

SUSTAINABLE CONSTRUCTION: CHALLENGES AND OPPORTUNITIES

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There has been an increasing concern over the impacts of construction activity on the environment and measures have been put into practice to mitigate them. These measures include legal frameworks, cultural, technological and managerial processes. The construction industry is under severe pressure in order to adopt environmentally friendly approaches and environmental responsibility is nowadays seen as a competitive advantage. However, implementing environmental management systems within construction organisations is not without significant constraints. Construction sustainability has therefore been a major dilemma for the construction industry. This paper reports initial findings of a larger research project on the implementation of sustainable construction in Mozambique. The paper presents and discusses the most important challenges and opportunities facing construction organisations in implementing environmental management systems in Mozambique. The data were collected through a case study of a construction project conducted from the client's perspective. Construction organisations must devise robust and innovative environmental management strategies in order to comply with the sustainability requirements and take advantages of the opportunities arising from the implementation of such practices.

Keywords: construction, environment, sustainability.

INTRODUCTION

The construction industry plays an important role in the economic and social development of nations. The construction industry is all who plan, develop, produce, design, build, alter or maintain the built environment and includes manufacturers and suppliers of construction materials, clients, contractors, consultants and end users of facilities. The industry has however had a significant impact on the environment. The traditional approach of the industry has been based on the premise that innovations and investments drive the economic growth and satisfy the consumers' needs and desires. It is however necessary to recognize that the products and processes of the industry have severe consequences on the environment. Construction activity makes extensive use of natural resources, various sources of energy, and water. According to Worldwatch Institute, building construction alone consumes 40 percent of the raw stone, gravel and sand used globally each year and 25 percent of virgin wood. Buildings account for 40 percent of the energy and 16 percent of water used each year around the world. The negative impacts of these activities are evident. Raw materials extraction, transportation and manufacture have often led to resource depletion and biological diversity (fauna and flora) losses (Roodman and Lensen, 1994). Energy consumption produces emissions that contribute to global warming and acid rain. Wastes resulting from the construction process often pollute air, water and can pose serious health and safety problems. In addition, construction activities cause comfort disturbance and deteriorate health conditions.

Baloi, D (2003) Sustainable construction: challenges and opportunities. *In: Greenwood, D J (Ed.), 19th Annual ARCOM Conference, 3-5 September 2003, University of Brighton. Association of Researchers in Construction Management, Vol. 1, 289-97.*

An increasing concern over these impacts has triggered the adoption of measures to mitigate them by the different parties (Hill and Bowen, 1997). These measures include legal frameworks, technological and managerial processes. In recent years, like other industries, the construction industry has been under severe pressure in order to adopt environmentally friendly approaches and environmental responsibility is nowadays seen as an important competitive advantage.

SUSTAINABLE CONSTRUCTION

Sustainable construction can be viewed as a subset of sustainable development applied to the construction industry. It can be defined as “the creation and responsible management of a healthy built environment based on resource efficient and ecological principles” (Kibert, 1994). Concerns over the environment deterioration date back to ancient times but the turning point towards practical and effective actions is relatively recent. The Agenda 21 was formulated in 1992 in Rio de Janeiro, Brasil, as an international blueprint for sustainable development (development and environment). The Agenda is a comprehensive plan of action to be taken globally, nationally, regionally and locally by UN System, Governments, interest groups, businesses and the society in general.

Agenda 21 provides alternatives to combat degradation of land, water, air as well as to preserve the diversity of flora and fauna. Since then all economic and social sectors including industries have made effort in order to translate and pursue sustainability within their specific contexts. As a means to set a specific sustainability agenda for the construction industry, the Habitat Agenda and CIB A21 have been established. The Agenda 21 for sustainable construction was published by the International Council for Research and Innovation in Building and Construction (CIB) in 1999. According to the main principles of sustainable construction are the following:

- maximisation of resource reuse;
- minimisation of resource consumption;
- use of renewable and recyclable resources;
- protection of the natural environment;
- creation of a healthy and non-toxic environment; and
- creation of quality in built environments.

Sustainable construction embraces three main dimensions namely social, economic and environmental in contrast with the traditional perspective, where the main concerns were economy, utility, and durability. The social dimension addresses issues pertaining to the enhancement of people’s quality of life. The economic dimension addresses economics issues such as employment creation, competitiveness enhancement, lower operating/maintenance costs, employment creation, high quality of working environment leading to greater productivity and many others. The environmental dimension deals with the design, construction, operation/maintenance and deconstruction approaches that minimize the adverse impacts on the environment such as air emissions, waste discharges, use of water resources, land use, and others.

