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To What Extent Do Sustainable Buildings Encourage Sustainable Behaviour?



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Summary

This paper represents the ongoing study of theory and practice in relation to the development of sustainable buildings and the embedding of sustainable processes and features to minimise their environmental impact, and to positively influence sustainable behaviour throughout their lifecycle. This has involved an extensive literature review, an online survey, analysis of project documentation and the assessment of buildings via case studies involving face-to-face interviews and questionnaires. The wider project investigates the development of five exemplar sustainable buildings; The WISE building [1], The DACE Centre [2], Sidwell Friends School [3], The Core building [4] and The Genesis Project [5]. Each have environmental education and the promotion of sustainable building practices as key functions. For the purposes and limitations of this paper only the WISE building is featured.

1. Introduction

Since the Rio Earth Summit, 1992 [6] it has now become widely recognised that the Earth's resources are finite, pollution levels must be controlled and the burning of fossil fuel impacts climate through global warming with local, national and global implications such as flooding, extreme weather conditions and associated negative social and economic consequences [7].

Buildings currently account for around 50% of total carbon emissions in the UK totalling 360 million tonnes of CO₂ per annum [8]. The Climate Change Act 2008, UK [9] sets legally binding national greenhouse gas reduction targets of 34% by 2020 and at least 80% by 2050 compared to 1990 levels. This is equivalent to 61.2 million tonnes and 144 million tonnes respectively. The recognition that building practices need to change are evidenced by revisions in legislation with targets for zero carbon and low water usage new-build housing by as early as 2016 and new build non-domestic buildings by 2019 for England and Wales [10].

Clearly, in order to achieve these targets we need to develop and utilise low carbon technologies. Equally, the behaviour and attitudes of individual stakeholders and organisational practices has a significant role to play in reducing the environmental impact of the built environment. Design

decisions, material specification, working practices, building operation and user behaviour can all combine with new technologies to achieve low or zero carbon buildings which enable low environmental lifestyles, considering we spend up to 80% of our lives within buildings [11].

2. Definitions

2.1 What is a sustainable building?

There are a number of international standards developed over recent years that have reached a high level of complexity in defining and assessing the environmental impact of buildings ranging from highly technical requirements including BREEAM [12] and LEED [13] to more esoteric considerations such as the Hannover principles [14] and One Planet Future [15] which consider, for example, human rights and sustainability, social and spiritual aspects of sustainability and buildings, responsibility for the effect of design decisions and the use of nature as a model for design. For the purpose of this study the Building Research Establishment Environmental Assessment Method (BREEAM) has been adopted as a benchmark of sustainability in order to compare and contrast selected buildings under the following categories: Management, Health & Well-being, Energy, Transport, Water, Material & Waste, Land Use, Ecology and Pollution.

BREEAM has developed over time to reflect the environmental lifecycle of a wide variety of building typologies, assessing environmental, social and economic impacts at each stage of design, construction, operation and use. BREEAM assessed buildings are awarded credits depending on their environmental performance and can achieve a rating of either unclassified, pass, good, very good, excellent or outstanding. BREEAM In-Use is a scheme to help building managers reduce the running costs and improve the environmental performance of existing buildings. Operating a building represents a major economic, as well as environmental and social cost, with rising energy prices and an uncertain economic outlook, cutting energy waste and other such measures can improve profitability as well as sustainability and can enhance the corporate social responsibility (CSR) profile of an organisation.

In addition, BREEAM Education assigns credits for integrating sustainable features in buildings that have educational benefits for users, utilising the building and landscape as an educational learning and teaching resource.

Innovation credits are also available for sustainable procurement, responsible construction practices, reducing CO₂ emissions, use of low/zero carbon technologies, water consumption and flood prevention, life cycle impacts, responsible sourcing of materials and construction site waste management.

However, even when adopting this industry recognised standard there are many different approaches to achieving a sustainable building under the BREEAM guidelines with broad variability because of, for example, design limitations and aspirations, wasteful construction practices, poor operation and use of buildings.

