CHAPTER 3

INTRODUCTION TO SUSTAINABILITY

Carbon dioxide emission in the atmosphere remains the largest greenhouse gas contributor to the issue of global warming.(The Digest of South African Architecture 2001/2002 Volume 6:160).
The construction industry is the world's largest industrial employer with 111 million employees and approximetely 28% of all industrial employment, furthermore the built environment consumes between 40 and 50% of all energy generated in the world. (Gibberd 2003).Buildings on their own could responsible for up to 40% of global warming. (Architect and Specificator January/February 2005:35). The magnitude of construction activity is fast depleting the world of its non-renewable resources.
Considering the impact that the built environment has socially, econonmically, and environmentally, it becomes crucial that architects all over the world need to conceive design solutions that mitigate the effect of greenhouse gases, thus yielding a sustainable architecture.

WHAT IS SUSTAINABILITY?

According to the Oxford English mini-dictionary the word '*sustainability*' means: avoiding using up natural resources.

The World Commission on Environment and Development describes sustainable development as development that "meets the needs of present without compromising that ability of future generations to meet their own needs." (Yang,J; Brandon,PS; Sidwell, AC 2005:ix)

SUSTAINABILITY AND ITS RELATION TO THE PRETORIA STATION INTERCHANGE

The development of the Pretoria Station Interchange needs to be both contextually and environmentally appropriate. The combined effects of global warming and the ever looming resource depletion situation means that every new development should be carefully considered according to the principles of the 'Triple bottom line' of social, economic, and environmental aspects.

This chapter analyses sustainable developments and their impact on the planning of buildings. Commonly used international building sustainability assessment tools are briefly introduced, but emphasis is placed on the locally developed assessment tool, namely, SBAT (Sustainable Building Assessment Tool). Towards the end of the chapter, the Pretoria station interchange is analysed according to the SBAT and the results are plotted on a results chart.

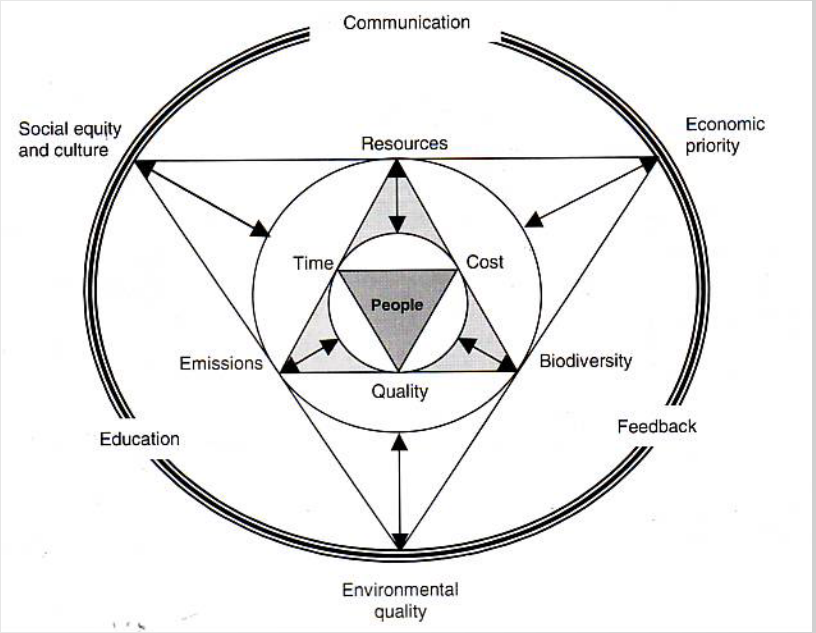


Figure 3.1.1 Intergrated approach to sustainable built environment (Yang, Brandon, and Sidwell 2005:xiii)

SUSTAINABLE ARCHITECTURE

In the context of architecture, sustainability can be broadly defined as: the conscious design of buildings in a manner that employs the most minimal disturbance to the ecological balance of a site, avoids the use non-renewable resources, contextually appropriate with regards to climate, and requires low maintenance over its lifecycle.

