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Thoughts of a design team: Barriers to low carbon school design

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ABSTRACT

With the increasing threat of serious climate change, various governments are aiming to substantially reduce their carbon emissions. In the UK all new schools and domestic buildings are required to be 'zero-carbon' from 2016. Schools are seen as community centres of activity and learning by local authorities, as such there is an emphasis to make schools exemplar buildings within the community and demonstrate best practice with regards to low and zero-carbon design. This paper focuses on what are the pertinent drivers and obstacles to low carbon school design based upon literature review and a survey of experts in the field. We find that more barriers are identified than drivers for low carbon design, with the greatest drivers being legislation, environmental concerns and running costs. The greatest barriers were identified as increased equipment in modern schools, complexity of building systems and the perceived extra cost of low carbon design and technologies. It is suggested that most barriers could be overcome by improving communication between the design team, client and end users, and that truly integrated design teams are the key to mainstream low carbon school design.

1. Introduction

The Intergovernmental Panel on Climate Change (IPCC) warns of significant warming resultant changes to weather patterns as a result of anthropogenic carbon emissions. The UK Government is committed to an 80% reduction in carbon dioxide (CO_2) emissions from 1990 levels by 2050 (HMSO, 2008) and the Kyoto protocol encourages other countries to adopt similar reductions in CO_2 emissions. Buildings are responsible for over 40% of energy use in most countries and are responsible for ~30% of global carbon emissions (WBCSD, 2008). A UK Government study (BIS, 2010) has shown that the UK building industry has the ability to influence ~298 Mt CO_2, this equates to nearly 56% of all CO_2 emission in the UK (BIS, 2010). Clearly the building industry is an important source of carbon emissions for the UK and other countries and needs addressing. In an effort to meet its legally binding carbon reduction commitments, in 2008 the UK government set an ambition for new schools and domestic buildings built from 2016 to be 'zero carbon' (CLG, 2008) (although new legislation may push the deadline for schools back to 2019 to match the EU Energy Performance of Buildings Directive). While the exact definition of 'zero carbon' in this case is yet to be finalised there is clearly an impetus to significantly reduce carbon emissions of new buildings in the near future. In this paper the terms low carbon and zero carbon refer to in-use carbon emissions rather than the carbon emissions associated with their construction (embodied carbon). This was decided from the standpoint that buildings last a long time and the cumulative in-use carbon emissions over the buildings lifetime are far greater than the embodied carbon, this can be inferred from the figures presented by the UK Government (BIS, 2010). There has been a lot of focus on producing low or zero carbon homes, with for example, research conducted on the feasibility of zero carbon homes (Osmani & O'Reilley, 2009) as well as case studies of zero carbon designs (Wang, Gwilliam, & Jones, 2009). Off the shelf zero-carbon homes are even available for purchase (ZED Factory). However, schools are larger, more complex and low or zero carbon schools are not often the subject of academic research. Schools are a central part of a community, acting as hubs of learning and also often as focal points within a community through their use out of hours for other activities, such as adult learning, art and crafts and exercise classes. These extracurricular activities now influence the design of new schools, as a result of the influence of the local council (acting as the client). A government report (DCSF, 2009) suggested that schools have the potential to become beacons of good practice within a community able to inspire sustainable behaviour not only through learning but also by example and engaging with local communities.

In a study comparing display energy certificates for schools across the UK (Godoy-Shimizu, Armitage, Steemers, & Chenvidyakarn, 2011) it was found that there is a large variation in the amount of energy used both in terms of floor area (per m^2) and per pupil. When compared with historic data there is a general reduction in fossil fuel heating required, presumably due to better insulation levels over time as schools are refurbished or new ones built, although this reduction could be attributed to

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higher pupil densities or increased internal heat gains. However, any carbon saving is offset by a larger increase in the electricity requirements of the schools. The new academies (HMSO, 2010) perform particularly badly compared to primary and secondary schools, Godoy-Shimizu et al. (2011) state that "the significantly higher emissions associated with the academies is unexpected as they tend to be newer schools, recently built or refurbished." The increase is due to electricity consumption attributed to increased usage of educational equipment, computers and greater implementation of buildings services. Many new schools have been built in the recent past across the UK; more are planned for construction in the future. Evidence shows there has been some improvement in the fossil fuel energy usage of schools but that increased electrical consumption means that carbon emissions are still increasing. Given the need for significant nation-wide carbon emissions reductions by 2050 this suggests further work is needed to understand how emissions can be reduced in new schools. This paper aims to examine which drivers and barriers to low carbon design that have been identified in the literature. Then by drawing upon the experiences of a panel of experts with varied backgrounds and roles within the design team, identify which are perceived as the greatest barriers to the design of low carbon schools. It is hoped through this process that common features of the greatest barriers can be identified and hence addressed, making the design of low carbon schools easier to achieve in practice.

