DEVELOPING A SUSTAINABLE DEVELOPMENT APPROACH FOR BUILDINGS AND CONSTRUCTION PROCESSES

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Abstract

This paper suggests that buildings could play an important part in supporting sustainable development in developing countries. It explores the relationship between buildings and sustainable development and begins to suggest how this should influence buildings and construction processes in developing countries. The paper describes work being carried out which aims to support a sustainable development approach in building and construction processes. In particular it describes lessons learnt, and the tools and approaches developed as part of Thuba Makote, a pilot school construction project and the Sustainable Building Assessment Tool (SBAT), a project that is developing a framework that aims to integrate sustainable development considerations into the briefing and design processes of buildings.

1. INTRODUCTION

Sustainability can be described as a state in which humankind is living within the carrying capacity of the earth. This means that the earth has the capacity to accommodate the needs of existing populations in a sustainable way and is therefore also able to provide for future generations (World Commission on the Environment and Development, 1987). However, as we are currently in an unsustainable state, as a result of humankind having exceeded the carrying capacity of the earth; we must make a strong and concerted shift in direction in order to return to within the carrying capacity of the earth (Loh, 2000). This concerted, and integrated, action and change of direction can be referred to as sustainable development.

A review of literature on sustainability suggests that sustainability can be described in terms of social, economic and environmental states that are required in order for overall sustainability to be achieved (Gibberd 2003). The World Summit on Sustainable Development Plan of Implementation provides a range of sustainable development objectives that should be aimed for in order to achieve sustainability (United Nations, 2000). This plan is complex, but the key objectives relevant to buildings and construction can be extracted and summarised. These are listed below. It is therefore possible to describe sustainability in terms of states and sustainable development in terms of objectives within the environmental, economic and social arenas.

1 CSIR, Division of Building and Construction Technology
Environmental Sustainability State: Robust, vibrant, productive and diverse biophysical systems that are able to provide resources and conditions necessary for existing and future populations on an ongoing and steady basis.

Environmental Sustainable Development Objectives

- **Size, productivity and biodiversity:** Ensure that development conserves or increases the size, biodiversity and productivity of the biophysical environment.
- **Resource management:** Ensure that development supports the management of the biophysical environment.
- **Resource extraction and processing:** Ensure that development minimises the use or support of environmentally damaging resource extraction and processing practices.
- **Waste & pollution:** Ensure that development manages the production of waste to ensure that this does not cause environmental damage.
- **Water:** Ensure that development manages the extraction, consumption and disposal of water in order not to adversely affect the biophysical environment.
- **Energy:** Ensure that development manages the production and consumption of energy in order not to adversely affect the biophysical environment.
- **Resource use:** Ensure that development manages the extraction and consumption of resources in order not to adversely affect natural systems.
- **Energy:** Ensure that development manages the production and consumption of energy in order not to adversely affect natural systems.

Economic Sustainability State: Responsive structure, systems and technology, able to accommodate change and ensure that limited resources are used and maintained as efficiently and effectively as possible to provide for the needs of existing and future populations without damaging the biophysical environment.

Economic Sustainable Development Objectives

- **Employment and self-employment:** Ensure that development supports increased access to employment and supports self-employment and the development of small enterprises.
- **Efficiency and effectiveness:** Ensure that development (including technology specified) is designed and managed to be highly efficient and effective, achieving high productivity levels with few resources and limited waste and pollution.
- **Indigenous knowledge and technology:** Ensure that development takes into account and, where appropriate, draws on indigenous knowledge and technology.
- **Sustainable accounting:** Ensure that development is based on a scientific approach that takes into account, and is informed by, social, environmental and economic impacts.
• **An enabling environment**: Develop an enabling environment for sustainable development including the development of transparent, equitable and supportive policies, processes and forward planning.

• **Small-scale, local and diverse economies**: Ensure that development supports the development of small scale, local and diverse economies.

**Social Sustainability State**: Safe, happy, healthy, cohesive, fulfilled, educated societies that have organisational structures and innovative capacity that enables limited resources to be shared equitably and in ways that ensures that existing and future populations needs are met.

**Social Sustainable Development Objectives**

• **Access**: Ensure that development supports increased access to land, adequate shelter, finance, information, public services, technology and communications where this is needed.

• **Education**: Ensure that development improves levels of education and awareness, including awareness of sustainable development.

• **Inclusive**: Ensure that development processes, and benefits, are inclusive.

• **Health, Safety and Security**: Ensure that development considers human rights and supports improved health, safety and security.

