BARRIERS TO CONSTRUCTION INDUSTRY STAKEHOLDERS' ENGAGEMENT WITH SUSTAINABILITY: TOWARD A SHARED KNOWLEDGE EXPERIENCE

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Abstract. Sustainability ill-practices in the construction industry can have major drawbacks on meeting governmental targets on carbon and energy reduction. Using a mixed-method approach drawn from three studies to explore the level of engagement of construction stakeholders in adopting government sustainability agendas, the research identifies a wide range of perceived barriers, which operate broadly at 'individual' and 'organisational' levels. Sustainability knowledge in construction is fragmented, diverse, embedded in various documents, and developed in a non-concerted and integrated way across stakeholders, localities, regions, and countries. There is an emergent need for a socio-technical 'knowledge solution' to create circles of impacts that bind building professionals, energy administrations, and citizens in a shared sustainability experience to address a number of issues.

Keywords: sustainable construction, awareness, engagement, knowledge management, stakeholder perceptions, behaviour.

Introduction

The UK government has raised political and economic attention on the state of the climate, in particular during its presidency of the European Union in 2005 and the G8, and has set to meet EU commitments to achieve an 80% cut in CO_2 emissions by 2050 (HM Government 2010). It is widely acknowledged that our built environment is responsible for some of the most serious global and local environmental change (European Commission 2005; BERR 2007;

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Clarke *et al.* 2008). Creation and operation of the built environment accounts for at least 50% of all energy consumption in Europe (Martinaitis 2006; European Commission 2005), conversely, in the UK more than 50% of all carbon emissions can be attributed to energy use in buildings (MPA 2011). The construction industry therefore faces pressure to increase the sustainability of its practices, which is understood to imply significant changes in the industry's understanding of the demands of society and of its clients, as well as its own sense of corporate social responsibility, and implies major changes in its working practices (Rezgui 2007; Rezgui, Miles 2011).

Following a 2007 announcement for zero carbon homes from 2016, the UK Chancellor of the Exchequer announced in the 2008 budget a zero carbon target for schools from 2016, Public sector buildings from 2018, and all other non-domestic buildings from 2019 (BSRIA 2009). Supporting these policy requirements, the UK building regulations have already gone through a number of amendments with the next expected in 2013, with the target CO_2 reductions embedded. Wales, which forms the focus of the research, has set aspirations for zero carbon for new buildings earlier than proposed in the rest of the UK (WAG 2009).

Whilst there is a wide public awareness of climate change acknowledging main causes and concerns (DEFRA 2002), and scientific evidence highlights the significance of the human factor in reducing the impact of climate change (IPCC 2001, 2007; Schellnhuber *et al.* 2006), only a minority engage with effective measures to reduce their lifestyle impacts on the environment (Norton, Leaman 2004; Lorenzoni *et al.* 2007). Reducing the impact of climate change is linked fundamentally to our built environment and implies a need for a radical change in values and behaviour towards a paradigm of sustainable construction. In fact, the aspiration for energy and CO_2 reduction by the UK government inevitably involves the need for widespread social change, including by citizens (Lorenzoni *et al.* 2007).

Significant discrepancies between public awareness about climate change and natural resource depletion, on the one hand, and behavioural change, on the other, have been noted (Lorenzoni *et al.* 2007; Whitmarsh *et al.* 2011), suggesting complex interactions of psychological, social and environmental factors influencing behaviour (van Vliet *et al.* 2005; Whitmarsh *et al.* 2011).

While there is considerable work towards regulating the energy and construction sectors, there is less systematic evidence regarding stakeholder responses to whole-system transformations and how such transformations are likely to be experienced, enacted and negotiated in terms of stakeholders' everyday practice and work. Building on existing literature, this paper explores the constraints and factors that influence individual stakeholders of the construction industry to adopt sustainable practices at work, including changing their own behaviour, the reasons underlying these perceived constraints, and policy implications for encouraging engagement. The paper draws upon findings of three recent mixed-method studies conducted across Europe and in the UK (Wales) on stakeholder perceptions and responses to sustainable construction. Moreover, the research involves a critical understanding of: (a) the role that stakeholders' activities play in influencing carbon emissions and energy consumption; (b) stakeholders' sustainability information sources and how these are perceived and used.

1. Related works

Related to the core theme of the paper, it is interesting to note that despite a large public awareness of climate change and a general shared concern (Spence *et al.* 2011), there is limited behavioural response from the general public (Lorenzoni *et al.* 2007). Research indicates that the socio-technical practices that impact on sustainability are embedded in the everyday; that is, they are intangible and largely taken-for-granted (Burgess, Nye 2008). As a consequence, construction industry practitioners, who predominantly work for Small and Medium-size Enterprises (SME), are unlikely to be fully aware of the daily practice implications resulting from transformations within current policy and regulatory environments (Rezgui *et al.* 2010).

The construction industry is characterised by a complex socio-cultural and organisational environment reflected by its endemic resistance to change (Vakola, Wilson 2004) and the requirement for different management strategies due to contradictory interests of owners, contractors and craftsmen (Lill 2009); indeed it is perceived as 'unique' when compared with other sectors (Egemen, Mahomed 2005). In developing the regulatory environment to meet carbon and energy reduction targets, it is essential to enable long-term changes in individual attitudes and behaviours while promoting positive engagement.