2.2 What is sustainable behaviour?

A broad definition of sustainable behaviour is behaviour that results in the satisfaction of our needs today without diminishing the prospects of future generations to do the same [16]. This can be refined by applying the triple bottom line concept of sustainable development to individual and organisational behaviour that achieves economic, social and environmental sustainability-how we think about our place in the world, the things that we value, and how we relate to other people.

3. Theoretical Principles

Obstacles faced by the green building movement are no longer primarily technological and economic. Instead they are social and psychological. It is often the behaviour of individuals, organisations and institutions that determine the level of engagement with the sustainable construction agenda [17].

3.1 The Value-Action / Intention-Behaviour Gap

The gap between our attitude toward urgent environmental and social issues and our actions or behaviours in tackling them has been well researched and can be applied to the design, construction, operation and use of buildings. Even the best efforts to develop an effective sustainable building will be undermined if, in its design, construction, operation and use, sustainable practices and technologies are not understood or made explicit at each phase. This is variously known as the 'value-action' or 'intention-behaviour' gap.

The reasons for these gaps are a highly complex set of human responses in relation to the perception of environmental, social and economic problems. Gaps exist between designed and as-built performance due to problems of communication between stakeholders, lack of integrated design practices between professionals, operational difficulties and unplanned behaviours of building users.

3.2 Individual Behaviour

People are inherently subject to and highly influenced by social and organisational norms. Those who are well informed about sustainable practices are more likely to adopt responsible views and those views translate into corresponding behaviour [18]. Simply educating people is not wholly effective and environment is critical in facilitating behaviour [19]. It was also concluded that general positive attitudes to the environment are not very predictive of eventual behaviour [20]. Factual knowledge can lead to a change in attitude toward behaviours linked to social and moral values that lead to subjective norms (socially appropriate action) and will eventually lead to behavioural intention and outcomes [21].

On an individual level people tend to over-discount the future in their consumptive behaviour [22] e.g. individuals purchase energy *inefficient* appliances despite the implications for future energy costs by failing to calculate and make decisions based on payback periods. Substantial empirical work shows that people tend to make self-serving, or egocentric, judgements of what is fair [23]. People also tend to see themselves, their future, and the world in a better condition than it is or will be (positive illusion). Public opinion polls on environmentally responsible behaviour show that people want to project an aspiration of their values rather than a reality of their lifestyle or action, commonly known as 'greenwash' or in more contemporary language 'eco-bling'. At the most basic level people continue to associate sustainable buildings with 'hippie' culture and create the false assumption that all green buildings are associated with the environmental movement and see economic competitiveness and environmental protection as mutually exclusive or opposed.

Interventions and strategies can modify individuals' environmental behaviour. Antecedent interventions (intervention before unsustainable behaviour) such as signs and prompts can be incorporated into a building to remind us that we have attitudes which are favourable to sustainable behaviour. Consequent strategies involve intervention after a given behaviour and can include positive reinforcements through rewards for pro-environmental behaviour e.g. feedback on CO₂ or money saved. Consequent strategies have proved better than antecedent ones in relation to some individual pro-environmental behaviour [24]. "The practical challenges for such initiatives are far-reaching and would involve sizeable shifts in the culture of planning and building practice: if we are serious in understanding the conditions for a more sustainable society, we need to recognise that

the more directly involved people are in the construction and preservation of their dwellings, the more likely they are to care for and cherish the planet we all inhabit" [25].

The key to encouraging sustainable behaviour is to remove barriers. People consciously and subconsciously tend towards congruency in their environments, they want their actions to match perceived outcomes based on social norms (cause and effect) therefore in a sustainable building where operation, services, technologies and materials are inherently sustainable, it can be argued that sustainable and ecological behaviour is more likely. Individuals who believe it will be difficult to carry out environmentally responsible behaviour are unlikely to engage in that action [26]. "It is behaviour, lifestyles and peoples aspirations that are at the heart of achieving a sustainable environment. The form of urban areas and buildings within them, do not determine sustainable behaviour, but they might provide the right setting for it" [27].

