DEVELOPING A BUILDING SUSTAINABILITY ASSESSMENT MODEL FOR THE SOUTH AFRICAN BUILT ENVIRONMENT

SEARCHING FOR NEW APPROACHES TO IMPROVE THE EFFECTIVENESS OF BUILDING ASSESSMENT

Ewelina Kaatz

A Thesis Presented for the Degree of
DOCTOR OF PHILOSOPHY
in the Department of Construction Economics and Management
Faculty of Engineering and Built Environment
UNIVERSITY OF CAPE TOWN

November 2005

The copyright of this thesis vests in the author. No quotation from it or information derived from it is to be published without full acknowledgement of the source. The thesis is to be used for private study or non-commercial research purposes only.

Published by the University of Cape Town (UCT) in terms of the non-exclusive license granted to UCT by the author.

University of Cape Town

In the loving memory of Jerzy Kaatz and Marguerita Omotoso

ABSTRACT

The fundamental premise of research presented in this thesis is the search for conceptual approaches and practical measures to enhance the practice of building assessment in fostering sustainable construction. Hence, this thesis advances the theory for the practice of building assessment that incorporates the principles of sustainable development. The research findings are communicated via a functional specification for a building sustainability assessment model, suitable to the South African context.

The research focuses primarily on process-related aspects of building assessment. Important insights for the development of the model's specification are gained from the review of the practice and experience of Environmental Assessment (EA) in addressing sustainability at a project level. Lessons are also drawn from the Process Protocol (PP), which provides a means of describing the building project process in a way that is transparent and accessible to building stakeholders. The most relevant insights sourced from these two fields of expertise are grouped into three key themes. These include *integration* (i.e. integration of sustainability principles, stakeholder values and perspectives), *transparency and accessibility* (i.e. open participation and communication competence) and *collaborative learning* (i.e. active involvement and transfer of knowledge). It is proposed that these themes form key outcomes of building assessment and be viewed as crucial functionalities of the model.

The model is presented as a generic method that can be customised to suit the context of its application. The potential *use scenarios* of the model, identified in this thesis, include the formulation of a building project proposal, a building project sustainability appraisal and a building performance audit. The use of process maps produced through this research facilitates the identification of interfaces between the model and the building process in terms of decision-points and associated information needs in each use scenario. The model's *user personas* are also discussed (i.e. building stakeholders) with regard to the potential benefits and challenges of their participation in the building assessment process. The theory for building assessment advanced in this thesis was validated during a workshop with South African academics and built environment practitioners, held at the University of Cape Town.

The thesis concludes that building assessment methods can do more than assess the sustainability of a building. More importantly, they provide a means of introducing the principles of sustainable development into the processes that produce the built end-product. This suggests a need to move beyond the terminology of building assessment and instead talk of *enhancement* models that would facilitate a shift in the practice of building assessment from measuring to one of proactive improvement.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

Number *Page*

LIST OF PROCESS MAPS

DEDICATION AND ACKNOWLEDGEMENTS

This thesis is dedicated to all those who have participated in the process of its creation, and especially to those who have believed in me. Thank you.

Firstly, I should like to express sincere appreciation to Prof. Paul Bowen for creating the opportunity to conduct this research. In addition, special thanks to Dr. Richard Hill for encouragement and guidance. I would like to thank you both for providing me with valuable comments on this thesis.

I feel most indebted to Dr. David Root. I thank him for his patience, unending emotional support, stimulating discussions and faith in me. Without his assistance this thesis would not take its actual shape and be completed. May you be proud of it.

I would like to thank Dr. David Root also for coordinating the validation workshop, which was a crucial component of the research methodology. At the same I wish to kindly thank Gita Goven, Sandy Rippon, Garth Blassoples, Wayne van de Vent and Dr. Richard Hill for offering their time to attend the workshop and for their constructive comments.

I wish to express my appreciation to the University of Cape Town and the National Research Foundation (NRF) of South Africa for the financial support, which I received in the course of my PhD research.

I should also like to acknowledge the understanding and generosity of my family. I am most grateful to my mother, Danuta Kaatz, my sisters, Joanna Grzybko, Małgorzata Makuch and Anna Kaatz, and their families.

In addition, I shall always remain grateful to my beloved friends. I would like to thank especially the Pendukeni, Molepo and Omotoso families for their love and support. This thesis is also dedicated to my dear friends: Monika Pendukeni, Ngoanamathiba Molepo, Nkateko Mayevu, Priscilla Mensah and Xhanti Payi, who helped me through the most challenging moments of this research, and who made my 'South African experience' truly unforgettable.

Chapter 1

BACKGROUND TO THE RESEARCH

1.1 INTRODUCTION TO THE RESEARCH AREA

A widely quoted definition of sustainable development states that it "*meets the needs of the present without compromising the ability of future generations to meet their own needs*" (WCED, 1987:43). This developmental philosophy has been accepted as a leading premise of many socio-economic activities undertaken by the government of South Africa, and it is also reflected in regulations of the construction sector. For instance, the *Housing Act No. 107* of 1997 (RSA, 1997a) and the *National Housing Code* (RSA: Department of Housing, 2000) clearly state that the delivery of housing should implement and uphold the principles of sustainable development.

The need to promote sustainable development in construction arises from the concern about the construction sector's considerable and often detrimental impact on the natural environment, and its direct impact on the living standards of South African communities. Furthermore, the acceptance of the paradigm of *limits-to-growth* (Meadows *et al.*, 1972), where pollution, environmental degradation and depletion of natural resources are perceived as barriers to growth, provides an additional motivation to implement responsible development of the construction sector worldwide.

As construction affects all aspects of life, it is crucial that the future development of this sector aims at enhancing the biophysical, social and economic environments. Hence, it is necessary to incorporate social values and knowledge about the environmental consequences of construction activities into the strategic objectives and goals of building projects. In this way the socio-economic and biophysical factors *"do not merely set external limits to development but can inform the very character of development"* (Dower, 1998:774).

1.1.1 Defining Sustainable Construction

The Rio Declaration on Environment and Development (UN, 1992) defines sustainable development as equitably meeting developmental and environmental needs of present and future generations (Principle 3 of Rio's Declaration). According to Diesendorf (2000), the needs of the present and future generations include a sound environment, just society and healthy economy. Based on these assumptions, sustainable development in construction can only be achieved when social, economic and environmental aspects of construction are taken into consideration and effectively influence decision-making at all levels.