'The creation and responsible maintenance of a healthy built environment based on resource efficient and ecological principles.' (Yang,J; Brandon,PS; Sidwell, AC 2005:ix)

5 keys principles guide the path towards sustainable architecture, (The Digest of South African Architecture 2001/2002 Volume 6:160) namely:

Analyzing the site conditions
Energy consumption
Indoor environment components
Waste management
Reduce water consumption

ANALYZING THE SITE CONDITIONS

Climate informed orientation of the building on the site based on optimum light and ventilation exposure helps drastically reduce the building's reliance on mechanical cooling and electrical energy. A well designed building site allows natural energy sources to work for the architect. (The Digest of South African Architecture 2001/2002 Volume 6:161).

ENERGY CONSUMPTION

The amount of energy consumed by the built environment accounts for between 40 and 50% of the entire world's enegy consumption. Products such as energy-efficient flourescent bulbs have the potential to reduce the energy impact and life-cycle maintenance of a building, similarly, water-efficient products are also available, all aimed at improving the energy consuption of the building.
Substantial cost capital savings for heating, ventilation, and air-conditioning can be achieved by controlling the heat gain or loss from windows and heat produced by lights and office equipment. (The Digest of South African Architecture 2001/2002 Volume 6:161).The careful selection of materials and understanding of the energy properties thereof curbs the situation of wasteful consumption.

INDOOR ENVIRONMENT COMPONENTS

The comfort of the interior spaces in any structure is of paramount importance, an err in such regard results in sick building syndrome and indoor pollution. Needless to say, sick building syndrome and indoor pollution leads to reduced staff productivity and efficiency, and in severe cases, even litigation. The choice of materials largely regulate indoor comfort, therefore it is important that the materials do not have a negetive effect on the interior space.

WASTE MANAGEMENT

Buildings alone currently contribute about 600 million tonnes of air pollution each year. (The Digest of South African Architecture 2001/2002 Volume 6:161). The design of buildings should anticipate the possible future trends during that particulars life-cycle, in such a manner that the material should be easily recyclable and reusable. Building materials such as glass steel, and timber are examples of materials that are fully recyclable. In the event of demolition the building should leave a minimal ecological impact on the environment.

REDUCE WATER CONSUMPTION

It is advantageous to reduce water consumption within the building and on the building site. Within the building, products that are water efficient more especially for ablutions, are being developed. On the building site, it is advised to use landscaping that does not require huge amounts of water, and also to harvest rainwater to supplement irrigation systems.

SUSTAINABLE COMMUNITIES

Sustainable communities are those that balance the Earth's physical resources with the social, economic, and environmental needs of its society. (Yang,J; Brandon,PS; Sidwell, AC 2005:ix)

Agenda 21 provides the following description:

'Humanity stands at a defining moment in history. We are confronted with a perpetuation of disparities between and within nations, a worsening of poverty, hunger, ill health, and illiteracy and the continuing deterioration of the ecosystems on which we depend for our well-being.
However, intergration of environment and development concerns and greater attention to them will lead to the fullfilment of basic needs, improved living standards for all, better protected and managed ecosystems and a safer, more prosperous future. No nation can achieve this on its own, but together we can in global partnership for sustainable development.' (Steele 1997:9)

Sustainable communities are those that strive to abide by the afore-mentioned principles, that is to be resource efficient by not depleting the earth of its natural resources.
Coupled with with being environmentally friendly, sustainable communities need to be both socially and economically viable.
The community well-being largely determined by its environmental, social and economic sustainability.

SOCIAL SUSTAINABILITY

Improvement of the quality of life and human rights through the creation of a safe, healthy, and secure environment.

Improvement of the quality of life and human rights through the creation of a safe, healthy, and secure environment.

Educating the community on issues affecting sustainability.

User friendliness through easy and convenient access by foot, car or wheelchair.

Encouragement of public participation through active interaction with the affected people.

ECONOMIC SUSTAINABILITY

Creation of low skill labour intensive jobs during construction period.

Economic upliftmet through the provison for SMME, and informal trade accommodation.

Commissioning of local artist an sculptors.

Income generation through incorporation of tourist activities.

Reduced running and maintenance costs by virtue of passive design systems considerations.

Ensuring that development is based on a scientific approach which measures and monitors social, environmental and economic impacts and this is used to guide development.

ENVIRONMENTAL SUSTAINABILITY

Reduced wastage of natural resources and emmission of greenhouse gases.

