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Title: Economic Challenges of Sustainable Construction

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Economic Challenges of Sustainable Construction

Abstract
During the last decade, sustainable construction has emerged within the UK as a subject of policy, research and innovation. In practice, however, the demand for sustainable construction is still low. Further, the promotion of sustainable construction faces several challenges, for example, from an economic point of view: there is a poor understanding of economic benefits to be derived, while the high capital costs and low market value, comparing with conventional building, creates a dilemma for stakeholders. Many UK developers are concerned that the implementation of a green agenda will result in increased risks, higher capital costs and even difficulties in obtaining financial support. Life cycle costing is an effective methodology, which illustrates the long-term value of sustainability, but is limited with regard to short-term financial return. The lack of accurate information relating to the cost and value of sustainable construction means that clients are unable to make informed decisions concerning sustainability.

This paper reviews the literature on sustainable construction and is divided into four sections: principles of sustainable construction, benefits of sustainable construction, challenges of sustainable construction and the limitations of life cycle costing. The results of this research show that the business benefits have been made and can be illustrated by many pioneer projects in the UK. However, the misperception of higher capital cost and the lack of awareness of market value are still significant barriers to the implement and demand for sustainable construction. It is critical, therefore, to establish the economic performance of sustainable construction in order to motivate stakeholders to consider methods of sustainable construction.

Keywords: sustainable construction, economic challenges, business benefit, life cycle costing and decision making

1.0 Introduction

Sustainable construction is seen as a new way for the building industry to respond towards achieving sustainable development on the various environmental, social-economic and cultural facets (CIB, 1998). Since the first international conference on sustainable construction in Tampa, USA, 1994, green building has become a significant global issue, while a number of pioneer projects have demonstrated that green buildings can provide a more healthy, comfortable working and living environment for both their current and future occupiers. To date, however, sustainable construction is still neither popular nor at the centre feature of the construction industry in the UK.
Moreover, the promotion of sustainable construction has been restricted due to the perception that it will result in higher risks and increasing construction costs. Sustainable construction, therefore, faces some economic challenges.

The primary barriers, therefore, to implementation are the misperception of incurring higher capital costs and the lack of awareness of market value. The current economic measurement tool, life cycle costing, is very effective on illustrating the long-term value of sustainable construction, but limited on showing the initial cost reduction. Most of clients and developers are encouraged to consider the short term financial return rather than long term consequences of their actions because the current financial system discourages long term investment through the practice of discounting (Smith et al, 1998). The lack of a visible market value is another reason why clients do not consider sustainability during the feasibility of a building development.

The aim of this paper is to investigate the current economic challenges of sustainable construction and to establish its business benefits in order to motivate decision makers to implement more sustainable construction in practice. It reviews recent research into the development of sustainable construction and examines the literature related to the economic issues of sustainable construction and limitations of life cycle costing. Finally it concludes that it is critical to educate both client and professional consultants the long-term benefits of sustainable construction and to create a green market in built environment.

2.1 Principles of Sustainable Construction

Sustainability is a holistic concept that holds economic, social and environmental factors in balance (Hydes and Creech, 2000), moreover it is complex concept, which is hard to define in simple terms. Pearce et al (1989) concluded that there have been over 200 different definitions of sustainability, making it difficult to determine practical ways in which to support sustainability. The term 'sustainable construction ' was originally proposed to describe the responsibility of the construction industry for attaining 'sustainability'. In 1994, the first international conference on sustainable construction has held in Tampa, USA. Kibert (1994) has defined sustainable development as:

"The creation and responsible management of a healthy built environment based on resources efficient and ecological principles"

Furthermore, he expands this definition to include six principles, (Miyatake, 1996)

- Minimisation of resource consumption;
• Maximisation of resource reuse;
• Use renewable and recyclable resources;
• Protection the natural environment
• Creation of a healthy and non-toxic environment; and
• The pursuit of quality in creating the built environment

Kibert's definition can be considered as the inception of sustainable construction. It identifies the central objectives of sustainable construction, which provides a high building performance for the occupiers. However, it does not establish its relationship with social and economic environment.

Hill and Bowen (1997) divided kibert 's principles in four 'pillars': social, economic, biophysical and technical.

• Social sustainability highlights improvements in the quality of human life, and human living environment, which include culture, health, education, and intergenerational equity.

• Economic sustainability includes the use of full-cost accounting methods and real-cost pricing to set prices and tariffs for goods and services and achieve more efficient use of resource.