DEVELOPMENT AND SUSTAINABILITY

The contribution of the construction industry to sustainability is a worldwide concern. However, the problems confronting developing countries are enormous and much more complex than those affecting the developed world. Typical problems of developing countries include low income, poor water supply systems, incipient sanitation systems, poor education and health systems, lack of trained human resources, finance and many others. More often than not the most basic human needs are not therefore being met, in contrast with the developed world where in many cases these needs have even been exceeded (Loh, 2000). As such, it is not surprising that much of the available resources be devoted to the solution of the most basic problems.

The differences between the two worlds are significant and include skills levels, priorities, construction industry capacity and institutional capacity. Due to their huge technological advances, developed countries tend address sustainable construction problems from the technological point of view. That is the reason why the research and development agenda for sustainable construction has a strong technological component. The ability to innovate and develop new technologies is a greater determinant of economic success than traditional factors of comparative advantage. But Welford (1996) emphasised that technological advances alone are not sufficient and science and technology can not be expected to solve all the mistakes made in the past and pave new ways to the future.

Apart from the technological side, developing countries need to address the behaviour and choices of people as the main enablers for sustainable construction as they come from a people-centred view of development (www.csir.co.za/akani). This means that a change in attitudes of people towards production is urgent.

The specificities of problems inherent in developing countries and the scarcity of resources to be allocated to sustainability actions have led to the need for a specific Agenda 21 for Sustainable Construction in Developing Countries. The Agenda will help establishing sustainable practices suitable to these countries. This Agenda differs from others in terms of scope and context. The formulation of the agenda is still underway and has been undertaken jointly by UNEP-IETC, CSIR Building and Construction Technology and Construction Industry Development Board of South Africa (Gibberd, 2001).

ENVIRONMENTAL MANAGEMENT SYSTEMS

Construction organizations need to devise appropriate measures to respond to environmental requirements. These measures include compliance with legal frameworks, technological innovation and managerial processes improvements. The usual manner in which organizations prepare to embark on environmental movement is through the establishment of environmental management systems EMS. The size of the company, its objectives and activities determine the most appropriate type and size of the EMS to put in place.

An environmental management system EMS can be defined as an organisation's formal structure, encompassing procedures, practices, resources and processes that implements environmental management (Griffith, 1994). It enables companies to respond to environment challenges and legislative/regulatory requirements proactively. An environmental management system focuses on the organisation's activities that have potential impacts on the environment, and includes the

consideration of the inputs, outputs as well as the corresponding impacts. The impacts are usually listed and prioritised according to their significance. All construction industry stakeholders, particularly clients, contractors, consultants, suppliers, and regulatory bodies, should ideally embrace EMS in order to recognise the impacts of construction on the environment.

INFORMATIVE CHALLENGES AND OPPORTUNITIES

There are many challenges and opportunities associated with sustainable construction. These challenges and opportunities stem mainly from the need for balancing the main sustainability dimensions namely economic, social and environmental issues.

According to Miyatake (1996) all players have to realise that the achievement of sustainable construction requires a change in processes of creation of built environments from linear to cyclical approaches. That is, the construction industry has to change the way in which all the construction activities are undertaken, namely placing much emphasis on recycling, reuse of materials as well as the reduction in the energy and natural resources use.

The construction industry needs to strike the right balance between environmental performance and economic performance. Several methodologies, techniques and tools such as Life Cycle Costing LCC and Life Cycle Assessment LCA for buildings are available for this purpose. The achievement of this balance is not easy and it is not without cost.

There has been an intense debate among researchers and practitioners on the benefits and costs of sustainable construction. It seems that no consensus will be reached soon, and two opposite views with regard to the challenges and opportunities of sustainability still prevail. While sustainability is seen as making good business and economic sense by some industry players, it is regarded as a burden by others.

According to Porter (1991) the conflict between environmental protection and economic competitiveness is a false dichotomy. It stems from a narrow view of the sources of prosperity and static view of competition. Environmental legislation and regulation must not be viewed as obstacles to competitive advantage. Tough standards trigger innovation and upgrading, instead. Tough regulations can force organisations into innovating to produce less polluting or more efficient products with high value. According to this perspective the adoption of sustainable practices is no longer a cost but a catalyst for constant innovation and new market opportunities.

The benefits that accrue from the adoption of sustainable measures include process benefits and product benefits. Process benefits include materials savings due to reuse, recycling, conversion of waste into valuable forms, savings from safer working conditions, reduction of the costs of the activities associated with discharges, waste handling, and transportation, lower energy consumption during production process. Product benefits include higher construction quality, lower life cycle costs, and safer construction process.

On the other hand, there are some serious challenges towards the achievement of sustainability. According to Bon (www.iris.ba.cnr.it) sustainable construction faces many economic challenges at the macroeconomic, meso-economic and microeconomic levels. First, the construction output has been in decline in developed world; secondly, although there has been a steady growth of the output in developing countries, it must be recognised that the attainment of sustainability is considerably

difficult in these countries; and thirdly, the construction sector depends on the implementation of sustainability measures from other sectors of the economy such as the manufacturers of construction materials and components.