Minimal interference with the existing ecosystem.

Minimal use of materials with a high embodied energy.

Efficient consumption of water, and harvestation of stormwater to supplement irrigation and other non 'health hazard' water uses.

Minimal use of non renewable resources and the reduced energy consumption through passive climate control systems.

Explore the potentials of reusing existing buildings on the brownfield site.

TABLE 1 Images of architectural sustainability

Image	*Dominant concerns*	*Dominant horizon*	*Symbolism/aesthetics*	*Approach*
Natural	Environmental place, ecosystems, health, balance	Local	'Touching the earth lightly' with forms echoing nature	Study local natural systems; emphasize sensitivity and humility in relation to nature.
Cultural	Cultural place, people, *genius loci*, difference, cultural sustainability	Local	Highly contextual with forms, materials and construction methods echoing the local vernacular	Study local culture and building; emphasize local involvement and local expertise
Technical	Technologies, global environmental impacts, cost-benefit analysis, risk management	Global	Leading edge contemporary international systems	Study science, economics and technology; emphasize transnational expertise

(Williamson, Bradford, and Bennetts 2003:25)

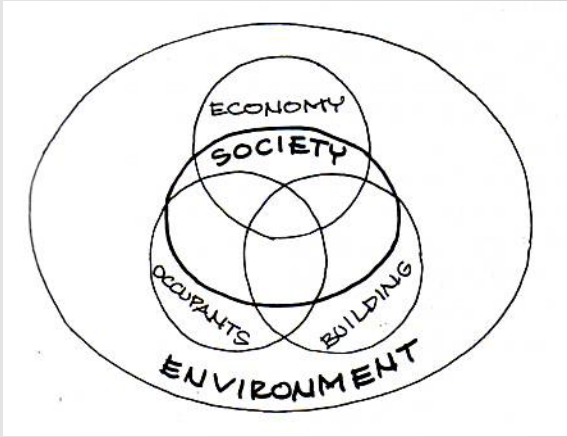


Figure 3.1.2 3 Systems diagram
(Williamson, Bradford, and Bennetts 2003:85)

INTERNATIONAL CONVENTION TO MEASURE SUSTAINABILITY

The international community's response to building energy concerns has been the development of various conventionally used tools that measure the sustainable performance of buildings. The United Kingdom, Europe, and the United States have been in the forefront in developing sustatinability tools such as the following: BREEAM, LEED, AND GBtool.

BREEAM

The Building Research Establishment Environmental rating Method (BREEAM) was developed in 1990 by the Building Research Establishment (BRE), a UK institution. Though initially developed for use on commercial buildings, it has become a benchmark for all building types to minimise any negative environmental impact. Versions of the BREEAM are currently being developed for Hong Kong and Canada.

The key aims of sustainable development described by the tool are the following:

Social progress which meets the needs of everyone.
Effective protection of the environment.
Prudent use of resources.
Maintenance of high and stable levels of growth and employment.

TOOL AIMS

BREEAM aims to provide guidance on how to minimise the negative environmental impacts of buildings while ensuring that these provide comfortable and healthy indoor environments. (Gibberd 2003:96)

To distinguish buildings of reduced environmental impact in the market place.
To encourage best environmental practice in building design, operation, management and maintenance.

To set criteria and standards going beyond those required by laws and regulations
To raise the awareness of owners, occupants, designers and operators of buildings with reduced impact on the environment.

ASSESSMENT APECTS

Management
Health & Comfort
Energy
Transport
Water
Materials
Land use
Site ecology
Pollution

LEED

The Leadership In Energy and Environmental Design (LEED), Green Building Rating System was developed by the US Green Building Council. Its mandate was to provide a standard medium that rates buildings in the United States in terms of sustainability issues.

TOOL AIMS

To provide a standard that improves the environmental and economic performance of commercial buildings using established or advanced industry principles, practices, materials and standards.

To be used by commercial building project stakeholders and project teams as a guide for green and sustainable design.

ASSESSMENT APECTS

Sustainable Sites
Water Efficiency
Energy and Atmosphere
Materials and Resources
Indoor Environmental Quality

GBtool

The GBTool has been developed to assess the environmental performance of buildings. The tool is part of the Green Buildings Challenge Assessment Framework, which is being developed by an international committee called the International Framework Committee. (Gibberd 2003:100)

The key aims of sustainable development described by the tool are the following:

To advance the state of the art in building environmental performance assessment methodologies.

