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## **SUSTAINABLE CONSTRUCTION IN DEVELOPING COUNTRIES**

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### **Abstract**

Sustainable construction is about much more than the fabric of the built environment. Housing and the social, commercial and transport infrastructures around them must all be built in ways that are sustainable in environmental and economic terms. They must also be sustainable in social terms. They must add value to the quality of life for the individual and the community. Sustainable development is understood as an integrative and holistic process of maintaining a dynamic balance between the needs and demands of people for equity, prosperity and quality of life, and what is ecologically possible.

This paper addresses the essential requirements for developing sustainable construction in developing countries including considering sustainability as a necessity, efficient management of resources, shared responsibility, quality improvement of construction processes and products, improving the capacity of construction sector, and the need for integrated research. The innovation of building materials and technologies as an opportunity of sustainable construction in developing countries is introduced. A tool for sustainable building is presented.

### **1. Introduction**

All buildings, including houses, hospitals, schools, offices and factories, and other forms of construction such as civil engineering including infrastructure, must be designed, built, maintained and adapted in ways which meet the many and changing needs of society. They must provide environments in which people live and work enjoyably and efficiently and which encourage working and social communities to flourish. Buildings and structures change the nature, function and appearance of town and country alike. They consume energy in their operation and in the extraction and preparation of materials, and they generate waste and pollution. They have a significant impact on the use of non-renewable resources. Landscaping can add significantly to the quality of the built environment, benefit wildlife and provide an opportunity to use plants of biodiversity interest and local provenance (DETR, 1998).

Due to the rapid rate of urbanization experienced in developing countries and the increasing pressures on what are often limited resources, there is great urgency to make sustainable interventions now, while these built environments are being created, rather than trying to change things after the fact. There is no doubt that large-scale development is needed to address issues such as adequate housing, rapid urbanization and lack of infrastructure. However, these problems need to be addressed in ways that are socially and ecologically responsible. The developing world can either choose to blindly follow the model laid down by the developed nations, or it can choose to opt for a more sustainable model of development. While the level of underdevelopment in developing countries may be a cause for despair, it also provides an opportunity for

development in these countries to avoid the problems currently experienced in the developed countries. Developing countries need not to go through the same process of development as that followed by developed countries. Instead these countries can choose to base all future development on the principles of sustainability (Plessis, 2002).

Sustainable development is understood as an integrative and holistic process of maintaining a dynamic balance between the needs and demands of people for equity, prosperity and quality of life, and what is ecologically possible (Plessis, 2003 and Wenblad, 2003). The sustainability of settlements is a multi-dimensional problem, dealing not only with settlement dimensions, but also with spatial characteristics, geographical location, environmental conditions, economic viability, institutional ability and structure, human development, social relationships, and local values and aspirations. The infinitely complex set of issues that determine sustainable development and settlement sustainability, and the recognition that these issues are interconnected and interdependent, identify sustainability as a systemic concept that requires a systems approach to problem solving and planning (Plessis, 2003).

Sustainable construction implies not only new environmentally orientated construction designs, but also new environmentally friendly operation and maintenance procedures. Not only must construction materials and components be produced in a sustainable way, but their use must also answer to new requirements deriving from holistic environmental prerequisites. For example, there is no sense in producing cladding glass in an environmentally friendly way, if that sheet of glass is going to be used as a façade or roof in an Arabian tropical climate. The concept of sustainable construction now transcends environmental sustainability to embrace economic and social sustainability, which emphasizes possible value addition to the quality of life of individuals and communities. Hence, the set of criteria that can be used to identify whether a settlement can be declared sustainable or not includes (Plessis, 2003):

- The physical structure; how the settlement sits within the natural environment and therefore responds to the topography; the spatial relationship between the different parts of the city; and the form of the built environment.
- The utilization patterns which are formed by the way the settlement uses its resources and which are described by the infrastructure and services provided.
- The social patterns; how people live, learn and work in, and relate to their settlement, and the opportunities provided by the settlement for meeting these social needs.
- The operational patterns; how the settlement functions and is managed.