The term "engagement" in this paper extends a previous definition by Lorenzoni *et al.* (2007) which concurrently involves cognitive, affective and behavioural aspects at an individual level to embrace wider values embedded within the organisational culture. In fact, social identity is perceived to be an important influence on people's energy behaviour (Steg *et al.* 2001; Nye *et al.* 2010), which implicitly highlights the difficulty in changing consumption habits. Whitmarsh *et al.* (2011) discuss the convergence of findings from the work around public engagement with climate change and the work on learning about climate change and carbon, and argue that the literature demonstrates that both individual and institutional dimensions of engagement are vital to understanding barriers to adoption of low-carbon lifestyles. Furthermore, they highlight the need to understand the 'situated' meanings associated with carbon; i.e. how individuals translate and apply knowledge about carbon and climate change to their daily lives through processes of objectification and anchoring.

In direct relation to this paper, Mathur *et al.* (2008) explore stakeholder engagement in sustainable construction. They note three distinct approaches for conceptualizing stakeholder engagement in construction projects. These relate to viewing stakeholder engagement as: a management technique; an ethical requirement; or a forum for dialogue to facilitate mutual social learning. They argue that stakeholder engagement should be considered from the perspective of an opportunity for social learning. They suggest that dialogue can be useful in increasing awareness, changing attitudes and affecting behaviours. They offer a comprehensive review of stakeholder management and its research and practice in construction.

Hence, engagement is here seen as both an individual and collective phenomenon reflected in the team and project-based nature of the construction industry. Stern (2000) argues that in addition to attitudinal factors, behaviours are influenced by contextual forces, personal capabilities and habits. This is in line with related literature drawn from environmental psychology which highlights the influences of past behaviour, knowledge, experiences, feelings, social networks, and institutional trust on individual attitudes and behaviour towards environmental issues (Blake 2001; Kollmuss, Agyeman 2002).

Models of these various factors have been proposed, including the theory of reasoned action (Ajzen, Sheikh 2013) and theory of planned behaviour (Ajzen 1991) which postulates that beliefs determine intention to act. However, these theories have been critiqued on the grounds that they present an individualistic and rational perspective of behaviour, and consequently more contextual models have been proposed (e.g. Marks *et al.* 2008). It is interesting to note Tanner's (1999) ipsative theory of behaviour which identifies internal and external conditions as potential constraints to pro-environmental action.

Whitmarsh *et al.* (2009) define the concept of carbon capability as: 'The ability to make informed judgments and to take effective decisions regarding the use and management of carbon, through both individual behaviour change and collective action'. Three core dimensions of carbon capability are identified (Whitmarsh *et al.* 2011): (a) decision-making (knowledge, skills, motivations and judgments), (b) individual behaviour or 'practices' (e.g. energy conservation), and (c) broader engagement with systems of provision and governance (e.g. lobbying, voting, protesting, creating alternative social infrastructures of provision). While this addresses larger public concerns, there is a gap in similar understanding of stakeholders across the construction value chain, which is addressed by the paper.

2. Methodology

A methodological challenge for the research is to avoid a narrow scoping of the research questions thereby providing a stimulus for meaningful engagement by the research participants (i.e. construction stakeholders). Evidence from behavioural decision research indicates that people do not come to unfamiliar or complex technological issues with fully formed views but nevertheless can be supported in the construction of their preferences through systematic elicitation and deliberative procedures (Morgan *et al.* 2002; Lichtenstein, Slovic 2006). Hence, the research utilises a mixed-method approach involving three studies incorporating qualitative and quantitative methods. The research is located within theoretical traditions that take socio-technical systems as the focal unit of analysis (Rip, Kemp 1998). This perspective provides a robust foundation for analysing whole built environment sustainability systems understood as linked processes of social and technological practices (Smith *et al.* 2005).

The paper addresses two research questions:

– RQ1: What are construction stakeholders' sustainability information needs and government provision deficiencies?
– RQ2: What are construction stakeholders' engagement barriers with governmental carbon and energy reduction targets?

These questions were explored via three mixed-method studies. The first study, which addressed RQ1, employed an online Europe-wide survey (February–April 2009) from which 252 responses were received with participants being demographically representative of the total population sampled. Quantitative data were analyzed in SPSS and qualitative data were coded thematically in NVivo. Limited sustainability best practice, regulation awareness and information provision deficiencies emerged as key themes from the consultation and provided the ground to address RQ2. To address this question the methodology employed two further studies focused on industry consultations in Wales. The second study was via three workshops

(c.70 participants in total) and a series of 15 semi-structured interviews with key industry representatives (May–September 2009). The first two workshops explored stakeholders' knowledge, understanding, attitudes, values and behaviours, and helped identify key barriers to sustainability engagement in Wales which were then debated and confirmed in a third workshop hosted by the Low/Zero Carbon Hub in Wales (Wales LZC Hub). The Wales LZC Hub is a coalition that is supported by the Welsh Government, the building industry, housing, and voluntary sectors, to help meet the policy targets. The findings from these workshops fed forward to a series of interviews where identified barriers were discussed from a variety of socio-technical perspectives. The third study involved consultations within two workshops and 13 focus meetings (a mix of one to one and small group consultations) (February–November 2010), which concentrated on addressing perceived barriers to engagement. A total of 27 stakeholder organisations took part in the consultations, including: construction companies and practitioners, advisory groups, umbrella professional organisations, consultants, policy makers and education and training bodies.