To maintain a watching brief on sustainability issues to ascertain their relevance to "green" building in general, and to the content and structuring of building environmental assessment methods in particular.

Sponsor conferences that promote exchange between the building environmental research communities and building practitioners and showcase the performance assessment of environmentally progressive buildings.

To develop an internationally accepted generic framework that can be used to compare existing building environmental assessment methods and used by others to produce regionally based industry systems.

To expand the scope of the GBC Assessment Framework from green buildings to include environmental sustainability issues and to facilitate international comparisons of the environmental performance of buildings.

THE SOUTH AFRICAN CONTEXT

SBAT

The Sustainable Building Assessment Tool (SBAT) was developed in 1999 by the Council for Scientific and Industrial Research (CSIR). The CSIR is South Africa's leading research institute. (www.joburg.org.za). Initially developed as school pilot project, the tool has since evolved and been adopted to a broad range of building types such as leisure, education, residential and commercial. It is specifically aimed at implementation in developing countries.(Gibberd 2003:135)

The key uses of the SBAT are the following:

Part of a brief to the design team: by building owners and developers planning new buildings or refurbishments.

A decision support tool for: building design teams including Architects, Quantity Surveyors, Structural Engineers and Mechanical and Electrical Engineers

A way of ensuring that policies on sustainability are implemented and integrated into the construction environment: by government and other organisations. (Gibberd 2003:135)

USING THE SBAT

Briefing
Design and Outline assessment
Detailed Assessment

BRIEFIING

The tool is useful in setting the targets that become the benchmark for the sustainability levels of the design.

DESIGN AND OUTLINE ASSESSMENT

The SBAT can be used to support decision-making during the design process in the following ways. Once the criteria have been read and understood the design team can develop sketch designs and an outline material/component specification. Where there are choices in design or choices of material, the relevant criteria can be referred to in order to come to a decision. As soon as there is a full sketch design and outline material/component specification, an outline assessment can take place. (Gibberd 2003:138).

DETAILED ASSESSMENT

The detailed assessment provides a more accurate measure of the building's sustainability performance. This section models the anticipatedimpact that the building is likely to have during its life-cycle.

BUILDING LIFE-CYCLE

The life of buildings can be broken down into a number of discrete stages. These are as follows:

Briefing: This stage starts with the decision to develop a building and includes initial conceptualisation of the requirements of the building

Design: This stage include 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 owner or users on completion

Operation: This describes the stage where the building is in normal use and ends when a decision is made to refurbish or demolish the building

Refurbishment/demolition: This describes the stage when the building is deconstructed, or refurbished for further use.
(Gibberd 2003:120)

BUILDING ELEMENTS

A complete building is a composition of the following elements:

Location: This describes 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.

Building envelope: This describes the physical envelope enclosing 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 building.

TRIPLE-BOTTOM LINE CONSIDERATIONS

ENVIRONMENTAL SUSTAINABILITY

Damage to existing ecosystems must be halted and where possible, damage should be repaired and new ecosystems developed to replace the ones that have been lost. By retaining and developing productive ecosystems it may be possible, over time, to be able increase the earth's carrying capacity and thus make it easier to balance this with human activities. Bio physical environments that support sustainability will include thriving, productive, resilient and adequately sized ecosystems that are well able to provide life support functions for man.

ECONOMIC SUSTAINABILITY

Economic systems have to be developed which enable societies to live within the carrying capacity of the earth. This will mean doing more with less. Economic systems will need to be more equitable, more resource efficient and value people and the environment.

SOCIAL SUSTAINABILITY

Societies will need to be more trusting, cooperative and share more. This will avoid wasting scarce resources on crime and defence. They will also need to become increasingly innovative and resourceful – in order to be able to maximise the benefit of limited resources for as many people as possible. Society will require organisation and capacity that enables, and ensures, that it's current and future members' needs are met and are able to live fulfilling lives within the carrying capacity of the environment. (Gibberd 2003:141).

