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The challenges and opportunities for sustainable building practices

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Abstract

With growing concerns for the environment and climate change, there has been a focus on the way new structures are commissioned and built; particularly in their use of energy and resources. This is not only apparent in the developed world; it is being driven by policy makers in both developed and developing countries alike.

However there are a number of challenges facing the adoption of sustainable building. Construction professionals in Australia interviewed as part of a study undertaken in 2006, highlighted: higher capital costs; cohesive knowledge sharing; and information on materials and technology. The principal challenge was materials selection and justifying the decisions made. The use of locally sourced material frequently resulted in higher first dollar costs and construction delays on projects.

In developing countries the challenge is not the sourcing or affordability of local materials but combining locally sourced, sustainable materials with appropriate and sustainable new technologies to provide innovative solutions to meet the demand for more sustainable building and construction projects. The challenge and the opportunity in both these cases is cohesive decision making, and the harnessing of capacity and knowledge to ensure the most appropriate strategies are in place to deliver sustainable building solutions.

Keywords Affordability, challenges, materials, technology, sustainability.

INTRODUCTION

There is a general acceptance within the wider community that use of fossil fuels, consumption of non-renewable resources and greenhouse gas emissions are causing environmental harm. Climate change is 'likely to be the greatest destabilising force politically and socially of the next Century' (Edwards, 1998, p.7). The Construction Industry is recognised as a major contributor to the consumption of energy and thereby greenhouse gas emissions. The Organisation for Economic Cooperation and Development (OECD) advising that the building sector 'accounts for around 25-40% of final energy consumption in OECD countries' (OECD, 2006, p.1). With growing concerns for the environment and climate change, there has been a focus on the way new structures are commissioned and built; particularly in their use of energy and resources. There is an increasing recognition that buildings cannot be designed without consideration for their social impact on the environment (John *et al*., 2005). Further 'the impacts of construction and use of any built projects on the environment are at both local level, such as noise pollution, dust pollution, odour pollution; and global level, such as changes of climate and ecosystems' (Shen *et al.*, 2006, p.243). This is not only apparent in the developed world; it is being driven by policy makers in both developed and developing countries alike.

Sustainable Construction

The issues highlighted above have been the driving force for more sustainable construction and the need to build 'green'. There are many terms for and interpretations of what constitutes sustainable building practice. Rather than providing a definition, the OECD sustainable building project identifies five objectives for sustainable buildings: resource efficiency; energy efficiency (including greenhouse gas emissions reduction); pollution prevention (including indoor air quality and noise abatement); harmonisation with environment; and integrated and systemic approaches (John *et al.,* 2005). Sustainable construction is in effect 'a series of sustainable or 'best practice' decisions, which start well before construction (in the planning and design stages) and continue long after the construction team have left the site: a process that takes in the design, construction and on-going maintenance of what is being referred to as a 'green' building' (Hayles & Holdsworth, 2005, p. 2).

Benefits Of Sustainable Aprpoaches To Design And Construction

According to Guidry (2004), there are three benefits associated with green building, namely: direct economic benefits; indirect social and psychological benefits; and environmental benefits. Cost benefits can be accrued as a result of sustainable building as 'integrating green principles into a building's planning and design process can generate 40% more savings and 40% better performance than simply adding green technologies to a traditionally planned and designed facility' (Lockwood, 2006, p.130). In addition, considering material sales and savings from avoiding landfill, deconstruction projects cost less than traditional demolition projects, whilst helping to preserve environmental resources at the same time (Green *et al.,* 2006).

Further, improving buildings' thermal properties will reduce consumption, the cost to the end user, and reduce CO_2 emissions (Reed & Wilkinson, 2005). The benefits attributed to green buildings include reduced energy costs, reduced employee health problems and increased productivity. These operate in conjunction with other less tangible benefits such as an enhanced company image for occupants of these buildings by demonstrating their corporate social responsibility, and potentially making them an employer of choice by providing a more attractive workplace (Edwards, 1998). Green building in the developed world is driven by a desire to reduce energy consumption and promoted as a financially-sound business decision.

Challenges To The Adoption Of Sustainable Building Practices

The challenges facing the adoption of sustainable building described in the literature can be divided into five distinct categories, namely: cost; information; design processes; construction processes; and materials and technology.