• **Participation**: Ensure that development supports interaction, partnerships and involves, and is influenced by, the people that it affects.

This description provides simple definitions for sustainability and sustainable development. A useful aspect of the definition is that it provides an ultimate state that must be strived for as well as a set of actions or objectives, which if addressed and implemented, will lead towards this state. The list of sustainable development objectives can be related to buildings and building processes in order to develop an understanding of the relationships that exist. In order to do this, buildings, in a similar way, need to be broken down and described in terms of a set of key elements. For instance, buildings can be described in terms of building elements and building lifecycle stages.

**Building Elements**

• **Location**: This described the location of the building

• **Site**: This describes the site and landscaping in which the building is located

• **Size and Shape**: This describes the size and shape of the building as a whole

• **Building Envelope**: This describes the physical envelope of the building

• **Internal Space**: This describes the space enclosed by the building envelope

• **Furniture and Fittings**: This describes equipment, furniture and fittings located within the internal space

• **Services**: This describes services in the building such as water, electricity and telephone

• **Materials and Components**: This describes the materials and components used in the construction of the building
**Building Life Cycle Stages**

- **Briefing:** This stage starts with the decision to develop a building and includes initial conceptualisation of the requirements of the building.
- **Design:** This stage includes the development of the design of the building through to tender documentation.
- **Construction:** This stage refers to the construction of the building and ends at handover to an owner or users, on completion.
- **Operation:** This describes the stage where the building is in normal use and ends when a building is refurbished or demolished.
- **Refurbishment/Demolition:** This describes the stage when the building is refurbished for further use or deconstructed/demolished.

Both of these descriptions are somewhat simplistic, however they are useful in that they begin to allow the relationships between sustainable development and buildings to be plotted. For instance, this can be described in the form of a matrix.

<table>
<thead>
<tr>
<th>Briefing</th>
<th>Design</th>
<th>Design Elements</th>
<th>Construction</th>
<th>Operation</th>
<th>Demolition/Demolition</th>
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<tbody>
<tr>
<td>Location</td>
<td>Site</td>
<td>Size and Form</td>
<td>Furniture and Fixings</td>
<td>Services</td>
<td>Materials &amp; Components</td>
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<td>Internal Space</td>
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<table>
<thead>
<tr>
<th>Figure 1. Matrix for generating building and construction sustainable development objectives</th>
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<tbody>
<tr>
<td>This matrix enables a set of objectives for buildings to be generated. For instance the following building and construction sustainable development objectives can be inferred from the sustainable development objective of ‘employment’:</td>
</tr>
<tr>
<td>• Location: locate the building where employment is needed</td>
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<td>• Site: design site to support job creation and self-employment</td>
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<tr>
<td>• Size and Form: design building size and form to support job creation and self-employment</td>
</tr>
<tr>
<td>• Building Envelope: design building envelope to support job creation and self-employment</td>
</tr>
<tr>
<td>• Furniture &amp; Fittings: specify furniture and fittings that support job creation and self-employment</td>
</tr>
<tr>
<td>• Materials &amp; Components: specify materials and components that support job creation and self-employment</td>
</tr>
<tr>
<td>• Construction: use labour intensive construction processes</td>
</tr>
<tr>
<td>• Operation: use labour intensive facilities management and maintenance processes</td>
</tr>
<tr>
<td>• Refurbish / Demolish: use labour intensive construction processes</td>
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<tr>
<td>The number and complexity of objectives generated by this matrix indicates that, in order for these to be applied, it is important to have an effective assessment framework in which objectives can be described and prioritised. In addition, to evaluate progress towards the achievement of objectives, linked performance indicators are required. An effective structured approach is also required in order to ensure that objectives identified are considered and actively addressed by the appropriate parties at the appropriate stages in the building’s lifecycle.</td>
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</table>
An Assessment Framework
The assessment framework should consist of an overarching goal, objectives and indicators. The overarching goal is to ensure that buildings and construction processes support sustainable development. The objectives describe a range of actions and approaches that should be taken to support this goal. These objectives should be defined through a structured approach (described below) and refer to local sustainable development priorities and opportunities. Indicators are used to measure progress towards achieving objectives set. The assessment framework aims to ensure that the right sustainable development objectives are set in terms of the state of knowledge and technology, the context, the project, and the stakeholders. It aims to make sustainable development directly relevant to buildings and construction through breaking this down into easily implementable steps, which can be integrated into buildings and construction processes.

