAM WORK ASSUMPTIONS

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**Keywords:** Project Management, team working, value management, problem solving.

## **Abstract**

*Value Management (VM) is generally accepted as a structured approach to problem solving, and one of its key principles is the utilisation of a facilitated team work approach. Although much anecdotal evidence exists to support the efficacy of the VM process, little empirically tested data exists. Moreover some contrary anecdotal evidence is reported.*

*A hypothesis was identified from the literature, that isolates the problem solving process part of the value management workshop technique. The hypothesis H1: "There is numerically significant difference between facilitated (Intervention) group outputs and Controlled Group (a non-intervention group) outputs"., was tested using an experimental quantitative, unpaired design study, that uses 'intervention' and 'control' groups.*

*The experimental study asked n=20 groups to address themselves to a commercial problem and make notes and recommendations. N=10 groups in the intervention sample were directed to consider the problem in 3 simple steps, designed to follow the most basic of the VM problem solving process. N=10 other groups, in the 'control' sample, were given the same task but were not asked to follow the VM problem solving steps. The hypothesis H1 was found to be correct, and the results used an independent t-test to arrive at a  $P < 0.01$  showing statistically significant results. Other perspectives on the data (H2) are applied in the paper, which find less statistically powerful results. The results allow the researchers to infer that the VM problem solving process is likely to have a positive effect on project development. Recommendations are made for enhancing the study to create greater statistical power amongst the second hypothesis H2 and to examine other potential variables.*

# **Sustainability: Buildings, Materials and Systems**

# ARE GREEN CONSTRUCTION MATERIALS INFLUENCING WORK IN SOUTH AFRICA

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**Keywords:** Construction, Green, Materials, Project, Work.

## **Abstract**

*The aim of the reported study was the exploration of the influence that green construction materials are having on work methods in South Africa. Through the lens of architects and contractors, the study determined that the uptake of green materials in the construction industry is not in tandem with the urgency needed to limit the environmental impact of building on the environment. The following collection of both interview and survey data shows that despite the known benefits of green construction materials regarding the reduction of pollution (and other emissions) and the operational cost savings, initial capital costs is feeding the pipeline of scepticism in the industry. Preference for conventional materials appears to continue because of perceived affordability and availability in the country. Also, the limited know-how around the usability of green materials constitutes another major hurdle to be scaled by the industry. In other words, there is a major reason to conclude that work methods in the sector in South Africa are yet to be effectively influenced by green materials. The findings of the study require further research as the flow of materials and information are a major cornerstone of construction project delivery.*

# A MORE SUSTAINABLE SOLUTION TO GEOSYNTHETIC PRODUCTS FOR SHORT-TERM REINFORCING APPLICATIONS

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**Keywords:** Geosynthetics, Limited-life geotextiles, Renewable resources, Soil reinforcement, Vegetable fibres geotextiles.

## Abstract

*It is now very difficult to find a construction site that does not utilise any geosynthetic products. Materials used in the manufacture of geosynthetics are primarily synthetic polymers – generally derived from the by-products of the oil industry. As a result of the finite nature of these raw materials and their associated pollution streams, there is growing pressure to use renewable resources for sustainable production. Also, the majority of geosynthetic applications are only required to perform for a short period of time, thereby leaving an alien residual in the ground for many years to come. Natural (vegetable) fibres provide a more sustainable alternative to polymeric based materials, particularly for short-term applications – termed limited-life geotextiles (LLGs).*

*This paper presents an overview of an extensive study that has been undertaken on the development of reinforcing LLGs manufactured from renewable and biodegradable vegetable fibres for short-term applications. Initially, structural form is considered. It is shown that LLGs can have tensile strength of up to  $100 \text{ kN.m}^{-1}$ , which is directly comparable to a mid-range geosynthetic product. The shear interaction properties of the LLGs was then compared to a number of different commercially available geotextile structures – manufactured from both natural and synthetic materials. The results demonstrate that coefficient of interaction values of around unity can be achieved with these LLGs. This is about 20–25% more shear resistance than their synthetic equivalent. The difference stemming primarily from the coarseness of the vegetable fibres themselves but also from the novel structural form. In terms of longevity, durability tests have been undertaken on the LLGs in various ground conditions. The data obtained indicate that degradation rates are sensitive to fibre type, together with the amount of water present in the soil. Coir fibre performed the best in worst deterioration environment tested. A simple basal embankment analysis is then presented to demonstrate a potential end application for the short-term reinforcing LLGs. In this analysis, it is shown that the rate at which the underlying embankment soil gains in effective stress, due to the dissipation of excess pore water pressure, could be designed to correspond to the decline in tensile strength from the degrading LLG.*