It has been argued that the notion of sustainable development in construction is too abstract (Graham, 1998). Graham (*ibid.*) states that sustainable construction should be defined by its goals and objectives. However, it is not enough to simply compile a set of social, economic and environmental objectives that should be achieved in the development of the construction sector. In fact, these objectives should help define sustainable construction and, at the same time, reconcile potential conflicts between social, economic and environmental goals (George, 2001). Subsequently, the objectives of sustainable construction would be translated into project values and drivers that will provide the means to deliver projects that are *sustainable.*

Sustainable construction should be based on ethical principles, have broad goals, measurable objectives or indicators and a broad strategy for implementation (Diesendorf, 2000). There is also a need for creating a supportive environment for sustainable construction practice and activities. This involves the development and promotion of a sustainable construction policy, i.e. "*a means of co-ordinating collective action for change*" (*ibid.*:33), as well as instruments necessary to implement such a policy.

Since the early 1990s building assessment methods have been perceived as useful tools for promoting environmental awareness in the built environment (Larsson and Cole, 2001). They have contributed considerably to the promotion of higher environmental expectations and, consequently, have influenced the performance of buildings (Cole, 2005). However the expectations regarding the role of building assessment methods and their operational requirements have changed with the shift in emphasis towards sustainability (*ibid.*).

1.1.2 The Role of Building Assessment Methods in Promoting Sustainable Construction

In very broad terms building assessment methods may be defined as tools for introducing biophysical, social and economic considerations into the decision-making processes during a building's life cycle. Therefore, they have the potential to integrate the premises of sustainability into the decision-making that embraces planning and design, selection of construction practice and techniques, management of the building's operation and its deconstruction or demolition. Due to their application, building assessment methods belong to a set of instruments that direct the construction activities and practices onto a sustainable path, i.e. leading to an environmentally sound, economically viable and socially justified development of that sector.

According to Devine-Wright *et al.* (2001), the implementation of sustainable development involves innovation and changes in the behaviour patterns, perceptions of stakeholders, procedures, and technologies. Building assessment methods may prove to be very important tools of integrating the premises of sustainability into construction practice, as they are capable of addressing all of the above-mentioned issues. However, this will only be possible when these methods effectively influence decision-making that occurs at every level and stage of the building process. In order to achieve this goal, it is necessary to ensure that all stakeholders are appropriately informed about the objectives of building assessment and acquainted with its methodology.

All assessment systems reflect a prevailing worldview and an associated set of values (Cole *et al.*, 2000). This means that criteria that are included in the assessment systems represent the priorities of those involved in their design and application. However, it is not only the content of an assessment framework, but also other factors, such as practicality, availability of data and dissemination of assessment results, that also influence the effectiveness of assessment methods in achieving desired end-points. It is thus critical to understand how building assessment methods may contribute to achieving sustainable construction before analysing and critically appraising the currently available methods in fulfilling this role.

1.2 RESEARCH FOCUS

The primary focus of this research is to develop an understanding of the potential of building assessment to be a vehicle for promoting the sustainability agenda in construction, with a specific emphasis on the South African context. It will be argued that the implementation of the sustainability agenda in the South African construction industry will have a significant positive impact on the country's economic development. The successful attainment of sustainability in construction will contribute considerably to the eradication of poverty, conservation and management of ecosystems and biodiversity, and the enhancement of the international competitiveness and development of the South African economy.

It is necessary to determine what factors would make the construction industry develop in a sustainable manner prior to any discussion about potential measures of implementing the sustainability agenda. One of the requirements would be to maintain the industry's output at levels equal or greater than in the past. Therefore, one needs to identify limiting factors related to the natural, human and manufactured capital that can compromise the industry's present and future productivity. Sustainable development is also about improving the quality of the industry's output by creating "*more value with less impact*" (WBCSD, 2000:4) and by implementing demand-orientated production strategies. Moreover, in order to be globally competitive with other markets, sectors of the South African economy need to keep up with international trends. Major international *foci* in the construction sector currently are clean production, minimisation of waste and pollution and an effective management of environmental impacts (Kaatz *et al.*, 2003). This validates the need for an enhanced capacity of the South African construction industry to constantly improve its services and adapt them in a changing environment.

The establishment of appropriate policies and guidelines for the implementation of sustainability in construction has become a priority. Recognising that developed and developing countries may require a different approach to this challenge, Conseil International du Bâtiment (CIB) commissioned the development of a separate research and development (R&D) agenda for achieving sustainable construction in the developing world. The "*Agenda 21 for Sustainable Construction in Developing Countries*" (du Plessis, 2002) represents an important milestone in striving for sustainability in the built environment. It sets development priorities and strategic objectives that align the development of construction industry with the philosophy of sustainable development. Having developed the agenda for sustainable construction, the next necessary task is to provide adequate support mechanisms for its implementation (Kaatz *et al.*, 2003).

Since the early 1990s, environmental building assessment methods have been used as a vehicle for promoting environmental awareness between all role players in the construction industry (Hill *et al.*, 2002). By broadening the scope of building assessment to cover also the socio-economic aspects of construction and introducing the principles of sustainability into the assessment methodology, building assessment methods may become powerful agents of translating the sustainability agenda into practice at a project level. The process of developing and applying building sustainability assessment methods in South Africa, and then sharing the experience and knowledge on a project-to-project basis, will raise awareness about the environmental crisis and the opportunities for sustainable future.

1.2.1 The Relevance of Established Building Assessment Methods to the Promotion of Sustainable Construction in South Africa

Developing nations often adopt definitions and remedies of sustainability, in the form of strategies and assessment methods, from the developed world (du Plessis, 2001). There have been attempts to follow international trends and customise universal building assessment frameworks to suit specific South African conditions. For instance, a building assessment system established within the South African *Green Buildings for Africa* programme by the Council for Scientific and Industrial Research (CSIR) is based to a large extent on the British building assessment system, namely, the Building Research Establishment Environmental Assessment Method (BREEAM) (*ibid.*).

However, it is difficult to customise a method that embodies cultural assumptions of the developed nations (Cooper, 1999). Cooper (*ibid.*) argues that sustainability cannot be measured simply in terms of energy and matter flows within the built environment without due consideration of the socio-economic, cultural and political contexts. Hence, the existing models are inherently ethnocentric in that they reflect the agenda of First World societies and are products of their social context.