A Structured Approach
A structured approach should aim to make sure that the assessment framework is to maximum effect. It does this in the following ways. It ensures that the framework is based on accurate up to date and relevant information. It ensures that key project stakeholders gain some understanding of sustainable development and are able, through the assessment framework, to discuss and agree on building and construction objectives that will support sustainable development. Finally, it ensures that once an assessment framework has been populated and agreed this will be used to influence the development of buildings and construction processes.

It is suggested that an assessment framework and structure approach is an effective way of beginning to integrate sustainable development into buildings and construction processes. This has been reflected in the work carried out by CSIR. Here an assessment framework, called the Sustainable Building Assessment Tool (SBAT), and a structured approach consisting of 9 stages with associated tools, is being developed.

The Sustainable Building Tool (SBAT)
The tool was developed to relate strongly to the context of a developing country and is designed to support sustainable development. This is reflected in the assessment criteria and how the tool is to be used.

The tool describes 15 sets of objectives that should be aimed for in buildings. It suggests that the extents 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, and are as follows:

SOCIAL
- Occupant Comfort
- Inclusive Environments
- Access to Facilities
- Participation & Control
- Education, Health & Safety
ECONOMIC
- Local Economy
- Efficiency of Use
- Adaptability & Flexibility
- Ongoing Costs
- Capital Costs

ENVIRONMENTAL
- Water
- Energy
- Waste
- Site
- Materials & Components

These objectives were established through a process of describing, and understanding, buildings in terms of their relationship to social, economic and environmental systems (Gibberd 2001). 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. The figure below shows the SBAT interface.

Figure 2. The SBAT interface
An important part of developing the SBAT was consideration of how this could become part of, and influence, normal design, construction and building management processes. This led to the development of a 9-stage structured approach based on the typical life cycle of a building.

**Structured Approach**

The structured approach has been developed to ensure that an assessment framework, like the SBAT, can be used to maximum effect. It is designed to ensure that at particular stages, targets are set and agreed by key stakeholders (during the briefing, site analysis and target setting stages) and that these are then used to guide design decisions and the selection of procurement and construction options. However, in addition to the SBAT (which sets the high-level objectives or targets for the building), additional tools are required at different stages of a building’s life cycle in order to support the achievement of these objectives. This is because there are different role players and processes at the different stages. A variety of tools are being developed for each of these different stages, these are listed and described in more detail below.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Briefing</td>
<td>Briefing document</td>
</tr>
<tr>
<td>2 Site Analysis</td>
<td>Site Analysis Report</td>
</tr>
<tr>
<td>3 Target Setting</td>
<td>Target Setting Report</td>
</tr>
<tr>
<td>4 Design</td>
<td>Design Review, Design for Sustainability Methodologies</td>
</tr>
<tr>
<td>5 Design development</td>
<td>Detailed Design Review Report</td>
</tr>
<tr>
<td>6 Construction</td>
<td>Construction Monitoring Indicators and Guidelines</td>
</tr>
<tr>
<td>7 Handover</td>
<td>Building User Manual, Facilities Management Training</td>
</tr>
<tr>
<td>8 Operation</td>
<td>Facilities Management Systems, User Awareness, GBA</td>
</tr>
<tr>
<td>9 Reuse/refurbish/recycle</td>
<td>As stages 1-6</td>
</tr>
</tbody>
</table>

**Figure 3: Structured approach stages and related tools**

The first of these stages is **Briefing**. During this stage a detailed picture of the building users and building users’ organisation is developed. This includes an understanding of the work and lifestyles of building users and an understanding of the trends affecting the organisation as well possible future scenarios. It also aims to establish the level of commitment to sustainable development within the client. This can be prepared through a briefing workshop that uses the SBAT. This helps to make sustainable development an *explicit, practical issue*, allowing discussion and agreement. The target-setting component of the SBAT enables a ‘target footprint’ of ‘required performance’ to be developed for the building. This footprint can be developed and agreed by the stakeholders as part of the workshop and issued to the design team as part of the briefing documents. This is a useful reference document as it helps establish the level of commitment by the client to sustainable development at the outset of the project and enables the client and the design team to monitor design development against an explicit performance brief. This stage aims to ensure that there is a shared understanding about sustainable development and strong commitment to
addressing this amongst all stakeholders in the project. The CSIR used this process to assist with briefing for the new MTN office building in Johannesburg.

Often the development of a new building offers the opportunity to make parallel changes in the organisations, communities and people that will use the buildings and that exist around them. For instance, an organisation may want to become more efficient, or government may want to use the construction process of a public building to create employment within a community. Where this requirement or desire exists, it should be made explicit in the brief. The briefing document therefore may contain a description of both ‘hard’ outputs such as buildings as well as ‘soft’ outcomes such as increased local employment, organisational change and increased capacity. It is suggested that Briefing documents for projects that aim to support sustainable development are increasingly likely to describe sets of mutually supportive soft and hard outputs that aim ensure that limited resources are used for maximum, long term effect.