Due to the nature of the various consultations there is a need for anonymity of participants; however Table 1 provides an illustration of the representative nature of the stakeholder organisations that have taken part in our two studies in Wales:

Table 1. Illustration of the Wales participant organisations

Organisation name	Organisation type
Arup	Engineering, design, planning, consultancy
Bentley Systems	Software developer (for AEC market)
Blaenau Gwent County Borough Council	Local Government
bre	Consultancy/research
Capita Symonds	Consultancy
Carbon Trust	Advisory group
Civil Engineering Contractors Association Ltd	Trade Association
Constructing Excellence in Wales	Best practice organisation (built environment)
Corus Group	Steel producer
Cowlin Construction	Main contractor/construction company
Davis Langdon	Consultant
Design Commission for Wales	Public sector - design champion
Energy Saving Trust	Non-profit energy saving advisor
FMB	Trade Association
Gaunt Francis	Architectural practice
Halcrow Group Ltd	Consultant - infrastructure and planning
Lee Wakemans	Project management, QS, H&S
Micaul Solar	Renewable energy systems
Mott MacDonald	Consultancy
Parsons Brinckerhoff	Consultancy
Powell Dobson Architects	Architectural practice
Rounded Development Enterprises Ltd	Social Enterprise – education in sustainable building

Continued Table 1

Organisation name	Organisation type
Smarta Technology	Installation – home automation and electrical
Summit Skills	Sector skills council – education
Utility Partnership	Utility infrastructure and energy management
White Design	Architectural practice/sustainability consultant
Willmott Dixon Construction Limited	Construction, housing and property

3. Discussion of results from the Europe-wide and Wales consultations

The studies indicated stakeholders' awareness and concern about the effect of ill-practices on carbon emissions and energy consumption. However, whilst many of our participants are aware that employees in organisations and on projects have moral responsibilities to deliver environmentally friendly buildings this does not systematically translate into sustainable practices and engagement as defined above, namely in terms of cognitive, affective and behavioural aspects at both a personal and organisational level. Indeed the adversarial nature of the construction industry, exacerbated by a culture of blame and tight financial margins, militates against effective actions at individual, team and to some extent organisational levels. The studies highlight possible reasons for this disparity between awareness and concern, and a pro-active level of engagement with sustainable construction. It was observed that various constraints result in limitations to engagement with sustainable construction. Consistent with the position of Lorenzoni *et al.* (2007) that the various barriers that function to limit cognitive, affective and behavioural elements of engagement can be interpreted either as principally personal or social, we analyse the perceived barriers in terms of the individual (section 3.1 and Table 2), organisational (section 3.2 and Table 3) and the wider industry levels (section 3.3 and Table 4). Tables 2, 3 and 4 present a summary achieved by review and amalgamation of the triangulated findings from the studies; they include quotes from the qualitative data and some supporting quantitative data results.

3.1. Individual perceived barriers

The clearest immediately identifiable perceived barrier to engagement is a lack of "actionable" knowledge about sustainable construction (Table 2), which manifests itself in various forms, including: (a) lack of knowledge pertaining to best practices; (b) the accessibility to existing relevant codified knowledge; and (c) the perception of information overload. The latter perception implies the need to note the distinction between 'knowledge' and 'information' as inferred from the comments recorded, most succinctly encapsulated by the comment regarding *"drowning in a sea of information yet starving for knowledge"*. The epistemological dichotomy between information and knowledge is not new (Rezgui *et al.* 2010). A commonly held view is that data are raw numbers and facts, information is processed data, and knowledge is authenticated information (Machlup, Mansfield 1983; Vance 1997; Rezgui *et al.* 2010), a view commonly shared in construction circles (Rezgui *et al.* 2010). However,

Table 2. Individual perceived barriers to engagement with sustainable construction