Attitudes formed from direct behavioural experience tend to be stronger and are more predictive of later behavioural change than are passive or abstract attitudes [28]. Therefore the more we use buildings as an experiential teaching and learning resource the more likely sustainable behaviour is to occur.

3.3 Organisational behaviour

It has clearly been established that behaviour and environment mutually affect each other [29] and that "environment-behaviour researchers need to participate in design decisions as part of the design team in an attempt to put greater emphasis on building users and their effect on the performance of the building as well as the effect of the building on the sustainable attitudes and behaviours of the users" [30].

The development of buildings presents a complex set of processes and sustainability can often be seen as an extra layer of complexity. From case study analysis and evidence from other sources [31] it is clear that the built environment professions will have to make significant changes in their collective sustainable and organisational behaviours, partly driven by changes in mandatory legislative requirements.

Information available to individuals regarding the viability of green building options becomes a reflection of subjective organisational goals, routines and culture as much as objective facts [32]. Barriers to green construction on an organisational level are due to internal structure and interaction, language and terminology, rewards and organisational resistance [33].

3.3.1 Internal structure and interaction

The design and construction of a building creates a distinctive form of organisation in which a temporary culture becomes set, one which includes the roles, decision rules and power balances among each of the team members. Power and influence in the team can be a critical factor, often compromising the overall sustainability of the project as new environmental technologies and practices are introduced. Often when sustainability requirements are 'added' to a standard construction project, the roles and relationships become reconfigured into a form that is outside the standard operating procedure and will inevitably incur additional costs. This will invite resistance.

Structural relationships within the design and construction team are traditionally linear; client-architect-engineer-contactor-subcontractor, which tends not to promote the tight integration of sustainable systems (water, heating, power) needed in a high performance building. In a sustainable building, the team must engage early on and in a more integrated and collaborative fashion. Team members are challenged to discuss and adjust parameters that are traditionally made in isolation.

3.3.2 Language and terminology

Many of the new sustainable technologies, processes, materials and standards involved in sustainable buildings comprise of new terms that may not be understood or may be misinterpreted and can therefore cause resistance to adoption. Also the language of sustainability challenges conventional terminology requiring a new knowledge base. This new terminology can identify participants in the team who aren't yet embedded in the sustainable construction industry [34]. Lack of environmental literacy makes the link between energy conservation and climate change more difficult for people to understand and creates a reduced sense of urgency or motivation for addressing environmental issues, much less to develop sustainable building practices.

3.3.3 Organisational Resistance

Organisations tend to resist change [35]. People within them generally prefer long term certainty of structures and routines that have been historically in place and resist the process of changing them. Habitual routines can take form in taken-for-granted design practices or construction methods. Typically, the costs of learning new forms of sustainable design and construction practices are not charged to the client. With fixed resources, architects and contractors must invest in this learning process potentially to the cost of other critical activities.

Fear of the unfamiliar can also drive organisational resistance, particularly when the consequences of change cannot be predicted and can put individuals off embracing sustainable practices in the future. Psychological blocks can prejudice managers away from certain actions or responses to demands for change. This may deny a developer, architect or engineer any opportunity to consider longer term gains. Cost is an important issue for the client and the design and construction industry and when financial decisions are made on whether to invest in sustainable features and funds are limited, often the sustainable option is the first to be rejected. There needs to be full consideration of capital costs versus lifecycle costs and payback periods which are rarely factored in to project costs and are often not seen as a priority for both architects and contractors.

The consideration of sustainable technologies requires more time. New technologies must be identified, integrated and tested as the technologies themselves develop and improve. Time pressures can prevent full investigation and solving of environmental issues in the production of sustainable buildings. Sustainable design and construction can challenge established authority within organisations which can result in interdisciplinary rivalry or organisational resistance [36]. Does the addition of a new skill set fall to the architect, contractor, engineer or a new green or integrative design consultant? [37]. Existing professionals in building design and construction may resist these changes to protect their professional status.