SOCIAL CONSIDERATIONS

OCCUPANT COMFORT

The quality of environments in and around buildings have been shown to have a direct impact on health, happiness and productivity of people. Healthier, happier, more effective and people contribute to sustainability by being more efficient and therefore reducing resource consumption and waste. However the quality of this environment needs to be achieved with minimal cost to the environment. (Gibberd 2003:141)

Lighting

All work and living environments are well daylit. Day lighting control and glare minimised.
No spaces require constant electrical lighting.

Ventilation

Required ventilation provided by natural means. No mechanical ventilation used in building
other than in toilets and kitchens.

Noise

Noise levels limited in work and living environments to acceptable levels.

Views

All living and work areas have access to a view out. All users located in 6m or less from a window.

Access to green outside

Access to green outside spaces

INCLUSIVE ENVIRONMENTS

Buildings can be designed to accommodate everyone, or specially designed buildings need to be provided. Ensuring that buildings are inclusive supports sustainability as replication is avoided and change of use supported. (Gibberd 2003:141)

Public Transport

Building is located 100, or less metres to disabled accessible public transport.

Routes

All routes between and within buildings of a smooth and even surface (ie easily navigable by wheelchair).

Changes in level

No changes in level between or within buildings or,
All changes in level catered for with appropriate ramps of 1:12 fall, or lifts.

Edges
All edges ie between walls and floor s and stair nosings clearly distinguished through the use of contrasting colour (For visually impaired).

Toilets
Required number of disabled toilets provided.

ACCESS TO FACILITIES

Convention living and working patterns requires regular access to a range of services. Ensuring thatthese services can be accessed easily and in environmentally friendly ways supports sustainability by increasing efficiency and reducing environmental impact. (Gibberd 2003:142).

Childcare
Childcare provided in building or close by (within 3km).

Banking
Banking services (ie ATM) provided in building or close by (within 3km).

Retail
Grocery, items required on a day to day basis available in building or close by (within 3km).

Communication
Postal, telephone or email facilities provided in the building or close by (within 3km).

Residential
Home, for occupants of the building is within 12km.

PARTICIPATION AND CONTROL

Ensuring that users participate in decisions about their environment helps ensure that they care for and manage this properly. Control over aspects of their local environment enables personal satisfaction and comfort. Both of these support sustainability by promoting proper management of buildings and increasing productivity. (Gibberd 2003: 143).

Environmental control
Users of building have reasonable control over their environmental conditions, this should include opening windows and adjustable blinds.

User adaptation
Furniture and fittings ie tables, chairs, internal partitions designed or specified allow arrangement/rearrangement by user. Provision made for personalisation of spaces if desired. This may include provision for pin boards, choice of colours, places for plants and personal storage.

Social spaces
Design for easy informal / formal social interaction. This could involved a tea room with comfortable seating. Seating provided along regularly used routes. Spaces shared between occupants/users (ie photocopying rooms etc) large enough to allow for comfortable social interaction.

Amenity
Easy access to refreshment facilities (tea point, kitchen, vending machines) and WCs for all users of the building.

Community involvement
Spaces or services shared or made available to local community. This could include access to computers, teaching learning spaces, leisure facilities, crèche.