Individual perceived barriers	Triangulated qualitative and quantitative examples
Lack of knowledge about sustainable construction, including practices and principles; availability / accessibility; information overload	*"BREEAM Codes tell us what to achieve in terms of rating but not what needs to be done to attain this rating."* *"There is a need for pervasive, 'embedded' sustainable construction processes."* *"The subject area is perceived to be enormous: people think 'where do I start?' The information is there – but how to find it?"* *"It is sometimes hard to get the basics; not so easy to find the basic stuff. There is just something missing; maybe knowledge is often in people's heads and you don't know who, or how to get to them."* *"When I am faced with a 76 page report, should I read it or just skim it? It's almost like learning for a degree; we need to dissect and integrate the information into our systems and understand how it fits with what we are doing. A library and indexing system is required; it is difficult to know where to put things."* *"We are currently drowning in a sea of information, but starving for knowledge."* *"Raw data are required; suppliers are good at providing this for specific products."* *"I need product information now; products are changing every day of the week."* *"A lot of people in power still don't know the basics."* In the quantitative survey the respondents were asked to indicate what type(s) of information they currently need to access and use in their work. The highest demand is for: Standards (79%), and Regulatory Documentation (78%). The main topics for which information is required are: Environment (68%); Energy (54%).
Uncertainty and scepticism about the necessity for, and effectiveness of sustainable construction practices (both industry stakeholders and end-users)	*"Transfer from knowledge to action: we know what to do, but not 'how?' or 'why?'"* *"We know how to manipulate environmental assessment methods such as BREEAM to meet current sustainability regulations. However, the underpinning design interventions do not embed genuine sustainability best practice".* *"There is a need for clarity to reduce complexity."* *"We need reliable cost information – cost/disruption/payback and reliable information on renewables; and to ensure that consumers are on board with the whole sustainability ethos: how much is it going to knock off my energy bill/what might it do to my house/how much have I increased the value of my property?"* *"Sustainability needs to be seen as a success at the first time, otherwise 'once bitten twice shy' will put people off, and push them away."*
Distrust in information sources including consistency, validity, authority, and timeliness	*"Aside from that which refers to experts' specialities, sustainability information is not generally transparent and can be open to interpretation. People often have to talk to others for corroboration. It can take a lot of time to find the bits that are useful; some companies contradict one another."* *"Information sharing is very valuable but it is not as good as it should be because of the commercial edge. We need some neutral information."*

Continued Table 2

Individual perceived barriers	Triangulated qualitative and quantitative examples
	"The biggest issue is trust: that people won't misuse the information that you put out, and how reliable is the information you see?" *"Is this giving us up-to-date information? Is it easy to find? Is what we want there?"*
Reliance on technology including new technologies for sustainability, and for information retrieval	*"IT literacy varies across the supply chain."* *"Lack of trust/faith in new technologies is a barrier to innovation."* From the quantitative survey web portals are the main channel to access Standards (82%), and Regulatory (87%) documentation. There is considerable dissatisfaction with this current practice: Standards 40%, Regulatory Documentation 44%.
Resistance to lifestyle change Perceived threats include changes in living standards, inconvenience, cost	*"There is a need to change people's behaviour – promoting/implementing sustainable lifestyles."* *"Various barriers may be identified, including: lack of understanding the consequences of our actions; making changes everyday; lack of consistency of information; and that consumers don't want to act alone.* *"Practitioners need to ask fundamental questions even for the client, for example 'how will you live there?' Social factors have to be understood. Sustainable building is: social, environmental, and financial."* *"Behaviour change also includes detailed payback to the householders."*

it can be argued that the presumption of hierarchy from data to information to knowledge with each varying along some dimension such as context, usefulness or interpretability can be open to interpretation (Rezgui, Miles 2009). Indeed, it emerged from the workshops that there should be a widely disseminated selection of the 'top ten' most important documents regarding sustainable construction. This suggests that large quantities of information are available, but they are widely dispersed and non-integrated, which introduces further complexity and barriers to innovation (Barrett, Sexton 2006).

This lack of, or abundance of ill-structured, knowledge may be a factor in creating uncertainty and scepticism about the necessity and effectiveness of sustainable construction. Practitioners indicate a need for clarity both for themselves and also to ensure that consumers buy into the need for sustainability activities during the operational stage of a building or facility. It is implicit in the statements regarding payback to consumers that in the case of some individuals a lack in transference of knowledge into action – being able to understand and explain 'how' and 'why' sustainable practices need to be adopted – constitutes a barrier to engagement. This is in line with observations made by the Low Carbon Construction Innovation and Growth Team (IGT) including: *"Where people are inclined to act through a sense of personal or corporate social responsibility, then either they will have done so, or they are prevented from doing so by a barrier to action. These will include the lack of available capital, or a reluctance to invest in improving the energy efficiency of a building when it may be sold long before payback"* (HM Government 2010). Furthermore, the IGT note that cost acts as a disincentive to retrofit as evidenced by the most frequently asked question during their work being: 'How are we going to pay for all of this?' (HM Government 2010). Additionally,

distrust in information sources exacerbates the disengagement because individuals feel that contradictions exist between information sources, and a lack of transparency leads to information being open to interpretation, as explicitly stated in the comment *"…sustainability information is not generally transparent and can be open to interpretation… some companies contradict one another."* The respondents indicate that commercial considerations bias the information available to them and there is a desire for reliable neutrality.

The studies indicate that web portals are a primary channel for accessing information by stakeholders, however there is widespread dissatisfaction with this method of retrieval. The need for dependable up-to-date information ensures that electronic media are heavily relied upon, yet wide variation in technological literacy remains a barrier to engagement in the industry. Conversely, this reliance on technology for information retrieval remains a barrier to engagement as it is closely tied to distrust in the sources, as shown by the comment *"Is this [source] giving us up-to-date information? Is it easy to find? Is what we want there?"* Our studies also indicate reliance on technology to be a barrier with regard to the plethora of energy tools available to aid in sustainable design (e.g. calculation tools, simulation tools, etc.) requiring specialist and expensive expertise; energy tools need to be user friendly, integrated with common design tools, and require minimum learning/training prior to use.