2. Drivers and barriers

Clearly there are obstacles to achieving low carbon design in schools, whether cost, regulatory, communication-based, procurement or simply risk aversion. Unfortunately the construction industry is distinctive in its fragmentation. It is characterised by a wide range of sub-contractors being used, ostensibly for their individual skill sets. This does tend to minimise risk, which is often held aloft as another key driver for this method of operation. Such subcontractors often perceive the contractor in the chain directly above them as the most important 'client', rather than the end-user of the building (Williams & Dair, 2007; Zuo, Read, Pullen, & Shi, 2012). Because of this limited involvement in the project, there is little incentive to reduce energy use through good design. This lack of a collaborative design process can lead to the building design not reflecting the intended use or the building occupants not using the building services as intended. This situation can be avoided if the client is aware of the issues, educated and proactive, ensuring that relevant information about the buildings usage is passed to the relevant parties. While the client can guide the design there is still the barrier for low carbon school projects that the client is not the end user and their vision may not reflect the reality of how the building will be used in practice.

Within an organisation, decision-making is not just guided by individual preferences but is also framed by the perceived goals and interests of the organisation and other associated stakeholders. Studies have shown that individuals who hold senior positions and are most embedded within an organisation are more resistant to change, particularly where change is perceived as a departure from traditional practices (Morton, Bretschneider, Coley & Kershaw, 2011; Van Knippenburg, Van Knippenburg, Monden & de Lima, 2002). Another deterrent to low carbon design identified by Williams and Dair (2007) is the unreliability or the perceived unreliability of sustainable products and systems. Stakeholders were adverse to the perceived risk of using what they consider to be untested technologies.

Morton et al. (2011) conducted a study into the perceptions about climate change and willingness to change current practices within the building industry. The study indicated that many individuals considered their organisation to be involved in practices relevant to climate change. When investigated further these practices were mainly related to sustainability and carbon emissions reduction (climate change mitigation). As such there is some overlap with the study presented in this paper. Morton et al. (2011) noted that the most salient limitations associated with current practices were time and cost. It was inferred from participant responses that it was perceived that clients associated environmental considerations with increased cost, and that they would be unwilling to bear this cost except in so far as it was necessary to meet government requirements. These views are confirmed in another study (Williams & Dair, 2007), which concluded that the high cost of some sustainable measures is a major barrier to low carbon buildings compared to traditional buildings. This is exhibited by this response from one individual (Morton et al., 2011):

> "The sustainable, low energy solution usually costs more and requires more design input/expertise. Client organisations still often want to spend the minimum time and money to achieve a suitable building to meet current regulations."

Furthermore, participants indicated that the primary current activity to address climate change was to adhere to industry guidelines such as BREEAM. It was perceived that guidelines provided clear standards, were effective and made environmental issues more routine. There was evidence that this activity is limited by the voluntary nature of the guidance and their limited focus. There is also the issue of the client incorrectly identifying the most relevant standard to target, for instance while BREEAM is a well known standard in the UK, it is not the most targeted towards energy efficiency due to its holistic sustainability approach, instead a better standard may be, for example, the Passivhaus standard. This will require the design team to extract information from the client about what is desired and make suggestions accordingly.

The aim of this study is to identify which drivers and barriers are most pertinent to the design of low carbon schools. First a literature review will identify the relevant drivers and barriers appropriate to low carbon schools. The compiled list of barriers will then be narrowed down to the most pertinent barriers and obstacles to low carbon school design. This will be achieved by drawing upon the knowledge and experiences of a panel of experts in the field using a Delphi based approach (Skulmoski, Hartman, & Krahn, 2007; Wilson, 1991). They will work together to refine the list of barriers and obstacles to achieve consensus over, which are the greatest obstacles. In this way the research is intended to both produce an as-definitive-as-possible list of obstacles to low carbon school design, and get an idea of how relevant these obstacles are to designers in the future. The Delphi method is acknowledged as being well suited to a research task when there is incomplete information about a problem or and issue (Skulmoski et al., 2007). The Delphi method is an iterative process by which the anonymous judgements and opinions of a panel of experts can be collected. This process allows the participants to freely express their opinions without in the absence of social pressures to conform with the opinions of others in the group. As such during the iterative process, decisions are evaluated on the basis of merit rather than that who has proposed the idea. In this way it is hoped that the Delphi method used in this study will highlight the true opinions of the whole design team rather than the opinions of just a few. Since low carbon school design is to become mandatory in the UK and it is likely that other countries will follow suit, the importance of the drivers is diminished and hence were not considered in the Delphi study. However, the perceived importance of different drivers compiled from the literature is presented here for completeness.