Captial Cost

The general industry view is that sustainable buildings come at a premium, with a minimal connection made between the up-front (capital) costs of construction and the operating costs, once the building is completed. Indeed, there is a widespread perception that sustainable buildings are higher in cost than the marketplace is will pay for; even when they are not (Zerkin, 2006). This is believed to be due to the lack of accurate, thorough, and quantifiable information regarding the financial and economic impacts of high performance buildings (Suttell, 2006). McKee (1998) suggests that office buildings are not the best place to test

new green technologies and designs, as developers and investors are not willing to carry the risk.

The barriers to developers choosing high performance green buildings centre on the perception of higher first-dollar costs, and that the market is not willing to pay them, further there are not reliable cost models to assist developers to understand the true costs and benefits of high performance buildings. Developers also face a risk that the lending institutions may not understand high performance aspects and their value in the marketplace. Finally any new approaches are perceived as risky, and the developers are reliant on others' information and may not be able to determine who to trust (Zerkin, 2006). Economic barriers to sustainable design can include: lack of information about inherent long-term economic benefits of sustainable building; lack of integration among various incentive programs (rebates, loans, technical assistance, and recognition programs); reality that first cost is the overriding concern among financial institutions and investors; and the inherently conservative nature of the building industry (Townsend, 1997).

Information Gathering

It is not always possible to predict whether a building will perform as predicted, whether the green costs are affordable or indeed whether the technology reliable (Edwards, 1998). There is a lack of research on the performance of green building. There is also concern that the complexity of some green designs (technological high performance) may bring about obsolescence earlier than conventional design (McKee, 1998).

Further issues include a lack of consensus about what sustainable building actually means. There is also disagreement as to: what the minimum performance standards should be; which activities are considered to be environmentally stressful; what the economics are; and how to evaluate or measure sustainable building (Townsend, 1997). Attempts to integrate the vast amount of information currently available and effectively disseminate it have so far fallen short.

The Design Process

There appears to be limited understanding of available green options by design professionals. This includes: insufficient knowledge to produce specifications; a lack of available high performance materials; difficulties in gaining approval of new technologies for building codes; uncertainty about approvals; regulatory barriers to adoption of technologies and labour issues due to potential labour-saving measures; all providing further challenges to sustainable design (Zerkin, 2006). In order for sustainable building techniques and materials to be adopted they must be specified by the designer. However, there is no standard assessment criterion for products that allows them to be directly evaluated, and therefore design professionals must invest a lot of time in assessing potential materials and technology (Weber, 2005).

The Construction Process

Building on the issues described in the design process, the construction process can also be a difficult one. Issues include a lack of knowledge and consequently skilled labour to install and maintain new technologies (and minimal availability of training for the industry). There is limited infrastructure to handle and make available recycled material from deconstruction, thereby making costs prohibitive (Zerkin, 2006). The additional workers and time required

also make deconstruction seem more costly than mechanical demolition (Green Leigh & Patterson, 2006). Furthermore time and financial pressures can have a negative impact on the effectiveness of environmental management systems on building sites (Shen *et al*, 2006).

Materials And Technology

The challenges described above are all impacted on by materials and technology selection. Sustainable building practices can make a huge difference to global environmental sustainability, particularly through a drastic reduction in the use of natural resource consumption and energy intensive materials like cement, steel, aggregates and aluminum (du Plessis, 2002). The process of transporting materials via road, sea or air can leave a trail of pollution in its wake, making it more sustainable to use local products.

Issues arise where, what is considered to be the most appropriate environmentally friendly product for a particular purpose is not available locally, thereby making materials selection extremely complex (Edwards, 1998).