Resistance to changes in lifestyle emerged as a significant perceived barrier to engagement in sustainable construction, explicitly stated in such comments as: *"Practitioners need to ask fundamental questions even for the client, for example 'how will you live there?' Social factors have to be understood"* and *"Various barriers may be identified, including: lack of understanding the consequences of our action."* This is reflected in the literature indicating that whilst recent energy price increases have made people more aware of their behaviour, resulting in increased interest in, and installation of, energy efficiency measures, barriers that prevent householders from going further include: disbelief in the putative savings, savings being too small to overcome the disruption involved, concerns over the health and comfort effects of air-tightness and over-heating, and the fact that some householders just aren't interested (HM Government 2010). From our studies the practitioners feel that the end users' lack of understanding the consequences of their actions requires contextualisation of new concepts because terminology is 'key', and also that they must be able to identify who is trusted and who the decision makers are. These findings are also in line with the difficulties people have with visualising the consequences of their activities in terms of future climate change and that they tend to pay attention to immediate and personally relevant issues (Lorenzoni *et al.* 2007; Moser, Dilling 2004; Wilson 2002).

3.2. Organisational perceived barriers

The first perceived barrier in this category (Table 3) is the lack of a supportive organisational culture reflected in positive initiatives that enable sustainability information and knowledge nurturing. Participants emphasize the negative effect to engagement induced by the diversity of information they are faced with and the resulting information overload. It is interesting in this respect to note the "law of requisite variety" which states that only variety can destroy

Table 3. Organisational perceived barriers to engagement with sustainable construction

Organisational perceived barriers	Triangulated qualitative and quantitative examples
Lack of enabling initiatives Information and knowledge sources are fragmented, diverse, unstructured, non-integrated	*"Better collaboration [mechanisms] are required to source new materials and supply channels for them and to smooth processes throughout the supply chain."* *"Poor networking inhibits progress through a lack of communication."* *"The first port of call is often to post questions on a forum; sometimes you get answers that are more useful to someone else, but it provides leads to follow up."* *"If internet searching fails the next step is to ask 'whom do I know who might know?'"* *"Searching on particular websites is often rather unsatisfying; you need to know exactly where to look. We don't have time to keep up with other people's websites and [current practice] needs to be streamlined: we need to find and agree on the most important and most helpful pieces of information. There is the danger of information overload – there is loads of good information out there but no way to find and read it all. So many 200 page reports – where is the piece that is interesting/relevant?"* *"There is a need for videos on leaning up operations and to disseminate best practice. Plus, practical guides on-site – 'this is how to do xyz'; 'savings in reducing snagging.'"* Accessibility of information is the most important barrier regarding all of the information types in the quantitative survey: Standards 55%, Regulatory Documentation 59%
Lack of training Including understanding the skills need; raising the demand for skills; understanding how to up-skill the workforce	*"A Builders qualification is needed and then a platform for more knowledge, suppliers, etc. Also this should be in 2 parts: standard information and flexible where others can put in their knowledge."* *"We share knowledge between ourselves and key designers, but we are only very slowly managing to educate the clients and contractors."* *"There is a preponderance of 'general' and low-skilled workers, therefore a need for fairly simple regular refresher courses."* *"There are huge gaps in understanding – procurement issues especially – particularly in the public sector; individual clients don't know the question."*
Work overload and priority to expedite current tasks and activities Including within tight financial margins	*"Procurement is an issue – alterations to current procurement processes."* *"We should be allowing designers freedom to increase potential for innovation; we are seeing lots of good stuff, but the economic climate is not helping."* *"The [sustainability] targets are not necessarily the top concern in CE; the financial/economic climate is more of a concern."* *"Sustainable procurement and whole-life costing are now being addressed, but this is a bloody nightmare…"*
Lack of time for reflective actions and capitalizing on lessons learnt	*"The concern is putting [sustainability] into practice; how deeply do people understand the legislation and put it into practice?"* *"If someone makes a mistake, how do we stop the others making the same mistake?"*

Continued Table 3

Organisational perceived barriers	Triangulated qualitative and quantitative examples
	"We need to understand best practice – but we're also developing it: what we need to do is to instil into everyone the value of it. If it is instilled in the ethos of how you approach the job, then it is the natural way. The challenge is to ensure that you are trying to solve the right problem!"
	"We don't have time to share documents around – what do we get out of it?"
Lack of information / knowledge sharing Including commercial imperative, costs, trust	*"There may be some reluctance to share from other companies because of the feeling that if you tell everyone what you know it will affect competition."*
	"There is good sharing of information between design teams, but inter-architects there is little because we have to strike commercial interests with cooperation."
	"People are happy to talk about key results, case studies – high level stuff – but not the detailed stuff."
	"Why should I share the information I have spent years developing for my competitors to take advantage?"
	"I don't think lessons learned are being done – especially in the public sector – and are not shared. We need to get councils to add into the contract with the client that a guide to how it was done is available."