Adoption of changes in practice is easier if presented as a positive and attractive option rather than as an issue of sacrifice [38]. Some professionals are put off by the phrase green or sustainable buildings and are much more engaged by terms like smart, intelligent or high performance buildings. The WISE building design aspiration was to have a clean, modernist and professional looking building, deliberately avoiding references to its green credentials in order to appeal to mainstream corporations in order to hold their events there.

3.3.4 Educational transformation

Construction professionals are highly influenced by the norms and rules introduced in their early training experiences. One approach is to integrate environmental education into existing curricula in the built environment sectors. This involves architecture and engineering curricula in the University, apprenticeships in the building trades, and even training of owners and building managers [39]. There are a growing number of sustainable construction training courses emerging in programmes related to architecture, engineering management, urban planning and environmental issues. Unfortunately, many do not foster cross-disciplinary collaboration necessary

for this holistic approach to understand the relationship between the built environment and the natural environment [40]. However, professional bodies are increasingly becoming engaged in driving the agenda through the accreditation of courses requiring sustainability in the curriculum. There is also a growing market in sustainability-related continuing professional development (CPD) courses for post qualification professionals.

Professor D.W. Orr [41] a leading academic in this field, speaks of “the hidden curriculum that is the building itself”. Much can be learnt throughout the entire construction process of an innovative sustainable building but there are inherent financial and technical risks in using the process as a research and development exercise when the ultimate aim is to produce a building to fixed schedules and budgets. In operation, a building has significant potential for research and study by both building professionals and students.

4. Case study

4.1 Methodology

Case studies involved interviewing key stakeholders at critical phases of the lifecycle of the buildings being studied, each aspiring to, or having attained the BREEAM ‘Excellent’ standard. The investigation of the interaction of factors and events highlighted successful common practices and innovative approaches whilst revealing problems and barriers encountered. This work is intended to highlight best sustainable practice, not only in the design, construction, operation and use of sustainable developments but how sustainable methods, materials, technologies and practices can be embedded in order to facilitate learning and teaching that ultimately encourage greater sustainable behaviour beyond the building development itself.

Face-to-face interviews were conducted over a period of two years from 2009 to 2010 for the five buildings, each in various stages of development. The interviews were designed to elicit responses to a set of semi-structured questions aimed at a wide variety of stakeholders throughout the four phases of development. This allowed for analysis of individuals’ perceptions and insights, as well as the collection of empirical data for quantifiable and generalisable conclusions.

4.2 The Wales Institute for Sustainable Education, Centre for Alternative Technology, Wales.



Fig.1 The WISE lecture theatre. Source:CAT

As well as having impeccable environmental credentials in terms of sustainable technologies, energy efficiency, passive design techniques and use of natural materials the Wales Institute for Sustainable Education (WISE) building (see Figure 1) provides feedback to its occupants’ data about their resource use and the thermal performance of the building fabric in the hope that this experience will influence their behaviour. The building is being used as a resource to teach and learn about a wide range of environmental topics providing sustainable space for research, workshops, lectures and seminars as well as accommodation and restaurant facilities all offering an experience of sustainable solutions in practice to influence and effect behavioural change. The main features of the WISE building include:

- Low embodied-energy construction materials such as earth and hemp
- Bio-composite, natural fibre technologies using hemp and lime
- Energy efficient glazing for maximum natural day lighting and passive solar heat gain
- Minimal energy requirements
- Solar water heating integrated into a district heating system
- Semi-transparent PV technologies used to provide both energy and shading
- Biomass combined heat and power linked to the heating system and grid
- Biological zero energy input sewage treatment systems
- Green transport systems using sustainable fuel sources.