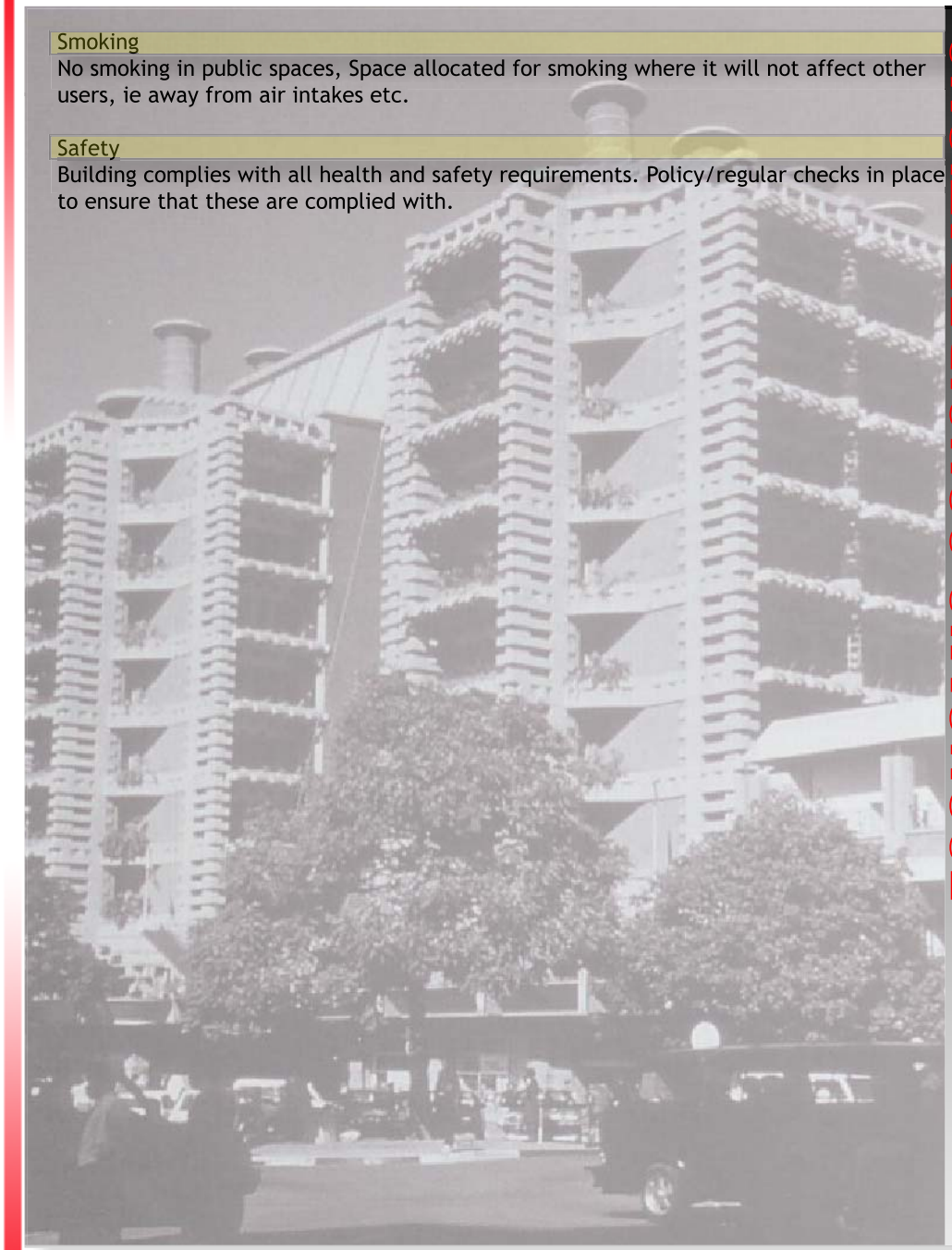
EDUCATION, HEALTH AND SAFETY

Buildings need to cater for the well being, development and safety of the people that use them. Awareness, and environments that promote health can help reduce the incidence of diseases such as AIDS. Safe environments and first aid can help limit the incidence of accidents and where these occur, reduce the effect. Learning and access to information is increasingly seen as a requirement of a competitive work force. All of these factors contribute to sustainability by helping ensure that people remain healthy and economically active, thus reducing the ‘costs’ (to society, the environment and the economy) of unemployment and ill health. (Gibberd 2003:143).

Education
Access to support for learning provided. This can be in the form of Internet access, structured courses, or the provision of learning material such as books, journals and newspapers.

Security
Measures taken to ensure that areas of the buildings and routes to and from the building are safe, and feel safe. Measures taken could include well lit routes, routes and spaces overlooked by occupied areas, clear visual links between spaces too.

Health
First aid kit provided in a central location. Policy to ensure that this can be used effectively.Information readily available on health, education, and career development issues. Thiscould be in the form of a well serviced notice boards located in a central position.



Smoking

No smoking in public spaces, Space allocated for smoking where it will not affect other users, ie away from air intakes etc.

Safety

Building complies with all health and safety requirements. Policy/regular checks in place to ensure that these are complied with.

ECONOMIC CONSIDERATIONS

LOCAL ECONOMY

The construction and management of buildings can have a major impact on the economy of an area. The economy of an area can be stimulated and sustained by buildings that make use and develop local skills and resources. (Gibberd 2003:144).