variety (Ashby 1956). In fact, while carrying out their tasks individuals must effectively manage the complexity they face (Kidd 2013). This complexity involves the internal and external environment of the organisation. It is important for the internal diversity of an organisation to match the variety of the external diversity in order to cope with changes in this environment (Chilton, Bloodgood 2010). More importantly, organisations need to find a balance between factors that attenuate environmental complexity and those that amplify managerial complexity. However, modern organisations involve too much amplification, and too little attenuation (Kidd 2013). A parallel can easily be drawn with web-based information portals. These tend to focus on informational needs of individuals, while the environment in which such information is provided is often overlooked. Greater emphasis should be given to the processes that underpin knowledge activities, as opposed to the information and knowledge itself. This situation is exacerbated in a social context by limited collaboration mechanisms across the supply chain and throughout the construction lifecycle. Many of our participants maintain that poor networking infrastructures lead to unacceptable demands on their already tight time constraints, with dissatisfaction leading them to rely on whom they know being available to answer questions via traditional methods. Such activities are also dissatisfying as the people on whom they rely are also bound by the same lack of enabling initiatives and cannot be sure that they know exactly where to look for the required knowledge.

Another constraint explicitly identified by a wide cross section of participants was an immediate requirement for training throughout the industry, which is in line with the literature (e.g. Cardoso Teixeira *et al.* 2006; Vakola, Wilson 2004). This barrier is perceived to be

extensive as it includes not only the 'general' and low-skilled workforce that is a perennial characteristic of the industry, but also the huge gaps in understanding in the public sector, and the need to educate clients. It was noted in one workshop, for example, that a worker may be supplying the most highly energy efficiency rated window but unless he knows how to fit it properly it will be rendered energy inefficient. This implies not only a need for up-skilling but also a lack in understanding the sustainability implications of common work practices. There is also a financial constraint embedded in this barrier – as one participant noted: *"we have to consider finance – the necessary changes may imply increased expense."* This consideration is also explicitly tied in with the perceived barrier of work overload and priority to expedite current tasks and activities. The industry remains constricted by tight financial margins, the result being that economic concerns are taking precedence over sustainability targets.

A clear requirement that emerged from our studies relates to best practice, which is perceived as a double-edged sword as it needs to be understood, but is also the responsibility of the organisations at large to develop and produce. A lack of time for reflective actions and capitalizing on lessons learnt is perceived as a barrier in this respect, and one that is closely tied to the lack of enabling initiatives and implicitly to cost constraints. Through positive reflection individuals are able to 'surface and criticise the tacit understandings that have grown up around the repetitive experiences of a specialised practice or task, and can make new sense of the situations of uncertainty or uniqueness which they may allow themselves to experience' (Schön 1983). Sensemaking emerges as an important factor. This involves making sense of the unknown by introducing structure and order, and exploring how individuals construct realities, and the effect this has on their environment (Weick 1996). In fact, the organisation may be seen as a system of perception, engaged in continuous sensemaking. Individuals create and share knowledge within their environment, i.e. the organisation or project at hand, and by doing so construct and express their own identity, and as a result have a positive effect on their environment. Nurturing know-how is thus perceived as a social process continuously influenced by individuals, their knowledge and the ways this is shared and used in their environment, i.e. team or organisation. Making sense of situations influences positive sustainability actions and triggers a sustainability-informed decision-making processes (Rezgui, Miles 2011). It is also symptomatic of the final perceived barrier in this category – lack of information/knowledge sharing. One participant noted quite clearly that *"information sharing has almost stopped because of competitive edge/advantage. It is environment driven."* Information/knowledge sharing is a cornerstone to the promotion of construction stakeholders' engagement with sustainability, which is evidenced directly in terms of cognitive, affective and behavioural aspects. The participants on the whole recognise a need and great benefit in sharing, yet whilst it occurs within teams and organisations there is a reluctance to share 'outside' due to commercial interests, most notable in the comment *"Why should I share the information I have spent years developing for my competitors to take advantage?"* Furthermore, in terms of best practice and lessons learnt the shared information is generally viewed as being mere showcasing of key results to demonstrate achievements according to the codes of practice now put in place legislatively, rather than the necessary knowledge of how such things were achieved and the common failures that were overcome.

3.3. Wider industry perceived barriers

The perceived barriers from the wider industry perspective generally put responsibility back on the government. Firstly there is perceived lack of government action to initiate and promote energy positive behavioural change. The implicit assumption may be construed as being that the government were responsible for the original targets and aspirations for reducing carbon emissions, energy consumption, waste, etc, but relied on an initially largely un-knowledgeable industry to achieve them. (Indeed there was even confusion with regard to the nature of the 'targets' with some participants noting that latterly these became 'aspirations'). Our studies indicate that participants feel there should be far greater support from the government to aid the industry as a whole with regard to perceived barriers such as resistance to lifestyle change, and that a common, shared perception is still lacking. This tendency to place responsibility

Table 4. Wider industry perceived barriers to engagement with sustainable construction