Most architects find it difficult to establish the embodied energy or life cycle costs of a particular product. For example, establishing a balance between harvesting practices, manufacturing processes, shipping, and the positive/negative impact a certain timber may have on indoor air quality once it is in situ (Weber, 2005) not to mention disposal or re-use at the end of the buildings life, is extremely difficult. While the process of Life Cycle Analysis (LCA) exists to make this evaluation, a number of issues arise, such as the incentive for suppliers to perform this analysis on their products. This is likely to be consumer or industry demand driven, however if the results are not positive in environmental terms they are unlikely to be published (Graveline, 2005). Furthermore, LCA commonly needs to be completed from a whole of installation perspective, which involves obtaining LCA data for a number of components and therefore suppliers. Further, these suppliers often consider this information proprietary and are reluctant to release it into the public domain where competitors will be able to access it; making the information currently in the public domain limited and the process involved obviously expensive, resulting in few clients who are willing to pay the premium required (Graveline, 2005). How efficiently and environmentally the completed building operates is most commonly measured in terms of energy efficiency and productivity, detracting focus from the cost to the environment of the structure itself, which can often be unsustainable.

Australian Construction Sector Study

A research study undertaken at RMIT University, Melbourne in 2006, which aimed to identify challenges facing the adoption of sustainable building in the Australian commercial sector, identified similar issues to those descried above. The results of the semi-structured in-depth interviews conducted with project managers from a number of sustainable building projects, demonstrated very similar experiences to those described in the literature, and are outlined below.

Cost was a major challenge to the development of green buildings, with the interviewees' experiences noting a cost premium of up to 30% and the potential for investors to be reluctant to invest in a relatively new type of building with no proven returns. Indeed, investment in sustainable buildings was perceived by investors as a risk, with returns not yet considered to be proven within Australia. The cost of 'green' materials is a key factor in the cost premium (see 'Materials and technology' below).

Availability of appropriate information/specifications, especially when choosing appropriate 'green' materials is an issue. Whilst there are websites available regarding 'green' specifications and products, these are not yet sufficient. There is also considered to be a lack of evidence of the benefits of green building in a local context (due to the relative immaturity of the industry when compared to e.g. Europe). In addition, evidence of the whole of life benefits of sustainable building in Australia is not yet available, with no local studies completed.

The construction industry is seeking out more information on sustainable building and the level of expertise is increasing, however clients' knowledge is often very limited, making sustainable building less attractive if they do not understand what they are paying for (including higher capital costs).

Sustainable design and technology do not create difficulty with planning permissions and approvals in Australia. Information on new technologies and the ability of organisations to investigate them during the design process is assisted by schemes like the Commercial Office Building Energy Innovation Initiative - COBEII (Sustainability Victoria, 2006), and web-based sources such as the Australian Green Procurement (AGP) database (AGP, 2006). Materials and technology selection is considered to be the most complex part of the design process. Likewise for the construction process, many of the issues relate to materials and technology selection and accurate, appropriate knowledge transfer. Some 'green' materials have longer lead times than their conventional equivalents which can cause delays. Recycling during the construction process does not cause undue difficulty in Australia, and is relatively well established.

Methods such as LCA and embodied energy calculations are not used to assess the suitability of materials in Australia. Based upon the responses of those interviewed, materials selection in sustainable building is subject to commercial viability as per conventional construction. Using imported products is quite common due to the relatively small market and range of local products available in Australia. Aesthetic considerations have been known to overrule the selection of local products which may be more environmentally friendly.

The availability of indigenous 'green' products and their capital cost are a major issue, which is also magnified by the often longer lead times to manufacture some of the more technical solutions. These long lead times can delay construction processes if the planner is not aware of them, and therefore has not factored them into the construction schedule. Furthermore, if a product is not available locally it is subject not only to longer production lead times, but also the vagaries of international shipping, which will bring into question where it should be considered a sustainable solution at all.

Discussion

Today's Green buildings, while a dramatic improvement over conventional construction, are rooted in conventional design approaches, pre-existing methods of analysis and design tools, and dependent on off-the-shelf products and materials. Issues arise when the requirements of a particular project do not fit well with this antiquated approach. Approaches to building and construction need to be continually improving and tomorrows of sustainable buildings will have to be radically different from todays. Sustainable design practices require an integrated systems approach that can assist in the implementation of the predicted drivers: the deconstruction of buildings; reusable components; recyclable materials; integration with ecosystems; hydrologic cycles; and renewable energy (Hayles and Holdsworth, 2005).