• Biological sustainability includes the motion that sustainable construction needs to protect the natural environment rather than pollute, encourages the use of renewable resource and reduce the use of water, energy, materials and land in each stage of a project.

• Technical sustainability requires high performance, durability, quality and mixed use of a building.

Hill and Bowen's principles successfully explained the four themes of sustainable construction. Although, whilst it was a milestone, it lacked a discussion of those "soft issue" believed to be a feature of sustainability.

In 1998, the International Council for Research and Innovation in Building and Construction (CIB) created a global agenda for sustainable construction - 'Agenda 21 on Sustainable Construction' at the World Building Congress in Gavle, Sweden. Agenda 21 is a conceptual framework that defined the links between the global concept of sustainable development and the construction sector.
Further, it identified the concepts of sustainable construction not only in terms of 'hard issues' such as materials, building components, construction technologies and energy related design concepts, but also in term of 'soft issues' (e.g. social, culture, economic and management issues). Economic and social sustainability, therefore, must be accorded explicit treatment in any definition.

After Agenda 21 was published, sustainable construction attracted more research attention: for example, Bourdeau (1999) compared sustainable construction information from 14 countries and concluded that sustainable construction is an important component in creating sustainable development and there was a need to reach 'a more consensus vision through a global common model'. Brochner et al (1999) encouraged the use of integrated innovative environmental technology via building performance concepts to improve construction regulation and specifications.

The present trend in sustainable construction research focuses on the environmental and technical issues, via design and developing new technical, materials and components to achieve more efficient and better quality building. However, the achievement of marginal improvements in sustainable performance per unit of production will be made insignificant when compared to a higher future production rate (Uher, 1999). Therefore, it is essential to seek the economic principles of sustainable construction in order to create a profitable market for sustainable construction. Some concepts in the economic terms can be concluded in the below:

- Value for money
- Maximum output with minimum input;
- Integration of short term return and long term benefits
- Stakeholder partnership between the demand and supply sides of the industry
- Business pattern changes from a linear process to a cyclic process (Khalfan, 2001)

3.1 Sustainable Construction Policies and Practices in the UK

3.2 Policies

Sustainable construction is a critical and emerging issue in the UK. The construction industry is one of the pillars of the national economy (8% of GDP). On the other hand, however, it has a major impact on the national environment and resource use. According to DETR (2000), construction sites and demolition produce 72 million tonnes of waste each year, representing 17% of the UK's total waste burden. Commercial waste from construction totals 30 million
tonnes, a further 7% of the UK total. Each year poor design and site management leads to 10 millions tonnes of materials being delivered to development sites which are unused (Crossely, 2002). Consequently, The government published a series of polices to request the construction industry to implement the principles of sustainable construction in current and future projects.

The key policy document, *Building a better Quality of Life: a Strategy for more Sustainable Construction*, was published in April 2000 (DETR, 2000). This strategy focuses on the important contribution of the construction industry in the UK and presents 10 action points in order to achieve more sustainable construction. They are:

1) The re-use of built assets
2) Design for minimum waste
3) The aim of lean construction
4) Minimising energy in construction
5) Minimising energy in use
6) Aviation of pollute
7) Preserving and enhance bio-diversity
8) The Conservation of water resources
9) The respect of people and their local environment
10) Target setting

The government also published a consultation paper called *Sustainable Development: Opportunities for Change Sustainable Construction* and its feedback paper *Analysis of the Responses to the UK Government's Consultation Paper on Sustainable Construction*. Both of these documents illustrated government strategy and the current stage of sustainable construction in the UK.


*Government and industry action following the release of the Building a better quality of life have been reviewed (Dti, 2001), which highlighted the need for more information on forthcoming EU directives effecting sustainability and for promotion of the business case for more sustainable construction. The sustainable construction task group*
(http://www.sustainable-development.gov.uk/consult/construction/) published a research
paper established the relationship between sustainable construction and business, which
concluded that senior executives of construction organisations should pay attention to the
growing influence of sustainable construction on business, and recommended them to
integrated a sustainability agenda into their business strategies.

The UK government also begun to encourage more sustainable construction by means of various
instruments intended to influence the market, for example: (CIRIA C571, 2001)

- The Landfill Tax (1996) is influencing waste management practices by encouraging greater
diversion of waste from landfill. Costs of disposing of construction and demolition waste to
landfill can be minimised through more efficient construction and innovative re-use and
recycle materials.
- The Climate Change Levy on business use of energy was introduced in April 2001
- The Aggregate Levy introduced in April 2002 to reflects the environmental costs of
aggregate quarrying and encourages the demand for and supply of alternative materials,
such as mineral waste and recycled construction and demolition waste.