Wider Industry perceived barriers	Triangulated qualitative and quantitative examples
Lack of government action to initiate and promote energy positive behavioural change	*"Disjointed thinking – there is a lack of common, shared perception; a lack of general awareness and/or real understanding when aware."* *"We know the direction that we need to go in but there is a whole industry that has to help us make this change."* *"We have made progress but we are not on track due to a mismatch between 'minister versus local delivery', and it is difficult to make changes in legacy buildings but we can do it with new build."* *"There is a need for action on increasing public awareness of the benefits of good design."* *"It's all very well for the [Welsh Government] to advocate and pontificate about sustainability, but it needs to manage it correctly."* *"Uploading information from Housing Associations: tends to be community driven. The agents dictate the extent of sustainable practice because their priority is to let."* *"Is there a possibility to learn from other sectors? Is there a model that can be applied?"* *"What's going on in the [Welsh Government] – the political thinking?"* *"Why do we have to pay for sustainability information? BRE are playing a double act, i.e. legislator and competitor".*
Government focus on regulation in an industry which suffers from poor stakeholder education	*"Whilst there are some good things going on in Wales, the industry strives to meet minimum standards and no more."* *"The industry generally wants to reduce emissions but end users need to be on board"* *"Building Regs are not on board; whilst there are initiatives to create change there is still the question whether or not there is training for planners on Low/Zero Carbon?"* *"How do the LC targets link in with waste, energy; what is mandatory? What is aspirational?"* *"There is a need to address knowledge (education even) of Councillors/ elected members who make the decisions but don't understand sustainability. Also local authority planners/other professionals who are driven by compliance and don't have incentive to look at wider value/risk perspective (but need to)."*

with government may in some cases indicate denial mechanisms as described in the climate change literature (Lorenzoni *et al.* 2007; Stoll-Kleeman *et al.* 2001). The literature discussing public engagement with climate change, and in particular mechanisms for understanding, indicates an increased awareness of the concept of 'carbon footprints', an increase in the use of carbon calculators, and information about tools such as smart meters, etc. However, information provision alone is insufficient to address competing values or the wider, structural barriers to low-carbon lifestyles, and may leave people feeling disempowered, disinterested or cynical about attempts by government to 'educate' the public by locating responsibility for climate action with individuals (Whitmarsh *et al.* 2011; Hargreaves 2010). Examples of denial mechanisms include denying personal contribution to climate change and personal responsibility, pointing to government inaction, claiming ignorance, being too busy to change one's behaviour, and focusing on other issues that are perceived to be of greater importance (Lorenzoni *et al.* 2007).

Secondly and closely related to this first barrier, is the perception that the government's primary focus is on regulation without recognising the depth of the increased challenges faced by an industry that is suffering from poor stakeholder awareness and education. Some participants imply that the latest thinking in the corridors of government is not clearly stated, for example one participant noted: *"we need to be updated every 6 months. What is the latest on national standards, landlords' expectations on building codes, etc.? What are expectations in say 2, 3 years time?"* There is perceived to be a mismatch in understanding between government members and practitioners, which results in a lack of engagement because the industry has to expend too much resource on simply meeting the required standards.

4. Discussion

The observations above indicate that some overlaps exist across the categorised areas. These concurrences appear to intensify constraints to engagement. For example, the perceived need to transfer knowledge into action, the need to know 'how' and 'why', is cited as a clear lack of widely available knowledge and a barrier due to uncertainty, whilst competitive advantage continues to deter people from sharing their information. The individual barriers include: lack of knowledge; uncertainty and scepticism; distrust in information sources; reliance on technology; and resistance to lifestyle change. Organisational barriers involve: lack of enabling initiatives; lack of training; work overload and priority to expedite current tasks and activities; lack of time for reflective actions and capitalizing on lessons learnt; and lack of information/knowledge sharing. The wider industry barriers are subdivided into: lack of government action; and government focus on regulation.

Overall the perceived barriers to engagement suggest a comprehensive requirement for behaviour change as a complex combination of contextual forces, personal capabilities and habits, and attitudinal factors are influencing current behaviour (Stern 2000). At this level individuals' behaviour may be viewed to be aligned with elements of the theory of planned behaviour (Ajzen 1991) which emphasizes that human behaviours are governed not only by personal attitudes, but also by social pressures and a sense of control, and its precursor – the theory of reasoned action – in which behaviour is determined by the intentions of indi-

viduals (Ajzen, Sheikh 2013). However, as our definition of the term "engagement" in this paper extends cognitive, affective and behavioural aspects at an individual level to embrace wider values embedded within the organisational culture, we feel that the ipsative theory of behaviour – which identifies internal and external conditions as potential constraints to pro-environmental action (Tanner 1999) – is more illustrative. The ipsative theory of behaviour holds that both internal and external conditions may constrain behaviour (Frey 1988), and in contrast to traditional psychological research, it points out the why of *nonaction* rather than focusing on the reasons for action (Tanner 1999). Three presuppositions for human behaviour are assumed: objective constraints, ipsative constraints, and subjective constraints. Objective constraints influence the performing of an act, and may comprise structural factors which include time limitations, cost, legal and political institutions, the current state of scientific knowledge, available technology, state of infrastructure, and available social interaction and information network (Tanner 1999), all of which are evident from our studies. Ipsative constraints prevent activation of behavioural alternatives – this may be illustrated, for example, in the decision whether or not to share information to enable engagement, as an individual's action is not constrained by the objective condition but by the fact that the particular alternative did not occur to him or her (Tanner 1999). Subjective constraints prevent the preference for behavioural alternatives. As construction stakeholders operate within the organisational compass behaviour is to some extent dictated by the organisational culture, therefore subjective constrains may directly affect engagement in sustainable construction as they prevent a desire to act and are responsible for the exclusion of particular behaviour alternatives in the ipsative set (Tanner 1999).