Moreover, the focus of sustainability issues in the built environment of the developed and developing countries differ. In the developed countries, the focus of sustainable construction is on *green* buildings, where the biophysical dimension of sustainability is emphasised. Hence, the protection of natural resources is an underlying theme of a *green* agenda that drives sustainable construction in the developed countries.

The strictly biophysical focus of the majority of well-established international methods ignores the broader economic, social, technical and process-orientated considerations that are imperative any building sustainability assessment as indicated by Hill and Bowen (1997). du Plessis (1999) also postulates that the construction industry in a developing country needs to consider not only its environmental impacts, but also the social and economic implications of its activities. Moreover, the construction industry should be proactive in addressing the challenges of developing nations while upholding the principles of sustainable development.

Therefore, developing countries should not unthinkingly adopt theories and methods from the developed countries due to the possibility of overlooking important areas of sustainability that are relevant to local requirements. Hill *et al.* (2002) point out that this is a significant shortcoming in the South African context. Sustainable development cannot be achieved in the construction sector if it adopts a fragmented approach to development that ignores crucial dimensions of sustainability, or a *one-fits-all* approach whereby an international assessment method is applied to different buildings in different localities (*ibid.*). What is needed, instead, are context-specific practices that draw upon experience gained in other contexts, but which have been developed to reflect the multi-faceted circumstances in which they are applied. Therefore, there is a need to develop a comprehensive building assessment system for South Africa that takes into account the environmental, economic, social, technical, cultural and political implications of building developments throughout the planning, design, operation and decomissioning stages of the building process.

It is argued in this thesis that the established environmental building assessment methods, such as BREEAM (Building Research Establishment Environmental Assessment Method) (Baldwin *et al.*, 1998), LEED (Leadership in Energy and Environmental Design) (USGBC, 2002) or GBTool (Green Building Tool) (Cole and Larsson, 2002), have a limited ability to effectively contribute towards sustainable construction because they have been designed to introduce primarily the biophysical considerations into the building process. Hence, these methods have only a limited scope to accommodate sustainability in its broader sense. However, recent attempts to develop *sustainable* building assessment methods have led to the development of methods which assess environmental, social and economic dimensions of a building development, namely, the SPeAR (Sustainable Building Appraisal Routine) (Arup, 2000) and South African SBAT (Sustainable Building Assessment Tool) (CSIR, 2001). Both methods are based on pre-set targets in assessing a distance to a desired end-point for all assessment criteria. SPeAR can be considered as a self-referential building assessment method, as it does not attempt to enable comparison between buildings on the progress made in addressing building sustainability issues.

SBAT has been developed by the Sustainable Building Group of the CSIR in South Africa to address the specific requirements and context of the developing world (Gibberd, 2003). However, its development followed the conventional approach to *sustainable* assessment in that it seeks to extend the range of factors that are considered. In contrast, research reported in this thesis seeks for new ways of enhancing the sustainability assessment of buildings by incorporating ideas and practices from other disciplines (i.e. Environmental Assessment (EA) and construction management) through a fundamental re-consideration of concepts that underpin existing *sustainable* building assessment methods. It is argued that this process of developing an alternative building assessment model and the resulting different approaches to building assessment will encourage, or even provoke, a vital debate about the significance of building assessment in South Africa, and in other developing countries which face similar problems.

1.2.2 Building Sustainability Assessment Requirements

It is proposed in this thesis to change the terminology of *sustainable building assessment* into *building sustainability assessment*. The former notion may indicate that a building is already 'sustainable'. The latter notion helps to emphasise that building assessment methods should be concerned with fostering the sustainability of building developments (projects) – encompassing the considerations of products and processes. Where the term *sustainable building assessment* is used in the thesis, it refers to existing methods and practice.

It is by defining the use and application of a building assessment method that one determines the most appropriate structure of the method and assessment methodology. Building sustainability assessment should help incorporate all dimensions of sustainability into decision-making regarding construction practices and individual projects. It therefore has to act as a *decision-making support system* that highlights priority issues and suggests possible trade-offs between considered options. In order to fulfil this role effectively, sustainability assessment needs to increase the awareness of all stakeholders about the environmental implications of every building development and potential opportunities for attaining desired socio-economic goals. In this respect, it functions as both a cognitive and normative framework; cognitive in that it provides a world-view which embodies the values and ethics of sustainability, and normative in that it provides a control mechanism for ensuring that those values and ethics are expressed through the building process and embodied in its product. This is achieved by providing a meaningful *design guideline system* that improves resource-efficiency and user satisfaction from optimal building performance, and an *assessment system* for comprehensive examination of building impacts.

In addition, in order to become accepted by all stakeholders, building sustainability assessment needs to be responsive to their needs and provide a means for demonstrating stakeholders' efforts towards sustainability. Hence, any building sustainability assessment system can act as a *marketing tool* to present stakeholder efforts in fostering sustainability of a building development as well as to label building performance.

Furthermore, this research raises significant questions about the mechanisms used to incorporate sustainability principles in building assessment. According to Lindstad *et al.* (2002), designing in a sustainable manner implies implementing a holistic approach. This is an important characteristic of any building sustainability assessment method, which should be capable of addressing all dimensions of sustainability. Hill and Bowen (1997), in providing a framework for sustainable construction, identify five dimensions of sustainability in the construction context: i.e. biophysical, social, economic, technical and process-orientated dimensions.

According to Hill and Bowen (1997), social sustainability principles focus on the quality of life of humans; economic considerations focus on affordability and employment creation; and biophysical aspects underline the importance of protecting the natural environment. Technical principles of sustainability include building durable structures and humanising buildings. The process-orientated principles provide a set of over-arching principles to be applied throughout any construction process and include promoting interdisciplinary collaboration, involving people affected by the proposed activities in decision-making and utilising a systems approach (*ibid.*).

In addition to introducing sustainability principles into the assessment framework, it is necessary to implement the objectives of sustainable development throughout the assessment process. The Brundtland Report (WCED, 1987) has identified two broad objectives of sustainable development (Eigenraam *et al.*, 2000). The first objective is to strive towards equity between generations and within generations (Dresner, 2002), while the second requires preserving the carrying capacity of the natural environment.