# THE ENGINEERING APPLICATION OF NIGERIAN SOILS FOR THE CONSTRUCTION OF LOW COST HOUSING: A SURVEY OF THE ACCEPTABILITY OF BRICKS

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**Keywords:** Acceptability, Bricks and Housing.

## **Abstract**

*The wide-scale availability of clays in Southern Nigeria should be an avenue for the successful promotion of alternative natural cladding materials such as bricks for the construction of low cost housing. However, local clays and lateritic soils for use in engineering application, mostly lie wasted and unextracted. A major issue of contention being their structural viability as a building material for modern structures, with the bulk of its usage limited to rural areas. As such a fundamental gap remains, wherein the economic potential of locally available clay reserves is not translated into commercial production of bricks and patronage. The study appraises the factors determining the acceptability level of bricks as cladding materials for low-cost housing construction in Nigeria. The opinions of key construction industry professionals as well as marketers and developers in Port Harcourt were sought through the administration of structured questionnaires. The study revealed that aside from the perceived structural shortcomings of bricks, several issues abound as being responsible for the unpopularity of bricks. Typically, such views centered around difficulties in securing skilled labor for brick laying, lack of exact standards of material and workmanship, perceptions of adaptability to the environment, accessibility, supply shortfalls/poor marketing by brick manufacturers and the attitudinal propensity of Nigerians to view local materials as inferior. The study espouses the need for public enlightenment; skills development in bricklaying, creation of a viable platform for improved productivity, more aggressive marketing and quality control via standardization.*

# **Simulation, Models and Methodology**

# THE IMPLEMENTATION OF THE BIOPHILIC CONSTRUCTION SITE MODEL (BCSM) IN CONSTRUCTION

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**Keywords:** Biophilic design concept, Construction, Ergonomics, Health and safety, Performance.

## **Abstract**

*The construction industry is better characterised by traditional or manual methods and harsh labour conditions that result in work-related stress and consequent deficient performance of workers. Labour intensive technology requires much more diligence in the application of innovative strategies on the construction worksite in order to achieve a viable labour resource that is a necessary factor of productive performance. Research in environmental psychology suggests that humankind's desire for contact with nature serves an important adaptive function in the form of psychological restoration that heals mental fatigue and the lack of motivation in the construction workforce. Based on this premise, a distinctive perspective on an underlying practical challenge is offered in the 'greening of the construction site' or the biophilic construction site model (BCSM). This involves the inclusion of the biophilic design concept as a relevant aspect of construction management and planning, which includes the specific design of workplaces that balance the human occupants with satisfactory access to nature experience. The relevant question explored includes the nature of the introduction of dynamic healing gardens in construction according to the nature of the project, environment, and the construction processes.*

*The research method entailed a comparative analysis of similar construction sites within the Northern Cape region of South Africa that involved an exploratory survey of the greening of construction sites, with and without the BCSM.*

*The findings indicate that workers experienced restoration and rejuvenation in a natural environment, which is in harmony with the promotion of H&S, and ergonomic strategies in construction, and the attention restorative therapy of workers as an effective motivational incentive package towards a viable construction management of the construction workplace. It can be concluded that the BCSM is relevant to the construction process, in addition to the built environment during the use phase of buildings.*

*It is recommended that contractors in general 'soften' construction sites while undertaking projects to create a more amenable environment to promote worker health and well-being, and performance.*

# EXISTING BUILDING RETROFIT: ASSESSING GAPS AND NEEDS FOR BUILDING PERFORMANCE SIMULATION

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**Keywords:** Hygrothermal, In-Situ, *U*-value, Moisture