## **2. Essential requirements for sustainable construction in developing countries**

Sustainable construction has some essential requirements for both developing and developed countries. One of the differences lies in the approach to satisfying these requirements that are appropriate to the specific contextual conditions and the resources that are available to pursue them. While these requirements are the main focus of sustainable construction in developed countries, in developing countries they merely constitute another layer in an already complex problem. Furthermore, while developed countries have made some progress in addressing the essential requirements of sustainable construction, developing countries are only now beginning to consider how to address these requirements from within the broader developmental challenges they are facing. This section outlines some of the essential requirements particular to developing countries.

### **2.1 Sustainability is a necessity**

Sustainability as a concept has only recently been introduced to the construction sector and the development happening shows that sustainability and sustainable construction are not yet an integral part of decision making and business practice. Sustainability is still seen as a luxury addition to normal practice and neither as a necessity nor as the main motivator driving business

and development decisions. The general perception is that the introduction of sustainable construction practices will increase costs and reduce profit. The need to make additional investments in machinery, equipment and training is very often an excuse not to comply with standards and practices based on principles of sustainability. The construction industry complains of lack of resources to invest in the technological changes required for the application of this concept and they are concerned that their level of profits will be reduced. While it is true that the change to more sustainable construction will incur some costs, there are also associated savings resulting from efficient resource use, higher productivity and reduced risk. The focus should be on identifying ways of capitalizing on the benefits of sustainability to increase profitability (Miranda1 and Marulanda, 2002).

### **2.2 Efficient management of resources**

The lack of resources is not always the primary problem, but the lack of coordination to manage them in a more efficient way. Converging resources from different organizations could help to increase the impact of these resources. Working together, the financing of research and educational activities, as well as the responsibilities to develop the construction sector can be shared by all parties. Costs can also be substantially reduced if the construction sector works together and shares responsibilities with government, universities and other private sector related industries and institutions.

### **2.3 Shared responsibility**

Sustainability is not the sole responsibility of governments and the construction industry. Citizens need to get involved and be aware of the impacts of their behavior and their use and misuse of resources. Individual participation of people is the key to achieving decisions needed to secure changes in the consumption patterns of the majority of the population. It is important to develop campaigns that on the one hand inform the public regarding the benefits and opportunities of the use of environmentally friendly building materials and products and, on the other, encourage a change in consumer habits towards a more sustainable use of resources. A general interest is required in the issue of sustainability by the construction sector, its clients and other stakeholders. This should be propagated differently through the various stakeholders (Plessis, 2002):

- Politicians; Sustainability issues should actively appear on the agenda of political leadership.
- Manufacturers; Environmental responsiveness should constitute a criterion in materials or product specifications.
- Local authorities; Sustainability should constitute a criterion or drive requirements for plan approvals, land use or land sub-division.
- Built environment professionals; Sustainability considerations should make it to the brief, design criteria or specifications. Related training institutions have a key role to play for training in these issues.

### **2.4 Quality improvement of construction processes and products**

Defects and inefficient processes are expensive forms of wasting environmental resources and pose a danger to both construction workers and the end-users of the product. Badly performing construction products also reduce the quality of life of those using these products. One of the most important steps towards sustainable construction is to improve the quality of construction products and the efficiency and safety of the construction process. It is a priority for the construction sector to reduce its use of resources. Areas of improving the quality of construction processes and products include (Plessis, 2002):

- **Reduction of building material wastage**

Reducing material wastage helps to reduce global material consumption, the amount of construction waste and, in the long term, the amount of demolition waste. It also reduces construction costs, making houses more affordable. Management, design and cultural

practices have a great influence on the wastage rates. These can be changed through education, site planning, management and design practices, as well as the use of new technologies.