Intergenerational equity is achieved by maintaining similar consumption prospects for future generations. It requires passing on an adequate quality and quantity of capital (i.e. natural, manufactured and human) to secure further developmental opportunities in the future. Intragenerational equity emanates from a moral obligation to ensure that the benefits of development are more equally enjoyed within the present generations, and to ascertain that developmental undertakings are consistent with present needs (Dresner, 2002). According to George (1999), public participation in decision-making is an effective means of promoting inter- and intragenerational equity, as most people have a high degree of concern for future generations and should be given an opportunity to decide about the quality of life issues for themselves.

The parallel objective of sustainable development is to conserve the natural capital, which encompasses all environmental assets and services (e.g. natural resources, energy and genetic information as well biogeochemical cycles and life-supporting systems) (Meadows, 1998). One approach to achieving this objective is simply to insist that stocks of natural capital, including fuel, minerals, soils, flora and fauna, are not depreciated over time (Eigenraam *et al.*, 2000). This approach is referred to as *strong sustainability* and stems out of concerns that there is an apparent lack of technological substitutes for some environmental amenities. In addition, strong sustainability imposes precautions regarding possible irreversible consequences for some types of environmental damage and uncertainty about the fragility of various environmental assets (*ibid.*).

However, it is often argued that natural capital may be converted into other forms, for instance into manufactured or human capital. It would therefore be possible to maintain the living standards of future generations by ensuring that the total value of capital passed on to future generations does not decrease (George, 1999). This approach is called *weak sustainability* and allows for the stock of natural, human and manufactured capital to change over time, provided that the total ability to consume is maintained (Eigenraam *et al.*, 2000).

It becomes apparent that any further discussion about introducing sustainability into building assessment entails opting for one of these two approaches (i.e. strong or weak sustainability).

The acceptance of either a strong sustainability or weak sustainability paradigm has a direct influence on the assessment emphasis. Whichever paradigm is accepted, there are certain essential considerations that have to be addressed. These include taking a long-term perspective during the decision-making process and the consideration of the sensitivity of the natural environment in which the human intervention takes place.

Another crucial challenge in any sustainability assessment is the operationalisation of the principles of sustainable development. This means that these principles should not only be reflected in the content of building sustainability assessment, but also in the assessment activities themselves.

1.2.3 Sourcing New Approaches for Building Assessment

The infusion of sustainability in the field of building assessment brings about a paradigm shift, which leads to an increasing demand for new approaches in the design of relevant methods.

This research explores the opportunities for adopting certain concepts and procedures used in Environmental Assessment (EA) (Ortolano and Shepherd, 1995) and the adoption of the Process Protocol (PP) (Kagioglou *et al.*, 1998) as a description of the construction project process for building assessment purposes. This thesis argues that these interventions can significantly enhance the ability of building assessment to facilitate decision-making orientated towards the objectives of sustainable construction. Both EA and PP can provide useful insights into the problem of addressing sustainability considerations in building projects.

1.2.3.1 Concepts and Theories from Environmental Assessment (EA)

According to George (2001), Environmental Assessment has been fairly effective as a test for sustainable development. The aim of EA is to introduce an effective and systematic consideration of biophysical, social and economic issues into all important decision-making stages (Bisset, 1996). The emergence of Integrated Impact Assessment, which is based on the use of a number of sustainable development principles and offers the same level of consideration to economic, social and environmental impacts (George, 2000), reinforces the commitment to infuse the premises of sustainability in the field of environmental assessment.

Building assessment methods need to play the same role in sustainable construction. Their major function is to facilitate the integration of sustainability premises into the decision-making process during project planning, design, construction, operation, and decomissioning. Therefore, an examination of EA methodology and experience as a means of addressing sustainability at a project level can, as this thesis will demonstrate, inform the development of new building assessment theory and practice.

One of the most difficult tasks of any building assessment system is to make provisions for a broad review of building developments or projects in terms of their environmental and socio-economic impacts while maintaining the required simplicity and practicality of the assessment process. A scoping procedure used in EA can be adopted in building assessment to narrow the scope of the assessment process to the most significant issues pertaining to an individual building context. Scoping will be shown to play a crucial role in attaining a desired flexibility and adaptability of building assessment, thus allowing for a multi-depth assessment.

EA is also perceived as a powerful tool for collective learning through stakeholder participation in the assessment process. In the early years of implementing environmental assessments, the role of public participation was to obtain information about public concerns and educate the public about a proposed project (Saarikoski, 2000). Presently, EA is regarded as a system for producing knowledge, as it offers a forum for different stakeholders to deliberate and exchange their views of the goals and their knowledge on the impacts of a proposed development (*ibid.*). As the values and perspectives that people hold are shaped during a discourse in which they engage, EA fosters greater personal and social responsibility and has the capacity to increase the importance of long-term environmental considerations in decision-making (Wilkins, 2003). This is also a desirable role for building sustainability assessment. Therefore all opportunities for meaningful stakeholder participation in building assessment need to be explored.

1.2.3.2 Alignment with the Process Protocol (PP)

In the context of this research the main purpose of building assessment is to facilitate the integration of sustainability premises into decision-making during the building process, which comprises project delivery, facility management and decomissioning. Hence, there is need to establish an effective way of introducing a comprehensive and systematic consideration of biophysical, social and economic issues into all decision-making stages.

However, the articulation of the building process had traditionally been hindered by a lack of the common set of understandings of what activities make up that process and, consequently, where the decision-making stages lie within the process. According to Turin (2003), building processes differ with regard to the changing nature of relationships between the participants and resulting patterns of information flows throughout the process. The Process Protocol provides a common set of understandings and identifies the generic activities performed in the building process without reflecting the interests of particular industry groups (Cooper *et al.*, 1998). The Process Protocol helps to avoid a situation when a particular stakeholder group (e.g. architects or contractors) dominates a given stage of the building process. It also aims to eliminate potential barriers for broader stakeholder participation in project activities. Furthermore, the Process Protocol offers useful insights into the requirements of a building assessment method to correspond to different patterns of the building process, where procurement paths may vary, and where the roles and responsibilities of particular stakeholders may differ. These include the coordination of activities and tasks, allocation of responsibilities and definition of the formats of input and output information packages.