## Abstract

*Thermal analysis is an important function which assesses the energy performance of the building fabric through calculation, simulation or in-situ analysis. The accuracy of these figures is fundamental to the projection of design requirements to achieve energy efficiency targets through the building fabric. This paper summarizes a study undertaken to replace calculation and in-situ thermal analysis of existing external walls with simulated hygrothermal models to address the need for increased accuracy. The paper reviews current trends for Building Performance Simulation (BPS) and outlines major criteria for simulation tools and evaluation. The review is carried out by means of literature review, in-situ thermal analysis and hygrothermal simulation of a Dublin property. The aim is to assess the gaps and needs of accurate BPS in existing building design and thermal retrofit. The findings indicate several results which challenge traditional understandings of building envelope performance. What is evident is that the external walls perform more thermally efficient in a dry state. However, in contrast to the concept of a 'drying out period', external walls display signs of a 'wetting period' until they reach a moisture equilibrium. Results and study methods are applicable to new build and existing structures as hygrothermal simulations are easily adapted to specific structures, time frames and internal and external environments. However existing limitations including building uncertainty, model uncertainty, and a steep learning curve are identified. Some future directions anticipated for improvement of current design tools and processes are presented.*

# VISUALIZING CAPTURED USER ACTIVITIES IN RELATION TO ENERGY USE – AN APPROACH FOR MOTIVATING AND AIDING PEOPLE TO CHANGE THEIR BEHAVIOR TO BE MORE SUSTAINABLE

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**Keywords:** Sustainability, Behavioural Changes, Activity Capturing, Activity and Energy Use Visualization.

## Abstract

*Even though technological advancements can help us to live with a lower environmental impact, it is a critical need to embrace sustainability as a lifestyle for humanity to survive in the long term. However, people usually have careless habits in consuming energy such as leaving lights on when they are not needed, which result in much wasted energy. In this paper, we present an approach for facilitating greener energy behaviour by raising people's awareness of their own behaviour and its impact on energy consumption, then motivating and aiding them to change their energy-related practices. Our Greener Energy Behavior (GreenBe) system is developed to capture human activities at homes and offices in a non-intrusive manner by utilizing building automation infrastructure, and to find out their suboptimal habits in using energy. Out of the collected data, users' behavioural patterns in relation to energy usage are extracted, and visualized to them. In its demonstration, the system successfully highlighted the potential of energy savings which users could gain by simply changing their behaviour. Users who experienced the system found it helpful in aiding them to change their energy-related practices. Better energy savings and sustainability could be achieved even without any automation solutions by directly raising sustainable behaviour.*

# **Thermal Comfort and Control**

# IMPACT OF A TARIFF BASED HEATING LOAD CONTROL ON ENERGY, COMFORT AND ENVIRONMENT: A PARAMETRIC STUDY IN RESIDENTIAL AND OFFICE BUILDINGS

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**Keywords:** load shedding, energy flexible buildings, performance indicators.

## Abstract

*In the perspective of systematic deployment of smart meters and smart HVAC systems, energy price is a possible incentive to automatically shift consumption from a constrained time-slot (e.g. around 7:00 pm) to a relaxed one (in the night). Such load shedding mechanisms are already in place in France for domestic hot water usage and are likely to be broadened to heating systems. This paper investigates the impact of an automatic tariff-based heating load control on the energy consumption, load curve, thermal comfort and environmental impact for the end-user. To achieve this study a method has been developed to assess the performance of a control strategy associated with a tariff signal through simulations. This method has been applied to different control strategies and tariff signals for several combinations of buildings and heating control systems. This work focuses on the existing building stock – with its main variations in terms of insulation, typology or heating control under different climatic conditions – while capturing the fundamental of building thermal response with the help of thermal simulation. This paper explains the methodology and the parametric study and shows that load shedding has limited advantages in terms of spare energy and comfort but can have a real effect on the heating load curve. Due to its systematic coverage this work aims at completing the current literature focused either on one technology or on control strategies.*

# **Thermal Comfort, Air Quality, Health, Behaviour and Wellbeing**

# RESILIENCE TO OVERHEATING IN HOMES IN SOUTHERN ENGLAND: HOUSEHOLDERS' AWARENESS AND PREPAREDNESS

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**Keywords:** climate change resilience, housing, occupation behaviour, overheating.