Local contractors

80% of the construction has been carried out by contractors based within 40km of the building/refurbishment.

Local building material supply

80% of construction materials: cement, sand, bricks etc produced within 200km of site'

Local component manufacturer (Furniture?)

80% of building components ie windows and doors produced locally (within 200km).

Outsource opportunities

Opportunities created and provision provided for small emerging businesses. This includes outsourcing catering, cleaning services and security as well as making space and equipment available for businesses to use for retail, education etc.

Repairs and maintenance

All repairs and maintenance required by the building (including servicing of mechanical plant) can be carried out by contractors within 200km of site.

EFFICIENCY OF USE

Buildings cost money and make use of resources whether they are used or not. Effective and efficient use of buildings supports sustainability by reducing waste and the need for additional buildings. (Gibberd 2003:144)

Useable space

Non useable space such plant, WCs and circulation does not make up more than 20% of total area.

Occupancy

Building and all working/living spaces are occupied for an average equivalent minimum of 30 hours per week.

Space use

Use of space intensified through space management approach and policy such as shared work spaces ie 'hot-desking'.

Use of technology

Communications and information technologies used to reduce space requirements ie video conference, teleworking etc.

Space management
Policy to ensure that space is well used. This may include regular audits, or space management system that charges space to cost centres.

ADAPTABILITY AND FLEXIBILTY

Most buildings can have a life-span of at least 50 years. It is likely that within this time that the use of the building will change, or that the feasibility of this will be investigated. Buildings which can accommodate change easily supports sustainability by reducing the requirement for change (energy, costs etc) and the need for new buildings. (Gibberd 2003:145).

Spaces
Spaces should be readily adapted for different uses. For instance spaces may be required for work during the day, social activities in the evening and quite study during weekends and at night.

Furniture
Internal spaces can be easily reconfigured to suite different organisation requirements / users.

Services
Services can configured to allow different internal arrangements and can be accessed easily to be extended / altered.

Structure
Structure / load bearing elements configured to enable variety of different internal arrangements.

Vertical Circulation and Service Cores
Vertical circulation and service cores configured to enable range of different spatial arrangements.

ONGOING COSTS

Maintenance
Specification and material specification for low maintenance and or low cost maintenance. All plant and fabric have a maintenance cycle of at least 2 years. Low or no maintenance components (ie windows, doors, plant, ironmongery etc) selected. Maintenance can be carried out cost effectively (ie replaceable items such as lightbulbs can be easily reached and replaced). (Gibberd 2003:145).

Cleaning
Measures taken to limit requirement for cleaning. Hard wearing solid flooring (limited or no carpeting) specified. Windows easily accessible for cleaning.

Security / care taking
Measures taken to limit the requirement and costs of security. This should include mixed use development (area is always occupied), buildings and spaces overlooked by occupied neighbouring buildings.

Insurance / water / energy / sewerage
Costs of insurance, water, energy and sewerage monitored. Consumption and costs regularly reported to management and users. Policy and management to reduce consumption (ie switching off lights on leaving building spaces) implemented.

Disruption and 'downtime'
Electrical and communication services, HVAC and plant located where they can be easily accessed with a minimum of disruption to occupants of building. This should maximising access to this from circulation areas (rather than work/living areas) and lift off panels at regular intervals to vertical and horizontal ducting.

CAPITAL COSTS

Buildings are generally one of the most valuable assets that people, and often organisations and governments own. Money spent on buildings is not available for other uses such as health and education. Often too, the high cost of buildings results in the services (ie health and education) and the accommodation (for work and living) is beyond the reach of people with the lowest incomes. Buildings that are cost effective support sustainability by helping provide access to accommodation and services for low income areas and by enabling money to be spent on other areas that support sustainability. (Gibberd 2003:146).

Consultant fees
Consultant fees not just calculated on total project cost basis. Incentives provided to consultants to reduce capital cost and ongoing costs.

Build-ability
Building designed to be easily and cheaply built. Building form simple. Replication of elements and components.

Construction
Construction approach designed to reduce initial capital cost of building. Building undertaken in a series of phases. Building built as shell first with finishes to be added later.

Shared costs
Cost of building shared with other users.

Sharing arrangements
Size and quantity of buildings reduced through arrangements to use existing spaces and buildings.