3.3 Practices

The UK government's policies encourage the construction industry to move from traditional
construction methods towards sustainable method. In response, a number of guidance and
incentive mechanisms exist to encourage the take up of more sustainable solutions. These include
the DETR's Energy Efficiency Best Practice Programme, Construction Best Practice Programme,
Movement for Innovation (M4I), Design Advice Scheme (DAS), the BRE environment assessment
Method (BREEAM) and the BSRIA Code of Practice.

Sustainable construction has also improved innovative research. Cater and Fortune (2002) review
of two research databases (Ei Compendex and CBA) and found that both the quantity and research
range has dramatically increased. They found that the articles on sustainability increased from 2 in
1990 to 139 m 2000 under the Construction Building Abstract (CBA)

Sustainable construction methods have been used in most types of building, for instance, school,
office building, university accommodation, etc. Prior to 1999, there are some 280 commercial
buildings in the UK, which according to most definitions of the term, and could be considered to
being 'green' (BRE, 1999). These buildings range in size from 2000m² to 120,000m², the largest
accommodating some 4500 occupants (Shiers, 1999). Green buildings now account for 25% - 30%
of all office space built since 1991 and an estimated 40% of all schemes built in the last 3 years (BRE, 1999). Despite the change introduced in office building, elsewhere the building stock has not been so active in introduced sustainable construction; most new construction still follows in a traditional path. There is a little evidence, however, to suggest that the introduction of a green approach to the design of UK residential property has lagged behind a number of other European countries (Anke van Haal, 1997)

4.0 Economic Benefits and Challenges of Sustainable Construction

4.1 The Economic Issues of Sustainable Construction

In 1999, a symposium entitled 'Cost and Value in Green Building' was held at the University of British Columbia, Canada. The primary goal of the two-days symposium was to consider the significant cost and value issues that either constrain or, more importantly, promote higher environmental performance standards in building (Cole, 2000). This debate presented a comprehensive overview of the cost-related issues associated with producing and using 'green building's; a convincing set of human, environmental and business arguments to justify higher performance goals; the performance and cost benefits that can be derived from an integrated approach to design and costing were presented.

Sustainable construction requires taking a long-term view, relative to the cost of green buildings: considering both the capital and running cost. The major economic benefits of sustainable construction are an improvement of building performance and durability due to a reduce from the maintenance and operation costs during building's life and thought the provision of an ideal living and working place leading to increase on productivity. However, the misconception of an increase capital cost and lack of a visible market value discourages both developers and contractors.

This paper reviews the issues surrounding the cost/value of sustainable construction, and analyses the economic benefits and barriers of sustainable construction: it concludes that the integration of short-term market value and long-term benefits is important for motivating the demand for sustainable construction.

4.2 Economic Benefits of Sustainable Construction

The objectives of sustainable construction are to reduce energy usage and the protection of natural and social environments, providing healthy and comfortable living environment, but also providing economic success for both developers and occupiers. The economic benefits of sustainable
construction are vital and stimulus but is raring understood by most developer and users. Traditionally, the main objective of construction was to obtain the best quality at the lowest construction cost within a limit time period. Seldom was the post constructing expenses, and the occupier's expense in the building considered. Recent research (Castillano, et al, 2000; Citex, 1999) found that the initial cost of construction accounts to only 2 per cent of a building, while another 6 per cent is expended on operations and maintenance, the remaining 92 per cent is spent on the people who work in the building based on a asset life of 30 years.

Sustainable construction expands the consideration of financial capital costs to include environmental and human capital costs. Johnson (2000) found that high performance buildings produce more economical benefits for their owners/operators than that base on more traditional designs, process, and materials. He presents a model of the economic costs and benefits of sustainable construction. (please see figure 1), which divides the potential economic benefits into the following four tiers:

<<< Insert Figure 1 Tiers of Economic Costs and Benefits (about here) >>>>

Tier 1: Traditional (TCO) - total cost savings
- General energy savings achieved by:
  - Improving the building envelope
  - Designing the structure to utilise passive solar energy
  - Utilising geothermal heating and cooling systems
  - Improving lighting energy efficiency
  - Utilising dehumidification
  - Reducing peak energy use

- Water Efficiency Savings achieved by:
  - Utilising low consumption
  - Utilising rainwater collection system
  - Utilising grey water system
  - Utilising on-site wastewater treatment

- Mechanical Equipment Downsizing, achieved by:
  - Reducing or eliminating venting
  - Creating more usable floor space
  - Re-using brownfield sites
Tier 2: Productivity including:
- Productivity improvement
- Reduction in absenteeism
- Improved reliability

