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Engaging construction stakeholders with sustainability through a knowledge harvesting platform

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ABSTRACT

With the new regulations and policies related to climate change, the construction industry has been put under pressure to increase the sustainability of its practices. Many organisations are now adapting their practices to meet government legislative targets (e.g. reducing carbon emissions) and consider the environmental, social and economic performance of buildings. In addition, the sustainable construction is also a rapidly changing field, with technological advances, changes in legislation and increasingly educated clients driving the industry to constantly adapt to remain competitive. This represents a key problem for construction professionals as they must continually be aware of new information, best practices, technologies and changing legislation (at a local, national and international level) which are often disseminated from different organisations/individuals through dispersed media.

This paper presents a web-based platform solution that provides integrated access to sustainability resources in the form of interactive, dynamic, and user-oriented services that fully exploit latest advances in computing technologies. The platform is an open, scalable and polymorphic context-based solution with modules enabling serendipitous information and knowledge discovery by utilising a symbiosis of technologies such as semantic web, social networking and mobile computing. An initial prototype has been developed, implemented and tested followed by a revised platform which has now been released in a continuing process of incremental development to ensure a fully functional and accepted solution.

1. Introduction

Political and economic attention to climate change has led the UK government, particular during its presidency of the European Union in 2005 and the G8, to strive to meet EU commitments to achieve an 80% cut in CO_2 emissions by 2050 [1]. Studies indicate that our built environment is responsible for some of the most serious global and local environmental change [2–4]. Creation and operation of the built environment accounts for at least 50% of all energy consumption in Europe [2,5], and in the UK more than 50% of all carbon emissions can be attributed to energy use in buildings [6]. Consequently, the construction industry is under pressure to increase the sustainability of its practices, the implication of which is a requirement on the industry's behalf to understand the demands both from society and its clients, and its sense of corporate responsibility, which in turn implies major changes in its working practices [7,8]. The UK government aspires to achieve construction of zero carbon homes from 2016, Public sector buildings from 2018, and all other non-domestic buildings from 2019. The UK building regulations have already undergone a number of amendments; the next, with the target CO_2 reductions embedded, are expected in 2013. 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 [10].

Public awareness of climate change acknowledges the main causes and concerns [11] and scientific evidence highlights the significance of the human factor in reducing the impact of climate change [12–14], however only a minority engage with effective measures to reduce their lifestyle impacts on the environment [15,16]. The literature indicates significant discrepancies between public awareness about climate change and natural resource depletion on the one hand, and behavioural change on the other [16,17], suggesting complex interactions of psychological, social and environmental factors influencing behaviour [17,18].

The UK government's aspiration for energy and CO_2 reduction requires widespread social change [16], and though considerable moves have been made towards regulating the energy and construction sectors, there is less systematic evidence regarding construction industry stakeholders' responses to whole-system

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transformations and how such transformations are likely to be experienced, enacted and negotiated in terms of everyday practice. Building on existing literature, this paper explores the constraints and factors that influence individual stakeholders to adopt sustainable practices at work, including changing their own behaviour, the reasons underlying these perceived constraints, and proposes an advanced collaborative web based environment to address the situation.

We propose a knowledge based sustainability approach specialising content to users' disciplines and interests and compatible with the latest computing technologies. In this paper, we present the Sustainable Construction Service Platform (SCRIPT), which is a service orientated architecture (SOA) developed to solve the key issue of knowledge dissemination in, and stakeholder engagement with, sustainable construction. Within the approach we combine a number of different technologies such as semantic web, social networks, mobile applications towards a knowledge representation concerned with sustainability in constructing for maintaining (potentially complex) models of the industrial context. By such an approach new business models such as online communities, online market places can emerge expanding the community and achieving a higher order of knowledge integration and mining. Our system, which is already fully functional, aims to provide construction professionals with the necessary knowledge to offer effective energy efficient and low carbon solutions, whilst also enabling them to utilise the latest best practice and regulations. The paper draws upon findings of recent mixed-method studies conducted across Europe and in the UK (Wales) with regards to sustainability and to the associated methods to engage construction professionals with sustainable practices.

In Section 2, we will present background to the SCRIPT project, outlining the consultation process that was undertaken. Sections 3 and 4 will describe the overall methodology and system requirements. Section 5 will detail the prototype and associated feedback. Section 6 will describe the technical implementation of the SCRIPT platform and Section 7 will describe our validation and present our conclusions in Section 9.

2. Background research

The field of sustainable construction is complex, involving multiple disciplines being applied across the life-cycle of a building project. In developing the platform we undertook a detailed consultation with construction-related businesses in Wales which confirmed that the management and dissemination of sustainable construction information is a key problem. This complexity is further exacerbated because information exists within a variety of overlapping and fragmented resources produced and maintained by a variety users, ad-hoc communities, organisations and government authorities. Such information also exists in a variety of forms including: structured and unstructured documents, spreadsheets, websites, drawings, images, video, databases, and as tacit knowledge. The growing complexity of this information and the differing information requirements of the industry have made it difficult to share and exchange knowledge between individuals and organisations. The use of ICT (Information Communication Technology), in particular the service oriented computing paradigm and its realisation through web service technologies, provides a promising solution for knowledge management and interoperability in the area of supply chains, e-business, extended/virtual enterprises, and virtual organisations, and has already seen success in related fields [9].

The literature 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 [19]. 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 [20]. The construction industry is characterised by a complex socio-cultural and organisational environment reflected by its endemic resistance to change [21] and the requirement for different management strategies due to contradictory interests of owners, contractors and craftsmen [22]; indeed it is perceived as 'unique' when compared with other sectors [23]. 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 whilst promoting positive engagement. Lorenzoni et al. [16] suggest that engagement concurrently involves cognitive, affective and behavioural aspects at an individual level to embrace wider values embedded within the organisational culture. Whitmarsh et al. [17] 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.

Engagement may therefore be seen as both an individual and collective phenomenon reflected in the team and project-based nature of the construction industry. Stern [24] 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 [25,26].

Whitmarsh et al. [27] 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 [17]: (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). Whilst 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.

3. Methodology

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 [28,29]. The research methodology therefore utilises a mixed-method approach involving studies incorporating qualitative and quantitative methods to elicit construction industry stakeholders' requirements, and prototyping for the development and testing of the proposed solution. The research is located within theoretical traditions that take socio-technical systems as the focal unit of analysis [30]. This perspective provides a robust foundation for analysing whole built environment sustainability systems understood as linked processes of social and technological practices [31].

The requirements gathering studies employed extensive consultations including: an online Europe-wide survey (February–April 2009) from which 252 responses were received;