Adoption of the Process Protocol as the model of a building project allows incorporating a process view in building assessment. This has implications for the participation of stakeholders in building assessment. Hence, mechanisms to facilitate stakeholder participation and learning in building assessment should also be explored.

Moreover, alignment with the Process Protocol makes the information received from building assessment more relevant and suited to all decision-makers in the building process. It also helps ensure that the assessment methodology is presented in a language which is understandable to the construction sector. Providing an adequate quality of information in a timely manner would significantly improve the decision-making process (i.e. allow for incorporation of sustainability considerations), driving the development of construction sector onto a sustainable path. Moreover, providing a common set of definitions and procedures for building assessment can help achieve a higher degree of consistency between assessments (Cooper *et al.*, 1998).

1.3 PROBLEM STATEMENT

There is an established need to introduce sustainable development into construction by integrating socio-economic and environmental objectives into building project values and processes. Most existing building assessment methods emphasise and promote green issues, which are the primary concern of the developed world from where these methods originated. Therefore, they are not as effective at communicating the values and practices of sustainable construction as they should. Because socio-economic development is of a higher priority in developing countries like South Africa, these countries have a clear need for building assessment systems that explicitly focus on attaining sustainability.

Consequently, there is demand for building assessment that would support a systematic incorporation of sustainability considerations in the building process and involve all stakeholders in the building process to ensure that their values are recognised and acted upon.

Any building assessment method needs to be sensitive to the context in which it is applied both at a wider societal level as well as to the specific circumstances of individual building projects.

Therefore, the research problem identified in this thesis states that:

While it is acknowledged that building assessment methods can foster sustainable development in construction, the established methods do not effectively incorporate the principles and objectives of sustainable development in their frameworks and methodologies. Hence, there is a need to re-examine the premises of building sustainability assessment in order to explore its desired qualities, and to clarify the potential roles that a building assessment method can play in this endeavour. Moreover, the existing methods have a limited ability to respond to the context of their application. Yet the recognition of specific needs and challenges faced by the construction sector in the developing countries, such as South Africa, in addressing the issues of sustainability is essential.

1.4 RESEARCH QUESTIONS

This research addresses the following questions:

- What are the main roles of building assessment methods in promoting sustainable construction?
- In what way can building assessment methods be better designed to educate the construction industry about sustainability and communicate principles and objectives of sustainable development?
- What attributes would make building assessment methods relevant to the South African context?
- How can building assessment methods provide a platform for involving building stakeholders in the assessment process?
- How can the communication of assessment goals be enhanced in a way that is relevant to stakeholders?
- Are there lessons to be learnt from Environmental Assessment and the Process Protocol that will assist in making building sustainability assessment relevant to all stakeholders?
- Is it possible to enhance the quality of the building process through building assessment?

1.5 RESEARCH PROPOSITIONS

The research propositions investigated in this research are listed below:

- The ability of building assessment methods to promote sustainable development in the construction sector can be enhanced through better integration of sustainability principles and objectives in their methodologies.
- Environmental Assessment and the Process Protocol can provide valid methodologies to engage building stakeholders in the assessment process more effectively.
- The effectiveness and relevance of the building assessment process can be improved by its integration with the actual building process or a building project's activities.

1.6 RESEARCH AIM AND OBJECTIVES

The aim of this research is to propose a specification for a building sustainability assessment model suitable for the South African built environment. An emphasis is placed on the functional aspects of building assessment rather than any technical and implementation-related considerations.

The proposed model for building sustainability assessment can be distinguished from existing methods in the following ways:

- Sustainability principles and objectives are infused in the assessment framework as well as the assessment process. The model promotes equity and the preservation of the carrying capacity of the natural environment.
- Collective learning and capacity building is achieved through stakeholder participation.
- Assessment methodology enables the model to be goal-orientated and context-specific. Although all participants define the assessment context, guidance is provided to give due consideration to relevant regional and global issues. Through the establishment of project values, the model should reinforce local priorities without losing focus on the long-term developmental goals of the construction industry.
- The scoping procedure focuses assessment efforts on the most significant issues identified by stakeholders. The comprehensiveness of building assessment is determined by the specific requirements of each assessment situation.
- Transparency of the assessment is enhanced through the use of process mapping. The assessment process is synchronised with building project activities to increase its effectiveness.

- Presentation and communication of project goals and assessment results help to showcase the efforts of a developer and project team towards sustainable construction practice and building. New categorisation of assessment areas should draw attention to the issues of greatest concern for project stakeholders.

The model for building sustainability assessment is capable of embracing the socio-cultural, economic, biophysical, technical and process-orientated dimensions of a building development. Its scope should encompass all stages of the building process, namely, the planning and design, procurement and construction, operation, refurbishment and decomissioning. At the same time, it is robust enough to effectively assess new and existing building developments of different types (e.g. residential, educational or commercial) in terms of their sustainability.

The main assumption underlying any sustainability assessment method is the ability to focus on the most significant issues in a particular assessment context, without compromising on the comprehensiveness of the method. The model allows for a thorough consideration of the biophysical, social, cultural, economic, political, social and process-orientated factors relevant to any building project being assessed while contributing to sustainability in the built environment. The use of a scoping procedure to narrow the scope of building assessment to the most significant issues helps to highlight and effectively address problems that are relevant in the context of the developing world.

Further, it is crucial that the model is proactive and goal-orientated. This means that the model needs to identify the opportunities for improvement and optimisation of a building product and process while avoiding and minimising adverse impacts. As scoping is a participatory and consensus-based exercise involving all major stakeholders, such as clients, designers, architects, engineers, contractors, subcontractors, end-users, and any other interested and affected parties, it provides a forum for establishing a clear vision and goals for each assessment situation. Establishing project values and vision that represent interests and values shared by all involved stakeholders and support the principles of sustainable development is a key function of the assessment process. This ensures stakeholder commitment and support during the entire building assessment process, which in turn determines its effectiveness. Most importantly, by implementing a participatory approach, the model promotes knowledge exchange and capacity building among all stakeholders through their participation in the process.

Furthermore, the model is mapped against the Process Protocol to facilitate the presentation of the assessment methodology and the interfaces between the methodology and the building process. This assists stakeholders in understanding where they fit into the process and what is required of them, and improves the communication process.

The end point sought through this research is a building sustainability assessment model that not only contributes towards infusing the sustainability agenda in the South African construction sector, but also enhances the demand for sustainable building.