- **Increasing the use of recycled waste as building materials**  
Recycling waste as building materials is a convenient way to reduce the environmental impact of the construction industry. Recycling helps to reduce the consumption of natural resources, deposition of landfill and energy consumption of material production and all its associated pollution.
- **Energy efficiency in buildings**  
This can be achieved through cutting down both consumption and embodied energy. Reducing energy consumption can be accomplished through education, the development of an energy code, improvement of systems (air-conditioning, heating, water heating), improvement of insulation, use of alternative energy sources and passive solar design improvements. Consumption can also be reduced through the redesign of appliances such as water heaters and lighting sources.
- **Water conservation**  
A combination of user education and design and technical changes is required. Improved water metering systems, rainwater harvesting systems, re-using water, waterless technologies and low-flow, aerated and self-closing faucets are suggested. The use of water on construction sites and in the production of materials also needs to be reassessed.
- **Durability and maintenance**  
Increasing knowledge on the service life of the built environment, and the capability of generating and managing life data are certainly a major challenge for achieving a more sustainable construction industry. This should include physical and functional durability of the constructed asset including the optimization of the service life in all phases of the building process. It also requires that building flexibility and capacity be upgraded. Maintenance also needs to be considered during design, and life-cycle costs can be used to select more competitive technologies.
- **Innovation in building materials and methods**  
An entirely new design paradigm is required, one more far-reaching than the move from brick and mortar to steel and glass at the beginning of the 20th century.

### **2.5 Improving the capacity of construction sector**

One of the most critical barriers to sustainable construction is the lack of capacity of the construction sector to actually implement sustainable practices. This lack of capacity is a factor both of the number of human resources and the skills levels of these resources. There simply are not enough professionals, tradesmen and laborers who have been trained to support sustainable construction. In fact, the capacity of the construction sector in many developing countries can barely deal with the demands of routine construction. The vast majority of construction firms are small enterprises that rely on outsourcing personnel as required. This has severely affected skills training and the retention of expertise in the industry as construction workers become highly mobile, walking in and out of the industry, depending on performance in other sectors of the economy.

### **2.6 Need for integrated research**

Research in building technologies and planning should be done in a holistic manner. The research institutions, development agencies and other organizations need not to address each issue individually and independently of other issues to which it is linked. For instance, agencies involved with building technologies should not only focus on specific technologies such as Ferrocement or soil blocks as isolated elements, while others deal with pollution, transport planning, environment or social issues. Co-ordination and cross-sector work between these agencies is

required and thus development activities related to the design and management of human settlements should take place in a holistic manner. Funding for holistic research projects, instead of projects focusing on one specific aspect such as energy efficiency is a priority for sustainable construction. Hence, an integrated research planning and dissemination between the theoretical and practical spheres is essential to sustainable construction.

### **3. Innovation in materials and technologies: Opportunities of sustainable construction in developing countries**

In developing countries the availability of conventional construction materials will fall considerably short of their demand, despite improved productivity, and several alternatives for them are being developed. Research and development institutions in India have developed a number of technologies for production of new building materials that are cost-effective and eco-friendly with special attention to utilization of industrial and agricultural waste. However, most of these technologies are still in the experimental or demonstration stage. In South America, experts are experimenting with renewable materials such as sugar-cane straw panels and bamboo, and innovative construction-waste recycling experiences have delivered interesting results for the generation of different construction aggregates to be used in new construction processes. In Malaysia research is focused on marrying modern production methods with traditional building practices. Some examples of innovative building materials in developing countries are shown in Figure 1 (Plessis, 2002).