## Abstract

In southern England, climate projections show increasing likelihood of the number and duration of heatwaves. With over 80% of the 2050 UK housing stock already built, the householder is an important gatekeeper to making the built environment more resilient to overheating. The National House Building Council and others have issued recommendations for mitigating actions, including more insulation, better ventilation, shading and reflective external surfaces. Research on overheating has tended to investigate building physics, overlooking the role of the householder in making modifications. Important questions remain, including to what extent do householders perceive a threat of overheating events; are they aware of recommendations for precautionary actions; have they taken or do they intend to take action and what has guided actions already taken. The current study aims to address these questions and to provide a baseline against which changes in the effects of experience of overheating, perception of threat and level of action in future years can be compared.

A survey was conducted with a large-scale sample (n = 1007) of urban/suburban householders in the south of England, balanced across housing type. Of the sample, 67% had already experienced overheating in their home but perception of risk and awareness of the recommended actions were low and intention to take further action was very low. Nonetheless, actions had been taken, ranging from ventilation (82.8%) to awnings/shutters to glazing (9.4%). Reasons for taking action varied by action type, with comfort featuring heavily for insulation and ventilation, and aesthetics for planting and a pale exterior surface. Although reducing overheating was the top reason for installation of awnings or shutters, very few householders had taken this action. Recommendations for policy are discussed including differential targeting of population segments and using messages that align with householders' motivations.

# ASSESSMENT OF INDOOR ENVIRONMENT QUALITY AT THE ROSE BOWL, LEEDS BECKETT UNIVERSITY

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**Keywords:** IEQ, Ventilation, Surveys, NABERS

## Abstract

*This paper examines the post occupancy performance of a building designed for health and wellbeing of occupants when set against internationally recognised indoor environment quality benchmarks. The Rose Bowl is Leeds Beckett University's iconic building created to provide the best work and study environment. Indoor environment quality (IEQ) has been assessed within the building using a methodology based on thermal comfort, indoor air quality, noise, lighting and occupant satisfaction, as set out in the long established National Australian Built Environment Rating Scheme (NABERS) for Indoor Environments. This inaugural wellbeing rating scheme was launched in 2008 by the Australian Federal and State Governments and used widely by public, private and other country facilities. The Rose Bowl building has been evaluated against this mature scheme to determine how well it performs for staff and students. In addition to monitoring specific environmental parameters occupants of the building have been surveyed to examine their satisfaction with the indoor environment in use. Environmental assessments have been performed in offices, classrooms and the main lecture theatre. Results of the IEQ assessments are discussed in this paper. In addition a summary of the feedback from staff and students working in the building is provided. The discussion looks at the IEQ results in conjunction with the occupant survey. Initial remedial actions taken by the Estates Services team are briefly presented.*

# UNDERSTANDING FACTORS INFLUENCING OVERHEATING RISK IN THE UK'S FIRST LARGE SCALE DOMESTIC PASSIVHAUS RETROFIT

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**Keywords:** Climate change, Overheating, Passivhaus, Occupant Behaviour.

## **Abstract**

*Overheating in low energy buildings is becoming a growing concern around the world. The effects of climate change on global weather patterns are leading to long hot summers and warmer winters. The energy used in buildings is widely recognised as a major contributor to CO<sub>2</sub> emissions that cause global warming. In order to reduce these emissions, we must make our buildings more energy efficient. This can lead to an increase in levels of insulation and airtightness, which can cause internal temperatures to rise. This places the most vulnerable in society at risk of serious health impacts. Current estimates suggest that future climate scenarios would make the 2003 European heat wave a regular occurrence by 2070. Passivhaus is a popular choice among designers and developers looking to reduce energy costs and environmental impacts. Therefore, designers must look to future climate scenarios or we could be faced with a spike in heat related health impacts from buildings being designed now. The aim of this paper is to present a proposal to study factors influencing overheating in the UK's first large scale Passivhaus retrofit.*



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