Hence, the main objectives for this research can be stated as below:

- Identify the role of building assessment methods in addressing and promoting sustainability in construction;
- Explore useful lessons from Environmental Assessment and the Process Protocol that can enhance building sustainability assessment;
- Develop the functional specification for a context-specific and goal-orientated building sustainability assessment model that contributes to sustainable construction in South Africa; and
- Advance the effectiveness and relevance of building assessment by aligning its methodology with a building project cycle.

1.7 RESEARCH METHODOLOGY

This research seeks to investigate building assessment methods paying particular attention to the context in which they are applied. In this respect the research treats building assessment as an unfolding social process rather than a scientific or technical exercise. This perspective is reflected in methodology adopted in this research, which entails the following:

- Conducting a critical analysis of the literature surrounding sustainable development, sustainable construction and building assessment methods;
- Examining methodological approaches used in Environmental Assessment that could be transferred to building assessment methodology;
- Aligning building assessment with the building process and project cycle with the help of the Process Protocol;
- Convening a workshop with built environment practitioners to validate the logic of reasoning applied in the development of the functional specification for the building sustainability assessment model against different application scenarios.

The research methodology is discussed in more detail in Chapter 3.

1.8 THE SCOPE OF INVESTIGATION

The research problem is addressed by proposing the functional specification for the building sustainability assessment model for South Africa. The research presented in this thesis focuses on possible ways of improving the practice of building assessment. From this, it derives a functional analysis of a building assessment model that would be characterised by an enhanced capacity to address sustainability in construction. An assessment method based on such a model would not only have a more direct influence on the physical attributes of buildings delivered in South Africa, but would also contribute to a change of construction practices in support of sustainability.

The review of literature on sustainable development and exploration of existing practice in addressing sustainability forms the basis for identifying potential roles and services that building assessment may play for sustainable construction. Most of research on building assessment methods that are to foster sustainability in construction is concerned with technical aspects, such as the content and structure of an assessment framework. Yet this research seeks to ask and answer more fundamental questions regarding the adequacy, applicability and capacity of a building assessment system to address sustainability of building developments. The originality of research presented in this thesis lies in addressing the functional and process-related issues of building assessment.

This thesis does not present an operationalised building assessment method. Instead, by developing the functional specification for the proposed model for building sustainability assessment, it provides theoretical foundations for the design of such a method. Although the development of this specification is driven by theoretical enquiry, it was validated by external commentary during the validation workshop practitioners from the South African building industry.

1.9 THESIS STRUCTURE

The thesis has been structured in the following way:

Chapter 1 introduces the topic of research, which refers to the use of building assessment methods to foster sustainable development in the construction sector. The research problem is stated with supporting research questions. Subsequently, research propositions are formulated with the aims and objectives of the study. In addition, a brief description of the research methodology is provided. The chapter ends with the delineation of the research scope and main assumptions.

Chapter 2 discusses a theoretical conceptualisation of sustainable development and sustainability. Sustainability is discussed in terms of different types of capital (e.g., natural capital, built capital or human capital). The Daly Triangle is used to distinguish between *means* and *ends* of development while depicting the interactions and dependencies between various forms of capital. This is followed by the introduction of the concepts of *weak* and *strong* sustainability, which provide alternative approaches towards sustainable development. Subsequently, different priorities of sustainable development agenda in the developed and developing countries are discussed. This confirms the requirement for context-sensitive measures to address sustainability in different regions of the world. Chapter 2 advocates the need to pursue sustainability in the built environment, which steadily becomes a leading driver of change in the construction sector. Established methods, such as BREEAM, LEED, GBTool, SPeAR and SBAT, are presented with regard to their strengths and weaknesses in promoting sustainability and their practical limitations in contributing to sustainable construction. Distinction is made between *green* and *sustainable* building assessments, which differ in terms of the assessment scope and methodological approaches. In addition, South African building assessment systems are critically reviewed, which leads to the conclusion that current building assessment practice should be enhanced to induce a required change in the performance of the construction sector. The chapter concludes with an argument to search for new approaches and methodologies that can enrich the practice of building assessment and make it more effective in addressing sustainability.

Chapter 3 outlines the methodology applied in this study to address the research aim and objectives. The research inquiry presented in this thesis seeks to add to the *theory of practice* (i.e. praxiology) in the field of building assessment. A conceptual model for building assessment, which is delineated in this thesis based on theoretical research, informs the development of the functional specification for the building sustainability assessment model. This is achieved primarily by synthesising relevant lessons from the theory and practice of Environmental Assessment and construction management – to previous practice in *sustainable* building assessment. The logic of reasoning applied in the development of the model's functional specification is subsequently validated during the workshop with South African built environment practitioners.

Chapter 4 explores Environmental Assessment (EA) in terms of how the practice of EA has responded to the philosophy of sustainable development. It begins by making a distinction between Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA). Subsequently, main components and factors which influence the effectiveness of EA are discussed. Further sections of this chapter contemplate the adoption of sustainability agenda in EA. This includes attempts to address sustainable development at a project level and practical ways of dealing with sustainability issues in impact assessment. The main theme that surfaces is the integration of sustainability principles and criteria as well as different scales of assessment. Two models of integrated impact assessment are presented, namely, an *EIA-driven* model and an *objective-driven* model. Moreover, the discussion of key areas of relevance to building assessment forms a significant component of this chapter. The emphasis is placed on the potential value of a scoping procedure for building assessment. Scoping focuses on problem-definition, prioritisation of significant assessment issues and on the design of assessment methodology. Decision-scoping is another useful procedure that can be sourced from EA. It provides a framework for incorporating environmental constraints and opportunities directly into the planning and design of projects. Furthermore, the issues of mutual adjustment, collaborative learning and communication competence are discussed with regard to stakeholder participation in the assessment process. This chapter concludes by pointing lessons for building sustainability assessment.