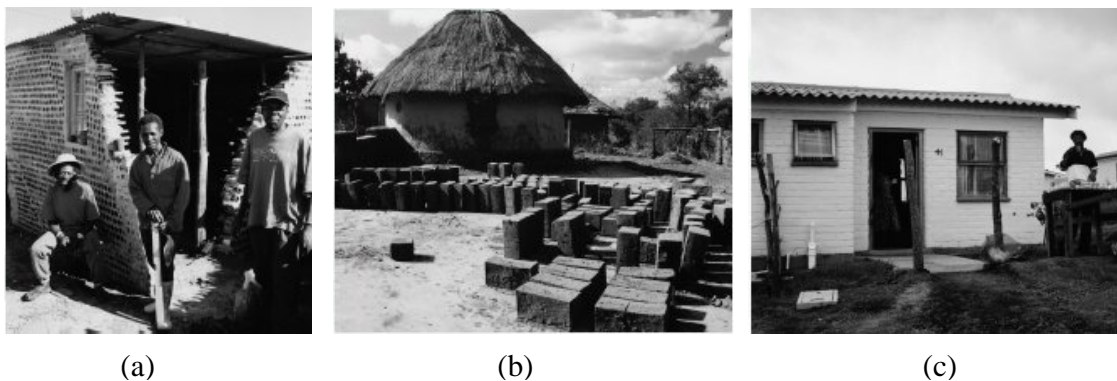


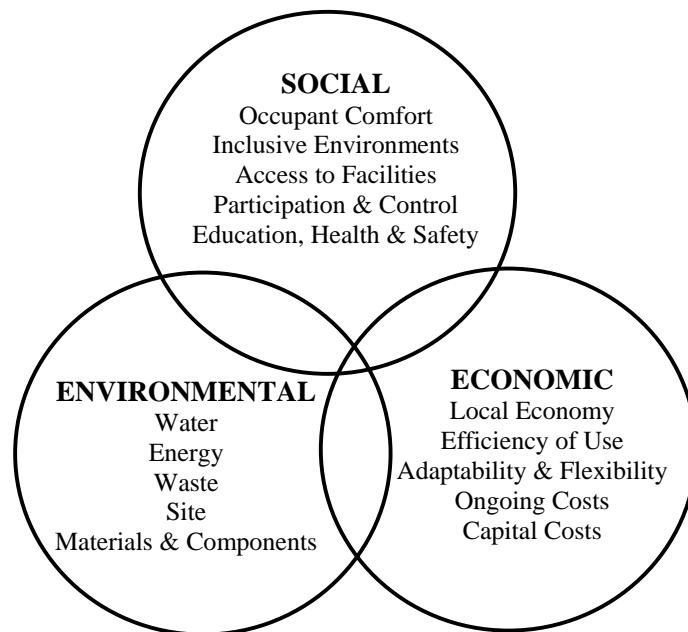
Figure 1. (a) Informal house built with old bottles, Free State, South Africa; (b) Traditional house and sun dried earth blocks, Limpopo Province, South Africa; and (c) Modern house built with compressed earth blocks, Buffalo City, South Africa.

The development of new materials and technologies needs also to take into account the fact that the majority of the population is not rich with very limited investment capacity. Furthermore, efforts must not only be concentrated on sourcing new and environmentally friendly construction materials, but attention must also be given to innovative recycling and re-use. This would require, as part of the strategy, a practice of producing buildings and materials with a longer life-span, and which are easy to recycle and can be disposed of at minimal environmental cost. Thus, the adverse impacts of construction activities and products on the physical environment would only be effectively minimized through efficient use of natural resources, especially non-renewable resources.

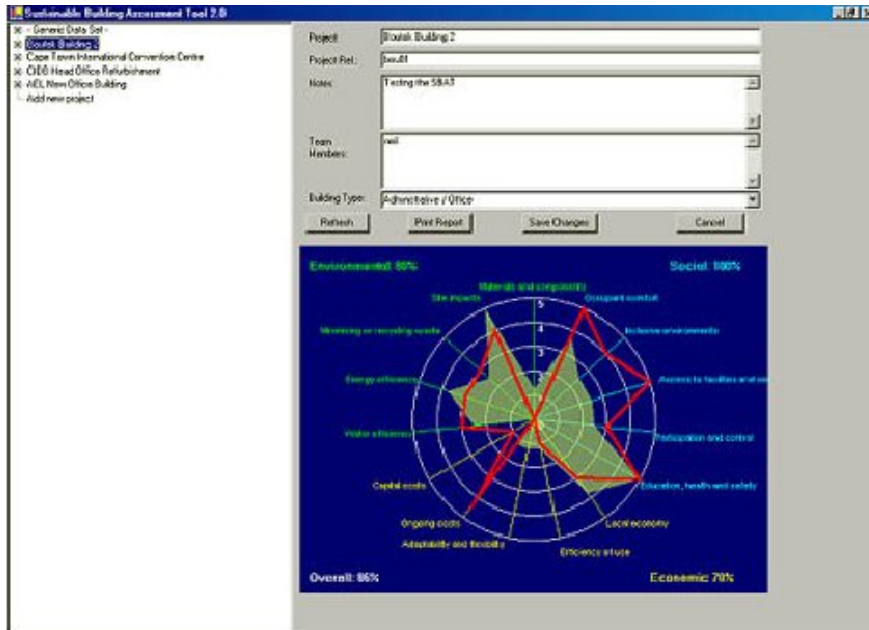
### **4. The Sustainable Building Tool (SBAT)**