Many agree that fear not greed has driven most environmental programmes within companies. According to Roberts (1997), although some companies have embarked on environmental management programs in advance of legislation, they do so mainly because of the threat of legal action. Apart from the challenges posed by costs, construction organisations have to deal with issues that characterise construction projects such as different locations with specific requirements in terms of environmental management.

However, Stavins (1996:47) conducted a statistical analysis from more than 100 academic and Government studies that help to uncover some of the problems. The main conclusion was that the reality lies between the two extremes positions, that is, the implementation of environmental management is both a challenge and an opportunity. According to Kleiner (1991) in the long term, the economic growth and the adoption of environmental management systems reinforce each other.

CASE STUDY: CONSTRUCTION OF UNIVERSITY FACILITIES

Background

A case study was conducted in order to ascertain the main challenges and opportunities associated with the implementation of sustainable construction practices. The unit of analysis reported upon is the construction of new facilities for a higher education institution in Mozambique. The case study enabled the investigation of the project within its real life context as well as using multiple sources of evidence. Primary and secondary data were collected through interviews with the client, environmental consultant, design consultant and contractor. A total of 10 professionals were interviewed. There were construction site visits and documents study as well. The case is used both as an illustrative example and as an evaluative study. The case study analyses parts of the application of sustainability measures on the construction of a new faculty buildings. A holistic and integrated perspective of sustainability including the main phases of the facilities life cycle was considered. The parties involved in the environmental management were the client, consultants, contractors, and the regulator. The main goal of the client was to translate the environmental requirements identified at the conceptual stage into an informative basis for the subsequent project stages including the procurement of consultancy services and works. The client's awareness of environmental issues and commitment at all stages of the project was of paramount importance to the success of the environmental management programme.

Project data

Mozambique is a country with a coastline of approximately 3000 km comprising a wide range of natural habitats characterised by high levels of biodiversity. The conservation and sustainable use of the coastal resources is a priority. The development area comprised 30 ha free of inhabitants but the area was being used as a means of subsistence for the local population, with plantations of coconut trees and other crops. The most salient biophysical features of the site are dune forests and thickets, wetlands, and mangroves. The environmental management spanned planning, design, and construction stages. The client played a key role throughout the process

with particular emphasis on the environmental aspects during planning, briefing and design stages.

Planning

The environmental legislation in Mozambique requires some types of development projects to pass through environmental impact assessment. Projects are screened and classified into categories depending on the nature, magnitude and probable environmental impact. According to this classification projects may fall anywhere between A and C groups. The determination of the screening category depends on several factors such as project location, sensitivity of environmental issues, nature of impact, magnitude and impact. This was considered group A project and thus required a full environmental impact assessment since it was expected to have sensitive, irreversible and diverse adverse environmental effects. An environmental consultant was hired and an environmental impact assessment was undertaken with the two key objectives, namely identification of the potential environmental and socio-economic impacts.

The assessment results included the following:

- review of the biophysical features of the suggested location
- identification, classification, and quantification of the potential negative and positive impacts
- assessment of the consequences on the environment of the future water supply system and sanitation for the new facilities
- assessment of needs for the treatment of liquid and solid residuals, disposal and management for the facilities
- recommendations on mitigation measures for each negative potential impact and estimate the corresponding cost

The environmental impact assessment study was approved by the regulatory agency and the project could proceed. The analysis of the impacts and recommended mitigation measures defined the scope of the environmental management plan EMP as well as the activities to incorporate in the monitoring program. The EMP provided guidance to the concerned stakeholders of environmental management for the design, construction and operational stages of the project. The EMP included guidelines for a compensation plan for any parties whose land, crops fruits trees or infrastructure were affected by the project, including the indicative costs.

Design

Consultancy services were procured and the design firm selected. The results of the environmental impact assessment served for laying the groundwork for an effective design stage. The environmental impact assessment information had to be considered for inclusion with other detailed aspects of the project at two design stages, namely scheme design and detail design. The scheme design looked into the aspects of the construction form and its relationship with environment. These aspects included the effects of the facility construction on the land (erosion, stability, landscape), water resources (natural drainage, ground water level, water courses), atmosphere (emissions, noise, vibration, odours), ecology (fauna and flora), and population (density, change, proximity).

The detail design focused more on technological aspects with emphasis on the structure, materials specifications and fabric elements. Aspects such as performance, functionality, and assembly were dealt with in order to improve the sustainability of the facilities through energy efficiency, use of green materials, reduced waste management, health and safety and reduction of pollution.