As a result, those responsible for design and construction need to rethink their approach to almost every aspect of their operations (Nobe and Dunbar 2004) and move towards an integrated design approach. Integrated design necessitates early involvement of all project consultants in the design process. A shared understanding of the objectives in building and occupying the building is essential (Hayles 2003) as is a life cycle framework; one which recognises the need to consider all of the principles of sustainable construction at each and every stage in planning, assessment, design, construction, operation and decommissioning of projects (Hill and Bowen 1997). It is essential that appropriate decision making structures are in place to harness capacity and knowledge; that the decisions made are ethical and moral; and that the process is fully auditable.

With the mounting interest and thus demand for sustainable construction comes an increasing need for construction professionals with knowledge in the various aspects of sustainable construction and 'green' building. It may be a long time before all construction companies think in terms of sustainability, green building and integrated design, but it is becoming more evident that the education and training of building industry professionals will have to accommodate these changes, not only in the area of 'high performance buildings', the current driver of sustainability in the developed world, but also to broaden awareness of sustainability in order to more fully develop the critical area of sustainable design (Kibert and Grosskopf 2005) and construction practices throughout the developed and developing world.

The adoption of sustainable or green building in Australia shares a number of challenges with literature derived from the experiences of other nations in the developed world, including capital cost, and the need for developers to have a proven return on investment for green buildings before they are willing to take on the risk. Issues regarding access to or the availability of information (and knowledge) are also shared experiences, which impact directly on design and construction processes. Aside from capital cost the biggest challenge is the choice of materials and technology and their affordability; with a limited local selection of indigenous sustainable materials, supplied at higher prices and with long lead times.

In developing countries the challenge is not the sourcing or affordability of local materials but combining locally sourced, sustainable materials with appropriate and sustainable new technologies to provide innovative solutions to meet the demand for more sustainable building and construction projects. Research undertaken by du Plessis (2002) identified barriers to sustainable construction in developing countries to include: lack of capacity of the construction sector; an uncertain economic environment; lack of accurate data; poverty and low urban investment; stakeholders' lack of interest in the issue of sustainability; technological inertia and dependency; lack of integrated research and entrenched colonial codes and standards. Shared with experiences in the developed world, lack of knowledge and information on sustainable construction issues and appropriate, affordable solutions are major obstacles that need to be overcome.

Within Australia, high performance buildings, with their technological approach to greening the built environment has resulted in increased complexity in projects without appropriate management systems in place to deal with the various issues that arise. These buildings are expensive because they rely heavily on new technologies, frequently developed specifically for individual projects, seemingly designed to outperform the previous one. In the developing world, where the majority of the population is poor with very limited investment capacity, technologies and materials representing increased costs will not easily be accepted. Therefore there is a need to combine traditional materials and construction methods with

modern processes and technology that can be developed locally, for greater accessibility, including combining indigenous materials with renewable energy technologies. The developed world would also benefit from such an approach.

Many indigenous communities have practical experience of depending on nature for shelter and livelihood, and have developed construction practices that make use of natural materials from their immediate environment; re-using what they can and often leaving demolition waste to biodegrade (du Plessis, 2002). They have utilised local knowledge to orient, design and construct buildings to take advantage of climatic conditions rather than working against them. Whether these practices are still viable is unknown, but it is possible to learn the lessons offered by these approaches and adapt them for current and future building projects. This is much more relevant than attempting to replicate the high cost, high performance sustainable buildings of the developed world where the cost of justifying the materials and technology used in terms of their sustainability, detracts from the essence of what the buildings set out the achieve in the first instance.

Conclusion

The challenges to sustainable building approaches in Australia were found to reflect that of other developed countries, in particular higher capital costs, lack of cohesive information relating to sustainable construction and availability and affordability of appropriate materials and technology. A number of the challenges highlighted could be addressed by more appropriate approaches to green building including an integrated systems approach which would impact positively on the design and construction process as well rethinking what sustainable building practices aspire to; refocusing sustainability away from energy efficiency and highly technical solutions, to a more holistic examination of the impact of building on the environment.

There are opportunities to learn from the mistakes being made by the developed countries, and to build capacity, particularly for education as well as in the adoption of indigenous and sustainable materials and technology, which combined with integrated approaches to design and construction management, can lead to more efficient, affordable and sustainable results.

The challenge and the opportunity in both these cases is cohesive decision making, and the harnessing of capacity and knowledge to ensure the most appropriate strategies are in place to deliver sustainable building solutions.

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