Tier 3: Image & Reputation including:
- Enhancement of Goodwill and Brand Image
- Positive Press Coverage
- Community, Government, and Regulatory Support

Tier 4: Economic and Environmental benefits
- Supporting local economy
- Providing employment
- Developing the whole society
- Preserving the natural environment

Yates, (2001), explored the business benefits of sustainable construction and concluded that the benefits are diverse and potentially very significant. He identified the business benefits are including:
- Capital cost savings
- Reduced running costs
- Increased investment returns
- Increased productivity, staff recruitment and retention
- More efficient resource use, and
- Major image/ marketing spin-offs

Heerwagen (2000) highlighted that green building contribute positively to business performance and organisational effectiveness. First, green buildings are relevant to business interests across the full spectrum of concerns, from portfolio issues to enhanced quality of individual workspace. Second, the high performance of green buildings will influence of the outcomes of organisations such as workforce attraction, retention, quality life, work output, and customer relationships. Third, green building can provide cost reduction benefits and value added benefits. Hydes and Creech (2000) using two case studies demonstrated that by using energy efficiency design could also achieve lower cost than conventional design.
Sustainable construction has a number of potential benefits, not only the short term cost reduction, but also in terms of whole life cost savings. Further, it reduces natural and human resource costs; this is beyond the traditional perception of sustainable construction. These benefits are critical and will bring a better value for the building itself, the developers and end users.

4.3 Economic Challenges of Sustainable Construction

While sustainable construction has many potential economic benefits, difficulties and barriers still exist in practice. The demand for most buildings is 'derived demand' (Bon and Hutchinson, 2000), that is, it depends on the demand for goods and services which can be produced from the building or from utility offered by the building. Thus, the construction industry exists at the interface between, on the one hand, the supply of existing buildings, each with its own physical and locational characteristics, and, on the other, the general conditions of demand prevalent in the economy (Raftery, 1989). Keeping (2000) argued that few investors have a significant desire to own sustainable buildings. Whereas Bordass (2000) found that UK's pioneering green buildings have often been procured by owner-occupiers, who are less constrained by market norms.

Bon and Kutchinson (2000) founded that sustainable construction faces economic challenges at three levels. On the microeconomic level, building are created within shorter time horizons in response to being a demand-derived commodity and increasingly dominated by mechanical, electrical and electronic equipment. Finance is adjusted to the short and medium term, which is in conflict with sustainable construction, which relies on decision based on the long-term perspective.

The primary barrier to the introduction of sustainable construction is a clients' widely held belief that sustainable construction will cost more and high risk (Johnson, 2000; Landman, 1999; Hydes and Creech, 2000; Castiliano, et al, 2000), for example, the belief that cost will increase by using new technologies and green materials. While extra design features might increase the consultant's fees. Landman argues that higher cost resulted from the unfamiliarity of the design team and contractors with sustainable method. Therefore, it is not only the higher capital cost but also a lack of education about the economic benefits for both developer and bank, financiers of the builders. There is little market incentive for clients to put more additional money into the innovation without extra return over the short-term period.

The client's cost advisors form a further barrier. Ballett and Howard (2000) found that UK's quantity surveyors have a perception that more energy efficiency and environmental friendly building cost between 5% and 15% more to build from the outset. They suggest that cost consultants overestimated the capital cost of green building, and suggested that they need to inform
the decision makers of the correct cost and value of green building. Johnson (2000) argued the extra fees levied by professional caused both the client and their advisor to avoid applying sustainable construction methodologies. The overestimation and unwillingness of consultants to implement 'green' buildings result in the lack of accuracy information concerning both the cost and value of sustainable construction.

Not only are clients concerned about the increasing costs but attracting higher risk (Hydes and Creech, 2000; Larsson and Clark, 2000, Shiers, 1999). These risks include: unfamiliar techniques, the lack of previous experience, additional testing and inspection in construction, lack of manufacturer/supplier support, lack of performance information, etc.

A further major barrier results a lack of market value. Sustainability is a kind of process, which is not an action, style, etc. While sustainable construction has plenty of long-term benefits but few present the market value. The analysis of the responses to the UK Government 's Consultation paper on sustainable construction' highlights that

"There is little sense at present that sustainable construction is an approach that will increase efficiency, productivity or profitability. The major obstacle to change is perceived to be a lack of client demand, especially, as several respondents suggest, that much of the science in the short-term is uneconomic. An important barrier is that short term economic costs do not equate to long-term sustainability... and... the fear of low profitability is an important concern for the industry. Sustainable construction will need to be specified in appropriate detail and properly cost."