This type of briefing document was used in the Thuba Makote project where beneficial social and economic impacts such as job creation and training as well as buildings were required.

The second stage is Site Analysis. This stage investigates the site in terms of Social, Economic and Environmental aspects in order to establish the context in terms of problems to be addressed and potential resources that can be used. This approach was used by the CSIR in the Thuba Makote project to analyse school sites and assist in the development of project briefs. This aimed to ensure that, where possible, the project helped address local social, environmental and economic problems, using, local resources where available and appropriate. The output of this stage is a Site Analysis Report that is used to inform the development of the brief and the target setting document.

The third step is the Target Setting Stage. This stage is used to develop detailed sustainable development performance targets for the building. This draws on a range of information. It uses outputs from the briefing workshop to establish the level of commitment by the client to sustainable development and the capacity and understanding within this area by the design team. The site analysis is used to provide a description of the local context in terms of problems and resources. Finally benchmark performance figures for similar buildings in similar contexts are required. All of this information is then used to develop a detailed set of achievable but challenging performance targets for the building. This document provides a detailed reference document, which is used to guide many aspects of the projects such as the design, selection of procurement method, type of construction process and facilities management policies. This type of document was developed by the CSIR with Arup to support the development of a sustainable hotel by the Ritz Carlton at Spier (Perkins, Gibberd, Campbell and Oliver, 2001).

This approach requires the design to be tested against the target document during the Design Development stage. This enables the performance of different designs and strategies to be evaluated and the best options chosen. The SBAT can be used at this stage to support the rapid evaluation of different decisions as it enables the ‘performance’ of an approach to captured readily.

As currently developed, the Structured Approach does not include extensive monitoring of site and construction processes. It suggests that sustainable development issues should be addressed in tender documents and covered by the contract and a detailed briefing to the contractor. This enables the contractor to
understand the requirements of the project and provides recourse if these requirements are not met. Simple Construction Monitoring Indicators and Guidelines have been developed within this area, including tender documentation and site checklists. They also enable information on a number of indicators such as construction training, employment of disabled people and women, and labour intensity to be captured, and reported on.

During and after the design development, it is suggested that the design team prepare potential users and managers of the building for handover and occupation of the building. This preparation should occur through briefings on the buildings and its systems, the development of a building user manual, and building user induction training and material. This enables the building and its systems to be understood fully and managed effectively by its new users. The CSIR has also developed the Green Buildings for Africa programme, which is designed to improve building performance over time.

Over the life of the building it is important to ensure that performance of the building and its systems are maintained at a high level. This requires systems for logging and reporting information on a range of building performance indicators, such as water and energy consumption. It also requires an appropriate level of awareness amongst building users who are able to improve performance through their actions, for instance by switching off lights. This can be supported through readily accessible information on current and past building performance. An approach using an intranet web page to deliver this information to building users is being explored in a commercial office building.

Finally, at the end of its useful life the structured approach suggests that, where possible, the building is refurbished and reused. Where this is not possible, as much of the building as possible should be recycled or reused. Ideally, this process of deconstruction would be assisted through reference to the building user manual, which would provide the information required to enable the process to happen easily with a minimum of waste.

2. CONCLUSION

The paper suggests that integrating sustainable development into buildings and construction will require a significant change of approach. Work carried out to date suggests that an approach can be developed through the use of an assessment framework and a structured approach. The assessment framework enables people involved or affected in the development of buildings to discuss, agree sustainable development objectives and monitor progress towards their achievement on the project. The structured approach ensures that actions required at each of the building lifecycle stages to achieve sustainable development objectives are allocated to and implemented by the responsible parties.

Developing and implementing sustainable development objectives in buildings is particularly important in developing countries where there may be considerable social and economic problems such as low/poor levels of health, education and employment and limited economic resources. The approach developed, it is suggested should ensure that there is maximum beneficial social and economic impact for the investment rather than merely concentrating on the more conventional approach of minimising
environmental impact. Buildings and construction therefore cannot be seen in isolation from users and local communities and should be responsive to local needs and opportunities. They should be seen as systems that require both physical aspects (such as the buildings and site) and non-physical aspects (such as use of the building and management systems) to work together in an efficient and integrated way to achieve sustainable development objectives.

REFERENCES