Chapter 5 examines the field of construction management to gain an understanding of how building assessment may play a more effective role in fostering sustainability of building developments. Key challenges in introducing sustainable development in the construction sector are identified. As a result, a need to apply a process view and to focus on social processes in construction projects is indicated. Subsequently, the chapter presents the Generic Design and Construction Process Protocol (Process Protocol), which provides a framework to help improve and optimise the design and construction processes. Main principles and features of the Process Protocol are discussed. These include the organisation of the building process that comprises 10 distinct phases with *soft* and *hard* gates. Another innovative feature of the Process Protocol is the use of *Activity Zones*. Activity Zones organise stakeholder participation in the building process aiming to enhance co-operation. The membership of each Zone is determined by specific project tasks rather than professions. In addition, the Process Protocol uses process mapping to represent the building project in terms of a sequence of individual process activities or gates and stakeholder primary responsibilities. The chapter also presents attempts made to introduce sustainability considerations into the Process Protocol. This is followed by the discussion of insights gained from the review of the Process Protocol that can enhance the practice of building assessment. Consequently, an emphasis is to be placed on stakeholder involvement, knowledge transfer and the use of process maps.

Chapter 6 presents the functional specification for the building sustainability assessment model, which is the focal point of this thesis. The findings of Chapters 2, 4 and 5 are grouped into three main themes, such as *integration, accessibility and transparency*, and *collaborative* *learning*. It is proposed that these themes form key functionalities of the model – apart from its main function of a building's performance assessment. In addition, three use scenarios for the model's application are proposed. These include the formulation of a building project proposal, a building project sustainability appraisal and a building performance audit. Each of these scenarios is discussed and presented using process mapping. Subsequently, the chapter discusses various users of the model. Benefits and challenges for each user group as well as those shared by all stakeholders are indicated. The chapter ends by outlining findings and comments obtained from the validation workshop with the South African built environment practitioners.

Chapter 7 contains a synopsis of main conclusions that refer back to the aim, objectives and assumptions of this study. The conclusions endorse the research propositions stated in the beginning of this thesis. Relevant recommendations are also made and areas of further work indicated. The chapter concludes with a brief discussion of the research findings in the context of the research aim and objectives stated at the outset of the research.

Chapter 2

LITERATURE REVIEW

2.1 CONCEPTUALISING SUSTAINABILITY AND SUSTAINABLE DEVELOPMENT

The complexities of current environmental problems, effects of interactions between human and natural systems and the causes of environmental degradation have only begun to be understood, and progressively identified (WCED, 1987). Consequently, questions have emerged surrounding the effects of development and present patterns of economic growth on the environment. It is commonly acknowledged that the environment may soon become a limiting factor for future human development, and that continuous environmental degradation will probably detract from potential economic growth (Pearce *et al.*, 1989; WCED, 1987).

The emergence of the concept of *sustainable development* marked a fundamental paradigm shift from seeing environment and development as separate challenges to one where they are seen as inexorably linked (WCED, 1987). Development cannot be sustained by a deteriorating environmental base, and the environment cannot be protected when economic growth ignores the costs of environmental degradation (*ibid.*).

Defining sustainable development has proved to be problematic. Dresner (2002) argues that the term has been used differently by different people and in different contexts. In some cases it is used to emphasise development through economic growth, and in others to emphasise sustainability through environmental protection. Yet it is apparent that the underlying difficulty lies more in defining the meaning of *development* (Dresner, 2002; du Plessis, 1999). It is questioned whether development should be about economic growth demonstrated by increased material consumption, or rather about non-material improvement in life experienced by a growing number of individuals and expressed as wellbeing, happiness or self-realisation (du Plessis, 1999; Meadows, 1998).

More often development is perceived and defined as an integral, value-based cultural process that encompasses the natural environment, social relations, education, production, consumption and wellbeing (Duncan, 1994). Pearce *et al.* (1989:29) argue that development "*implies change or transformation leading to improvement or progress*". Development, as opposed to growth, is need-orientated and therefore articulates a direction of human endeavour based on social visions and values (Dag Hammarskjöld Foundation, 2003).

Understanding sustainable development and all its components (or dimensions) is more important than trying to define it in an unambiguous manner (Dresner, 2002). Perhaps the concept of sustainable development should remain elusive in order to be accepted and debated by conservatives and liberals, if it is to drive the necessary political changes (O'Riordan and Voisey, 1997). Richardson (1997:43) argues that sustainable development is a *political fudge* and its vagueness allows conflicting parties, fractions and interests to "*adhere to it without losing credibility*". It is more important to agree on the meaning of sustainable development and the underlying values of the concept rather than on its precise definition (Dresner, 2002).

A definition first emerged in the "*World Conservation Strategy*" of 1980, published by the International Union for Conservation of Nature and Natural Resources (IUCN). Sustainable development was defined there as "*the integration of conservation and development to ensure that modifications to the planet do indeed secure the survival and well-being of all people*" (IUCN, 1980: Section 1.2). Development was defined as "*the modification of the biosphere and the application of human, financial, living and non-living resources to satisfy human needs and improve the quality of human life*" (IUCN, 1980: Section 1.3).

The World Conservation Strategy postulated combining development with conservation. Conservation was understood as "*the management of human use of the biosphere so that it may yield the greatest sustainable benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations*" (IUCN, 1980: Section 1.4). Therefore, development was perceived as threatening unless accompanied by an effective conservation of resources and protection of habitats. The three major objectives of the World Conservation Strategy aimed at the sustainable use of species and ecosystems, maintaining essential ecological processes and life-support systems, and preserving genetic diversity (IUCN, 1980).

Generally, economists agree that protecting nature and improving environmental quality can contribute to human development and economic growth (Pearce *et al.*, 1989). However, the cost of caring for and improving the environment may compromise potential economic growth, which is still seen as a key to solving existing socio-political problems.

The IUCN identified poverty, population pressure, social inequity and the terms of trade as the main agents of habitat destruction (IUCN, 1980). It was emphasised that a new development strategy should redress inequities, achieve a more dynamic and stable economic growth, and counter the impacts of poverty (SDCN, 1999). The World Conservation Strategy has been refined since 1980. The IUCN continues to emphasise the crucial link between conservation and development, but also calls for the commitment to a new ethic for sustainable living (IUCN, 1991). A current challenge lies in translating principles into practice.

However, it was the report published by the World Commission on Environment and Development (WCED), entitled "*Our Common Future*" (also known as the *Brundtland Report*), which popularised the concept of sustainable development and, in doing so, provided the following often quoted definition (WCED, 1987:43):

"*Sustainable Development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*"

It may be argued again that the vagueness and simplicity of this most commonly cited definition is both its strength and its weakness (Dresner, 2002; Carter, 2001). This definition indicates that sustainable development is a process of change, in which the use of resources, direction of investment and the institutional changes are consistent with the present and future needs (Dresner, 2002).