It is suggested that an effective way of beginning to integrate sustainable development into buildings and construction processes is to develop an assessment framework and a structured approach. This has been reflected in the work carried out by CSIR (Gibberd, 2003). An

assessment framework, called the Sustainable Building Assessment Tool (SBAT) was developed to relate strongly to the context of a developing country and is designed to support sustainable development. The tool describes 15 sets of objectives that should be aimed for in buildings. It suggests that the extent to which these objectives are achieved in buildings provide a simple, yet reasonably effective measure of the level of support for sustainable development. Objectives are arranged under the headings of Environmental, Economic and Social as shown in Figure 2. These objectives were established through a process of describing, and understanding, buildings in terms of their relationship to social, economic and environmental systems. Different environmental and economic and social systems have different levels of sustainability and the approach used to develop the SBAT aimed to assess not only the performance of buildings in terms of support for sustainable development but also assess the extent of the building's contribution to supporting, and developing, a wider set of more sustainable systems around it. Figure 3 shows the SBAT interface. An important part of developing the SBAT was the consideration of how this could become part of, and influence, normal design, construction and building management processes.



**Figure 2.** 15 sets of objectives that should be aimed for in sustainable buildings.



**Figure 3.** The SBAT (The Sustainable Building Tool) Interface indication environmental, social, economical and the overall impact (Gibberd, 2003).

## 5. Discussion

To improve the quality of life for people in developing countries, a number of critical issues such as access to adequate housing and infrastructure, rapid urbanization, informal settlement and institutional incapacity have to be addressed. However, we should not get trapped in the enormity of the developmental challenge and end up with an unfocused wish list that lost sight of the original purpose. We should make sure that the development that is necessary and happening already will be according to sustainability principles.

Development of sustainable construction requires concerted action by all stakeholders involved in the creation of the built environment. The developing world comes from a people-centered view of development, which recognizes that ultimately it will be the behavior and choices of people that determine the success or failure of sustainable development and construction, not only the availability of sustainable technologies. While technology is important, we also need to provide an institutional environment that encourages and enables people to change their behavior, as well as giving them reasons for changing their behavior. The minimum set of essential requirements for sustainable construction in developing countries should be satisfied and potential opportunities to advance sustainable construction should be thoroughly investigated. Some of the primary concerted actions that should be implemented by the stakeholders to pave an appropriate road to sustainable construction in developing countries include:

- Create an advisory stakeholder council Government or a coalition of the relevant regulatory bodies should convene an advisory stakeholder council that can formulate guidelines for sustainable construction, liaise with other sectors and advise government regarding appropriate policy and legislation.
- Raise awareness among government officials and politicians. If politicians were to fully understand and support sustainability, they would be a very powerful force for advocacy and raising awareness amongst the public.

- Adopt a regulatory framework for sustainable construction. Government, the professional regulators and industry representatives have to formulate and adopt a regulatory framework for sustainable construction that clearly outlines the roles and responsibilities of the various role-players and the performance indicators according to which they will be measured.
- Introduce compulsory continued professional education. Developing countries cannot afford to wait for the next generation of professionals to be educated and come into power before sustainable construction is introduced into the mainstream of practice.
- Provide funding to support emerging businesses and innovative technologies. While there are many technologies being developed in developing countries to support sustainable construction, there is often no funding and other support available to help the inventors of these technologies to commercialize them and set up viable businesses.
- Provide funding for training and education. The requirements of sustainable construction will demand new skills and continuous learning.
- Lead by example. National and local governments need to lead by example, greening their own facilities and practices and following their own policies and regulations.
- Sustainable construction is leading to the development of entirely new market niches in terms of services, materials and tools. The private sector can assist with the commercialization of these new services, materials and tools, and help their originators to create viable businesses.
- To create a market for sustainable construction, clients will have to develop their understanding of what sustainability means, how it relates to their lives and businesses, how it should change their procurement briefs and policies, and the benefits of demanding more sustainable options.

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