4.3 Face-to-face interviews (key findings)

4.3.2 Design

One of the key design aspirations of the WISE building was to bridge the gap between preconceptions of 'hippie' culture and the needs of modern building users. From interviews undertaken many respondents stated how the building fulfils its corporate function by being aesthetically pleasing, modern, cutting-edge and 'non-rustic' whilst maintaining its sustainable credentials. It was stated by many respondents that the building has the 'wow-factor' which stimulates questioning from visitors who did not necessarily have an interest in sustainability.

The architect worked on a number of CAT buildings previously and was fully aware of the ecological ethos of the organisation, as well as the educational aims and objectives of the building and its potential for influencing sustainable behaviour. Clearly, having a shared sustainable vision between as many stakeholders as possible added to the success of the project.

The design team took an unconventional approach in the form of a partnering contract PPC 2000 [42] which involved the contractor from the start. They also engaged in a collaborative process called 'Planning for Real' which involved client, potential users, contactors, architects and engineers which, according to the project manager "achieved a good understanding of the purpose and function of the building at an early stage". Experiences gained from this showed that more detail should be written-in, particularly quality control and working practices.

It is not surprising that CAT as an organisation is dedicated to promoting sustainability and is a highly immersive environment for its staff in every aspect of sustainability and many of them stated that The WISE building had a highly positive impact on their sense of well-being, working practices and productivity.

4.3.3 Construction

Sustainable building requires innovative technologies, methods and materials, and sub-contractors reticence is shown either through higher pricing, reluctance to engage with new processes or outright refusal to perform the work. However, contractors are increasingly realising that this is an emerging market and must embrace sustainability to remain competitive. They justifiably fear that equipment or process failure will fall on their shoulders. On the WISE project there was a catastrophic failure with the innovative rammed-earth walling structure due to unfamiliarity with the building techniques required, a lack of expert site supervision and training, which instigated a circle of blame between architect, project manager and contractor.

This ultimately led to litigation, significant financial losses, delay and ultimate withdrawal of the contractor from the project. When a new contractor was employed who had considerable experience of sustainable materials and techniques there was a palpable change in on-site confidence. Contractors, engineers or architects who are familiar with the technologies can avoid these situations by offering some form of indemnification for certain conditions of technological or

material failure. It should also be noted that they will have learned from this failure and they are now in a stronger position, having developed expertise in this field.

Working practices and methods were not that technically difficult but required some training and skills enhancement. Training in principles of ecological building were perhaps more important. This has more up-front costs but would have ultimately benefitted the project in terms of quality, longevity and durability of the building. There should be more consideration by contactors of lifecycle and sustainable thinking. Financing should reflect sustainable benefits.

Interestingly, contractors' perceptions of sustainability changed through the use of environmentally responsible materials e.g. site workers were impressed by the health benefits of working with low VOC paints rather than their environmental credentials.

It was found that mainstream contractors view many of the sustainable technologies and materials as experimental and untested which require duplication of processes to perfect their application and to achieve the same standards as more conventional methods. This suggests that one of the new processes might be for the contractors to build full scale mock-ups of the building components so that they are able to then duplicate the final solution in the real building, another example of a change in practice.

4.3.4 Operation

Several respondents from the interviews stated that there hadn't been enough time since the opening of the building in June 2010 to establish anomalies between design aspirations and operational performance and that the building needed to be operated for at least a whole year to fully develop the operating systems and potential implications for building users.

One respondent noted that "increased sustainability can lead to decreased functionality" e.g. the bleeding from untreated knotty timber caused finishes to be spoilt and was far less resistant to moisture, leading to rotting and the need to replace and redecorate far sooner than its intended design life.

The rammed earth walling system that is highly sustainable, in terms of embodied energy did not perform well acoustically in-use, and sound-buffering had to be installed retrospectively. Also excessive solar gains were alleviated by the addition of shading. It should be noted that despite the problems with the rammed-earth wall it is considered one of the main attractions of the building and elicited a lot of questioning and learning.