The client had a fully understanding of the project potential environment impacts as well as the way in which these could be translated into the design and construction phases. There were however several difficulties as the consideration of environmental aspects imposed additional demands on the design team. The team was familiar with the traditional design approach, which does not account for environmental issues. The design firm had no formal environmental management structure within its organisation and had little experience in handling environmental aspects. Furthermore, had little knowledge of environmental legislation, green materials and elements performance, environmental concepts and information. The environmental consultant has to work closely with the design consultant in order to bridge the gap and speed up the design process. This represented additional costs to the design consultant. In addition to these problems, the supply of green construction materials is very limited and alternatives, often environmentally less effective, had to be found.

The consultant considered environmental management as beneficial in that it helps to protect the natural environment and improve the quality of the built environment. The consultant showed interest in environmental management and is planning a training programme and establishment of formal structure so as to respond to the increasing demand for environmental management practices in the market. For that purpose the consultant intends to procure environmental consultancy services.

Construction

The detail design plays a crucial role in construction sustainability measures as it is at this stage that many important decisions are made. The main responsibility of environmental management during the pre-construction and construction stages rests with the main contractor. The supervision of the environmental management in accordance with method statements for construction was conducted by the environmental and design consultants. The method statement is a comprehensive description of the contractor's approach to carrying out the construction work. The regulatory agency took part in the compliance monitoring, as well.

The contractor had to bring together the environmental requirements of the client and design team through the establishment of environmental management plan at site level, which included a health and safety management plan. This plan was preceded by a site investigation to ascertain local conditions prior to tender submission and shortly before commencement.

The main areas of concern during the construction process were the appropriate site planning and organisation, accesses, traffic movements, prevention/minimisation of discharges, gaseous and airborne discharges to the atmosphere, chemical emissions, noise and vibration, management of hazardous substances, waste management, and health and safety.

Similarly, the main contractor had no formal environmental management structure within its organisation but had large experience in health and safety management. The contractor had to complement health and safety measures with additional sustainable measures embedded in the contractual documents. This involved the establishment of

a formal structure to implement the necessary supervision and control measures to ensure effective environmental management. The site manager and the supervisors were assigned the main responsibility for environmental management.

The contractor suggested that the environmental management would inevitably lead to additional costs and delays because the measures associated with the reduction of environmental impacts required the allocation of additional material, human and financial resources to accommodate process change and innovation. Several problems occurred but the commonest were misinterpretation of environmental requirements, non-compliance, poor communication among contractor's staff, and negligence.

The supervision had to intervene in several occasions in order to force the contractor to comply, but eventually the environmental management system on site improved. These findings are consistent with previous research. A study conducted by (Shen and Tam, 2002) in Hong-Kong, concluded that construction contractors considered sustainable construction practices as inevitably leading to extra costs and resources and thus unlikely to attract their interest.

From the contractor's point of view the benefits of EMS are not tangible at least in the short-term. The contractor considers important to contribute to the environmental protection, improve working conditions and to comply with the regulations.

CONCLUSIONS AND RECOMMENDATIONS

Sustainable construction represents the responsibility of the construction industry towards sustainable development. Construction activities, namely design, construction, operation, maintenance, rehabilitation, modernisation and dismantling, have significant impacts on the environment. The extensive use of natural resources and energy, pollution of air, land, soils and water resources are some examples of the implications.

There are many challenges and opportunities associated with the implementation of sustainable construction by the construction industry. Indeed, balancing economic and sustainability objectives is far from easy.

The initial results from the case study suggest that construction organisations in general and design firms and construction contractors in particular are unfamiliar with environmental management practices. The adoption of formal environmental management structures within these organisations is an exception and not a norm. Environment management has been approached in an ad-hoc manner, instead.

Generally, empirical evidence shows that the most significant challenges associated with environmental management include increase in costs, lack of environmental awareness, lack of environmental education and training (both technical and managerial), need for change management, lower supply of green materials and components, poor environmental legislation knowledge, poor communication, and lack of commitment.

The benefits that accrue from the adoption of sustainable construction practices in accordance with the results include compliance with the environmental legislation and regulations (avoid liabilities), contribution to the environmental protection, improvement of staff working conditions.

It seems that the main driver for environmental management implementation is the legal framework. These results are not surprising as the sustainability movement in

construction industry is still in its infancy in Mozambique and in many other developing countries. Outsourcing environmental services has been the common approach. As the practice matures though, many construction organisations will embark upon. Much work is needed in the adoption of environmental management systems by the diverse construction industry players particularly clients, consulting and contracting companies. In order to embrace environmental management, construction organisations must devise effective environmental strategies at corporate, business and operational levels, including the adjustment of organisational structures as part of their overall strategy and objectives.

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