The results from our consultations and the exploration of the key perceived barriers confirmed that sustainability knowledge in construction is fragmented, diverse, embedded in various documents, and developed in a non-concerted and integrated way across stakeholders, localities, regions, and countries. It also identified and established the need to create circles of impacts that bind building professionals, energy administrations, and citizens in a shared sustainability experience to address a number of issues, including:

– Lack of sharing, exploitation, and reuse of isolated sustainable practices and principles acquired through practice across the industry.
– Lack of education and awareness across key construction stakeholders and building end-users.
– Lack of easy access to structured sustainability information and knowledge.
– Unclear links between sustainability principles and current construction regulations and standards. (In fact, there is no explicit statutory requirement that the Building Regulations should cover sustainability, even though many of the approved documents already do so. This is a substantial statutory barrier to progress on the sustainability of buildings).
– Uncertainty about the cost of sustainable solutions/technologies.

Throughout the studies we became increasingly aware that "Islands of Information" exist across the field of sustainable construction. Different actors have built various repositories, organised events, etc., in an effort to fully understand the changing construction landscape,

but with little or no coordination or awareness of what one another is doing. With this in mind, in the Wales LZC Hub workshop the notion of creating a "Map of Everything" emerged, which was rated as the most highly weighted issue of immediate concern to the participants. The notion of a "Map of Everything" referred to a need to map out the structural and social elements involved in sustainability including the key organisations and people, information and training events, key publications, online forums, etc. We recognised from the results that a socio-technical 'knowledge solution' that factors in people attitudes and behaviours, within the wider context of their organisation and industry communities, alongside technical considerations may act as a welcome bridge between these "Islands of Information", and thereby address the issues outlined above.

Alavi and Leidner (2001) note that knowledge may be viewed from five different perspectives:

– state of mind perspective, emphasizing knowing and understanding through experience and study (Schubert *et al.* 1998);
– object perspective, defining knowledge as a thing to be stored and manipulated (Rezgui 2007, 1996; McQueen 1998; Zack *et al.* 2009);
– process perspective, focusing on knowing and acting (Zack *et al.* 2009);
– condition perspective, emphasizing access to knowledge (McQueen 1998); and
– capability perspective, viewing knowledge as a capability.

These different views of knowledge lead to different perspectives of Knowledge Management (KM) (Carlsson *et al.* 1996):

– IT perspective, focusing on the use of various technologies to acquire or store knowledge resources (Borghoff, Pareschi 1998). As knowledge is viewed as an object, KM should focus on ensuring that explicit knowledge, available in the form of knowledge items, is widely accessible across an organisation.
– Socialization perspective, focusing on understanding the organisational nature of KM (Gold, Malhotra 2001; Rezgui *et al.* 2010). KM should focus on supporting the processes of sharing, creating, and disseminating knowledge.
– Information system (IS) perspective, focusing on both IT and organizational capability and emphasizing the use of KMS (Tiwana 2001; Schultze, Leidner 2002; Rezgui 2007). The right KM strategy should be put in place to develop and nurture core organisational competencies, and create intellectual capital.

Our concept of socio-technical system relates to the third (Information System) perspective as reported in related studies in the construction industry (Rezgui 2007; Rezgui, Miles 2011). As such, this could be delivered as a "one-stop-shop" web-based platform, a concept that was further explored within the third study. It emerged that such a solution may address the perceived barriers to engagement with sustainable construction, particularly for the many SME organisations characteristic of the industry, but may also aid large organisations that already rely on their own intranets; as the director of one multinational construction firm noted:

"Yes, there is absolutely a need for a central platform. For smaller organisations getting answers is still a fog – there is a need for a source."

Conclusions

The paper suggests that sustainable construction goals can only be achieved if shared and value-added relevant resources of knowledge and expertise inform design, construction and operation activities across the supply chain. Two research questions are outlined that formed the focus of the research. In terms of construction stakeholders' sustainability information needs and government provision deficiencies (RQ1), limited sustainability best practice/regulation awareness and information provision deficiencies emerged as key themes from the Europe-wide and Wales studies and provided the ground to address the second research question (RQ2). As to construction stakeholders' engagement barriers with governmental carbon and energy reduction targets (RQ2), findings from these studies indicate an overall awareness and concern about environmental issues and the need to address these through sustainable construction activities. However, whilst stakeholders are aware that ill-practices in the construction industry can have major drawbacks on meeting governmental targets on carbon and energy reduction, and that employees in organisations and on projects have moral responsibilities to deliver environmentally friendly buildings, this does not systematically translate into sustainable practices and engagement as defined in terms of cognitive, affective and behavioural aspects at a personal, organisational, and wider industry level. Finally, the results from the studies indicate that a shared sustainability knowledge experience, in the form of a web-based "one-stop-shop" platform may promote more systematic engagement with a view to meeting governmental energy and carbon reduction targets and therefore be beneficial in addressing the perceived barriers to engagement. The authors are now pursuing their efforts with the delivery of a full, exploitable "one-stop-shop" platform as a socio-technical solution to the perceived barriers from these studies.

Acknowledgements

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