Errors in detailing and lack of understanding of sustainable construction techniques during the construction phase led to a disproportionate amount of reactive maintenance being required and impacted on the day-to-day operation of the building which had significant financial implications reducing available space for teaching and high yield corporate events.

It was stated that a new profession in the field of building management is required, one that understands environmental design, wider sustainability issues and building technology and should be engaged early on in the design process.

In terms of the space and sustainable behaviour, the building enables closer interaction of both staff and students increasing organisational efficiency and productivity. Natural daylight and the vistas were cited as a highly positive aspect of the building impacting on the general health and well being of occupants. It was also stated that the quality of finish compared to other buildings on the site caused people to dress differently and operate more professionally.

The educational function of the building as a teaching and learning resource is limited as it had strategically focussed on corporate events and the provision of educational space but teachers

stated that being able to physically point to real examples of sustainable practices, materials-in use, systems in-use and finishes that have been achieved was a great educational benefit.. Some respondents stated that it is not obvious that the WISE building is an eco-building and this had a big impact on corporate visitors and offers an opportunity to influence visiting organisations once the sustainable features of the building were highlighted. An opposing view is that the building should 'explain itself'. The WISE building certainly demonstrates architectural honesty but it can be argued that it could have incorporated more educational features.

The ability to guarantee a given temperature for teaching and corporate events proved quite difficult in a low energy climate-responsive building. From the user survey (see Figure 2) a significant number of people considered the building to be cold whereas others thought it to be warm, some stuffy and others airy. This is consistent with many other building evaluation surveys and illustrates the variability of comfort levels. Staff tend to be more environmentally aware and therefore know how to maintain comfort levels but students and visitors' lack building knowledge, and unsustainable behaviour was cited as a contributing factor to poor in-use performance. Generally, it is not understood how the thermostats work and they are often set too high, not allowing for the time lag associated with under-floor heating, and they tend to open windows despite there being adequate natural forced ventilation. This impacts on the imbalance between designed energy use and actual energy usage.

4.3.5 User Survey



Fig.2 User survey responses

wordle.net

Twenty one students taking the MSc Architecture: Advanced Environment and Energy Studies course, based in the WISE building, were asked to complete a questionnaire in order to elicit their responses as users of the building, its impact on their teaching and learning experience as well as physiological responses to environmental conditions and how the building has influenced their behaviour. The students are from a wide variety of backgrounds including architects, project managers, planning consultants, trades people and non-specialists in the field. Figure 2 illustrates by way of a 'word cloud' responses to the question 'what 3 words come to mind

when you think about The WISE building?' The 'cloud' gives greater prominence to words that appear more frequently in the source data.

Overwhelmingly the responses were positive with greatest prominence given to natural light, space, aesthetics, natural materials and sustainability. Some negative responses related to acoustics, thermal comfort, sterility and unpredictability which were reinforced by responses from the face-to-face interviews.

As part of the survey students were also asked what they considered to be the most and least sustainable features of the WISE building. From their responses the top three most sustainable features are, in order of popularity, natural daylight, natural materials and passive solar design. The least sustainable features are shown to be poor ventilation and air quality in the living accommodation, the high cost of the project, remote location, poor acoustics in the lecture theatre and poor internet access.

5. Conclusion

If we are to live more sustainable lifestyles our built environment should be responsive to our needs in a sustainable way whilst our behaviours should not undermine the potential for our buildings to achieve their sustainable design aspirations.

Among all stakeholders in the provision and use of buildings there needs to be a common language of sustainability. In their design, construction and operation buildings need to avoid giving incongruent messages to users and allow them to easily engage with the buildings functions and operations whilst understanding inherent sustainable features and how they can be realistically interpreted and made relevant to their lifestyles.

All sustainable buildings have the potential to be a valuable teaching and learning resource for developing an understanding of sustainable methods, materials, technologies and behaviours over the whole of their life cycle. It has been proposed that raising peoples' awareness in terms of the sustainability of their own built environment and landscapes can have considerable impacts on embedding lasting sustainable behaviour, tackling pressing environmental concerns.