Smith et al (1998) state that developers were encouraged to think of short-term profits rather than the long-term consequences of their action because our financial system actually discourages long-term investment through the practice of discounting. Discounting is used in financial assessments to calculate the most effective use of capital in investments. The application of discounting often leads to short term polices, because the cost yardsticks used discourage spending more money now to save more in the long term.

4.4 Limitation of Life Cycle Costing

Life cycle costing (LCC) is an effective tool used to measure sustainable building performance. While recent research (Castillano, et al, 2000, Citex, 1999) realized that the capital cost is only less than 5% of total cost during a building life. Life cycle cost analysis is an increasingly accepted analytical method that calculates costs over the 'useful' or anticipated life of an asset - reveals that
low up -front expenditure, can result in much higher costs over the life of a building or system. LCC involves the systematic consideration of all 'relevant' costs and revenues associated with the acquisition and ownership of an asset (Clift and Bourke, 1998). LCC is one of several methodologies that can be used to account and provide for a more comprehensive view of costs. Aye et al (2000) concluded that:

*Life-cycle costing methods have been used in decisions about property and construction options for many years (Stone, 1980; Flanagan and Norman, 1983). Robinson (1986) has expounded on levels of complexity of life cycle costing: the experiential, the feasible and the technical. The present study is at the feasible level, i.e. a broad analysis. ' Feasible life cycle costing may be defined as the outcome of cost and value analysis procedures built into an economic feasibility study'.*

Cole and Sterner (2000) compared the theory and practice of life cycle costing and illustrated the limits of LCC in practical building design, especially in green building. The limits include: lack of motivation to use LCC, a number of contextual factors that restrict its use, a host of methodological problems and limitations and difficult to access to reliable data. Sterner (2000) defined two main constrains for implementation of LCC techniques in Sweden building projects. They are lack of relevant input data and limited experience in using LCC calculations. Further, Bogensätter (2000) highlighted the lack of incentive and complexity technique lets not easy to integrate in the construction process, even design stage. Finally, Bordass (2000) argued that a life- cycle approach is often defeated in the marketplace because those who pay the upfront costs do not received the benefits; or those benefits derived are rapidly discounted.

**5.0 Discussions and Conclusion**

Despite the barriers discussed above, sustainable construction is being accepted by the international construction industry. Sustainable construction is not a technical problem; rather it comprises environmental, social and economic issues. Further, it is a complex concept and process, barely defined in a simple universal theory. The principles of sustainable construction have four dimensions, ecological, social, economical and technological, while the central economic theme of sustainable construction is to efficiently use resources to achieve the maximum benefits for all stakeholders in the building environment.

In the UK, the government has published a series of documents and introduced various instruments intended to stimulate the construction market into applying sustainable construction. Additionally, there has been a dramatically increasing in both the quantity and range of research into sustainable
construction issues. Despite this, however, the demand for sustainable construction is still low.

The economic benefits of sustainable construction is held to be significant; they include total cost savings, tax savings, added value, more efficient resource use, productivity improvement, increased organisation effectiveness, the generation of positive image and support for the local economy.

However, sustainable construction faces several economic challenges in practice. Traditionally, the objective of a building project is to complete the project good quality, lowest cost and within a limit period. All investors are cautious, and unwilling to receive an additional cost. The cost of environmental protection has usually been seen as a superfluous and unnecessary barrier to profitability (Boughey, 2000). The battle between economic growth and environment protection is critical to the construction industry. Investors and developers hold the misconception that capital costs will raise when they apply the sustainable construction methods; they lack to understand the economic benefits of sustainable construction. Furthermore, the challenge for investors includes the difficulties to obtain financial supports and a lack of visible market value. Life cycle costing is an ideal economic tool and effective to measure the long term benefits from sustainable construction. However, because of the lack of relevant 'live' cost data and limit experience of their use, it is not commonly used in the practice.

To respond to these problems, the construction industry needs to educate both its clients and professional consultants concerning the long term benefits of sustainable construction, create a sustainable construction market to assist its clients to achieve both the short term return and long term benefits from sustainable construction.

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Figure 1 Tiers of Economic Costs and Benefits

Tier 1: Traditional TCO
Tier 2: Productivity
Tier 3: Corporate Image
Tier 4: Economy & Environment

Increasing Measurement Difficulty
(Source from “The Economic Case for High Performance Building”, Johnson, 2000)