The study of exemplar sustainable buildings and the interaction of factors and events can highlight common practices and innovative approaches and methods as well as revealing problems and barriers encountered in achieving sustainable environments.

It is hoped by highlighting best practice, not only in the design, construction, operation and use of sustainable educational and community buildings but also how sustainable and educational features can be embedded throughout the building which will inform sustainable building design and enhance sustainable teaching and learning practices, change attitudes and ultimately encourage sustainable behaviour.

It can be argued that sustainable buildings allied to sustainable education can have a significant impact on environmentally responsible behaviour through combined technical and pedagogical interventions embedded into the design, construction and operational processes.

The research will continue to try and establish the correlation between sustainable buildings, environmental education and pro-environmental behaviour to ultimately inform the built environment professions through dissemination of research findings and to develop strategies that will have optimum environmental and educational benefits.

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APPENDIX A

Summary of findings from case studies

General lifecycle considerations

A new role of carbon/sustainability manager/champion with real power to take responsibility for the carbon performance during the design, construction & operation of the building

A single organisation with whole life responsibility for a building, ensures a low carbon approach to design, construction, fit-out, maintenance, refurbishment, retrofitting.

Creating a low carbon construction industry would develop skills and expertise that would be of great value to other sectors.

Governments and industry need to work together to identify best practices that stimulate the market for low carbon and energy efficiency measures.

Potential clients need clear explanations of the social, economic and environmental benefits of sustainable and low carbon measures, materials, technologies and methods.

Common language for sustainability is required throughout the construction professions.

Poor built environments reinforce unsustainable behaviours

Design considerations

Early and comprehensive stakeholder involvement (BREEAM assessor, contractors, facilities managers, users and educationalists)

Industry should agree a standard method of measuring embodied carbon for use as a design tool, and for the purposes of scheme appraisal e.g. Inventory of Carbon & Energy [?]

Interdisciplinary working practices needed. Integrated design practices.

Embed sustainable materials and technologies into buildings and make them 'transparent' to enable users to better understand sustainable principles and the functionality of their buildings.

Embed sustainable and educational aims & objectives into building design, construction, operation and use to encourage greater learning and sustainable behaviour.

Balance technical solutions with human interaction and behaviours.

Participatory design. Encourage participation of local community and building user groups early in the design process.

Construction considerations

Comprehensive training to move sustainable systems, methods, techniques and skills in mainstream construction.

Early contractor involvement will ensure that the design does not compromise sustainable construction

In most construction companies the sustainability manager has a facilitation role, rather than power to drive real change. Sustainable/carbon management needs to be a high level role.

A construction-specific accreditation scheme for companies committed to improving their environmental credentials.

Accredited courses for specialist low carbon technologies and techniques to ensure adequate skills & expertise to avoid undermining the credibility of sustainable building projects by unskilled workers and poor performing materials and technologies.

Operational considerations

A well-managed project handover (soft landing) with training for occupants and facilities managers on new low carbon systems, materials and technologies. A building should not be considered as complete until it performs in accordance with its design criteria

Incorporate and embed features that enable the sustainable operation of the building and opportunities for user engagement.

A need for up-skilling energy, carbon & sustainability knowledge with the maintenance of buildings. The role of sustainable building/facilities manager could have effective power to take responsibility for the energy and carbon operational performance.

User considerations

A need for raising awareness and training in the operation and use of buildings for occupants in order to maximise energy efficiency, carbon saving and use of sustainability features of buildings

Connect lifestyles and working practices to daily/seasonal cycles.

To What Extent Do Sustainable Buildings Encourage Sustainable Behaviour?



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Summary

This paper represents the ongoing study of theory and practice in relation to the development of sustainable buildings and the embedding of sustainable processes and features to minimise their environmental impact, and to positively influence sustainable behaviour throughout their lifecycle. This has involved an extensive literature review, an online survey, analysis of project documentation and the assessment of exemplar sustainable buildings via case studies involving face-to-face interviews and questionnaires.

Keywords: Sustainable architecture, sustainable behaviour, behavioural change, environmental education, environmental psychology.

1. Introduction

Buildings currently account for around 50% of total carbon emissions in the UK totalling 360 million tonnes of CO₂ per annum. The Climate Change Act 2008 in the UK sets legally binding national greenhouse gas reduction targets of 34% by 2020 and at least 80% by 2050 compared to 1990 levels. The recognition that building practices need to change are evidenced by revisions in legislation with targets for zero carbon and low water usage new-build housing by as early as 2016 and new build non-domestic buildings by 2019 for England and Wales.

A sustainable building offers a valuable learning and teaching experience throughout its design, construction, operation and use with the opportunity to reduce our environmental impact as well as encourage greater economic and social sustainability. By embedding, throughout the design, construction, operation and use, sustainable building techniques, interactive features, natural sustainable materials and renewable technologies, the living and learning space becomes an example of sustainability in action.

It is proposed that this enables those involved throughout the building process, from designers, engineers and contractors through to the building users to directly experience and undergo 'deeper experiential learning', raising awareness of environmental issues and enabling people to lead more sustainable lifestyles and working practices. It is the aim of this study to establish the extent to which sustainable buildings can encourage greater sustainable behaviour throughout their lifecycle and beyond the building itself through the experiences of all stakeholders.

Sustainable behaviour can be defined as behaviour that satisfies our needs today, without diminishing the prospects of future generations to do the same. We often hold certain values about what our behaviours should be, that in reality do not result in action, otherwise known as the 'value-action gap'. This is particularly true with behaviour related to sustainability which is often seen as unattainable in our working practices and everyday lifestyles falling outside our economic and social norms. By applying behavioural science theory to the design, construction, operation and use of buildings it is hoped to understand how buildings can influence peoples' behaviour to be more sustainable.

2. Discussion

Common obstacles faced by the sustainable building movement are technological, economic, social and psychological. It is often the behaviour of individuals, organisations and institutions that determine the level of engagement with the sustainable construction agenda. This paper looks at how the processes of developing a sustainable building are affected by human behaviour and in turn how sustainable buildings can influence the sustainable behaviour of all stakeholders.

Theoretical principles on how buildings can affect behavioural change are reviewed in the paper and consider evidence from a number of disciplines including change management, environment-behaviour studies, environmental psychology, ecological psychology, environmental education and education for sustainable development in order to identify opportunities for making sustainable construction a mainstream activity.

The use of exemplar sustainable building projects as case studies elicits valuable information about the use of innovative practices, materials and technologies and the experiences and behaviours of key stakeholders via direct face-to-face interviews and questionnaires. Some of the initial findings are presented in the paper.

Each of the buildings investigated has been selected for their exemplary sustainable and ecological credentials and for their link with environmental education and the promotion of more sustainable lifestyles. The development of sustainable buildings used for educational purposes highlights how best practice can be achieved and adopted as the future norm. This paper looks at evidence from one of the case studies, The Wales Institute for Sustainable Education at The Centre for Alternative Technology, a £5 million complex dedicated to the promotion of sustainable design, technologies and lifestyles.

It is possible to incorporate features that encourage and enable sustainable behaviour such as building performance feedback data, user control over natural process, the appreciation of the aesthetics, health and environmental benefits of natural and sustainable materials, how passive design systems work and the operation of (renewable) energy systems. This requires a level of integration and understanding by all stakeholders with a holistic view of buildings, structure, operation and responsibility for the health and well-being of people and our planet.

The research will continue to try and establish the correlation between sustainable buildings, environmental education and sustainable behaviour to ultimately inform the built environment professions through dissemination of research findings and to develop strategies that will have optimum environmental and educational benefits for users.

If we are to live more sustainable lifestyles our built environment should be responsive to our needs in a sustainable way whilst our behaviours should not undermine the potential for our buildings to achieve their sustainable design aspirations.