The definition of sustainable development contains two main concepts, i.e. the concept of basic needs and the idea of limits of the natural environment's capacity to meet present and future needs (WCED, 1987). The main emphasis is placed on the issue of equity between generations and equity within generations.

2.1.1 Intergenerational Equity

Intergenerational equity calls for securing developmental opportunities to future generations in current decision-making. It is based on strong ethical and moral obligations towards future generations to enable our descendents to enjoy at least the same quality of life. It is essential that each generation preserves the benefits of the culture and civilisation it inherited and passes on increasing amounts of accumulated capital (Dresner, 2002). The question is whether one should be concerned about the different kinds of capital (e.g. natural resources and environmental services, indigenous knowledge, technological advance, infrastructure or financial capital) that is passed on to the following generation or merely focus on its totality and refer to it as *wealth.*

One point of view is to consider the environment in terms of the natural resources or natural capital that is available for wealth creation, and to compensate future generation for any loss of environmental amenity by providing them with alternative sources of wealth creation (Beder, 2000) – when and if they are developed. The extreme approach to defining intergenerational equity according to this line of thinking is termed *the opulence model* (Brown Weiss, 1992). It allows the present generation to consume natural resources without limits in order to generate a maximum amount of wealth. There is no certainty about future generations and whether wealth accumulated today will indisputably benefit future generations as well (*ibid.*). This model ignores the possible consequences of irreversible changes to global climate and the functioning of life-support systems caused by unlimited economic growth.

Another point of view is to recognise other roles of the environment than merely its economic potential, which cannot be substituted with man-made wealth (Beder, 2000). This perspective necessitates the protection and even improvement of environmental quality for the sake of future generations, their development and survival. It recognises that future generations may not be better off with wealth as opposed to a rich natural environment (*ibid.*). According to Brown Weiss (1992), an extreme version of this viewpoint is embraced by a *preservationist model*, in which present generation refrains from depleting resources and significantly altering the quality of natural environment. Yet how fair is it to secure future generations' benefit at the expense of earlier generations (*ibid.*)?

Any theory of intergenerational equity should take into account not only the relationship and obligations of the present generation to other generations of human beings, but also their relationship to the natural system of which they are a part (Brown Weiss, 1992). This argument is based on the fact that human beings are integrally linked with other parts of the natural system, as they affect and are affected by whatever happens in that system. Brown Weiss (*ibid.*) identifies three principles, which form the basis of intergenerational equity:

1. *Conservation of options*: This refers to the conservation of the diversity of the natural and cultural resource base by each generation. Future generations are entitled to enjoy diversity comparable, but not identical, to that enjoyed by previous generations so that their options and choices in solving problems and satisfying needs and values are not restricted;
2. *Conservation of quality*: This requires that each generation maintains the quality of the planet so that the overall environmental quality passed on is no worse than that received; and
3. *Conservation of access*: This states that all members of a specific generation have equal rights of access to the legacy of past generations and have a duty to conserve this access for future generations.

These principles are not prescriptive but are intended to assure a reasonably secure and flexible natural resource base for future generations. Brown Weiss (1992) points out that these principles are based on values shared by different cultural traditions and are acceptable within different economic and political systems.

The Brundtland Report emphasises that even the narrow notion of physical sustainability implies a concern for social equity between generations. This argument has been logically extended to equity within each generation (WCED, 1987). In both cases, any actions should be dictated by the ethical stance on what is "*acceptable in terms of the distribution of well-being, sacrifice and risks between rich and poor, the present and the future, and humans and non-humans*" (Dresner, 2002:121).

2.1.2 Intragenerational Equity

The concept of a *sustainable society* was first presented at an ecumenical study conference on "*Science and Technology for Human Development*" convened by the World Council of Churches in 1974 (Dresner, 2002). The precondition for a sustainable society is a scenario where the need for food at any time is significantly well below the global capacity to supply it, and the emission of pollutants is similarly below the capacity of ecosystems to absorb them (i.e. there are no critical constraints on the global population from starvation or man-made global change). This can be achieved as long as the rate at which non-renewable resources are depleted does not exceed the rate of their substitution with renewable alternatives, or with resources made available through technological innovation. The conference participants acknowledged that equitable distribution of scarce resources and democratic participation in social decisions are necessary for social stability in the new social order envisioned (*ibid.*).

Physical sustainability cannot be secured unless development policies take into consideration the necessary changes in access to resources and the distribution of development costs and benefits (Farrell and Hart, 1998; WCED, 1987). The Brundtland Report recognises that current problems of uneven development, poverty, and population growth may compromise the future survival of human beings, and they may further deepen existing social tensions. Therefore, any environmental and development undertaking should integrate the objectives of social development by investing in education and empowerment, especially of vulnerable groups, and institute gender equity (WCED, 1987). Hence, *intragenerational equity* is about the use of resources in ways that increase equity and social justice, and about the distribution of power and influence within society through effective local participation in decision-making (Vanclay and Bronstein, 1995; WCED, 1987).

Poverty eradication is one of the key challenges in sustainable development agenda. Aristides Katoppo, a chief editor of Indonesia's *Sinar Harapan*, pointed out during the WCED Public Hearing in Jakarta in 1985 that environment or development generally cannot be separated from political development (WCED, 1987). According to Katoppo, poverty eradication cannot be achieved solely by the redistribution of wealth or income, but also requires the redistribution of power. The same line of argument is adopted by Rayner and Malone (2001) who assert that poverty should be viewed in terms of people's ability to participate in decision-making that shapes their lives, in addition to the lack of basic needs. This argument emerges from their alternative definition of poverty, which is viewed as "*a chronic, systematic exclusion of people from society*" (*ibid.*:184). Broad participation in local decision-making produces more pragmatic and negotiated outcomes compared to national decision-making and global debates, which are generally dominated by abstract efficiency considerations (*ibid.*).

According to von Weizsäcker (2000), ecological eco-efficiency cannot suffice in the attainment of a sustainable future without social justice. Environmental stress has often been attributed to the growing demand on scarce resources and pollution generated by the rising standards of living of the relatively affluent sectors of society. However, poverty itself pollutes the environment and creates environmental stress (WCED, 1987). Increasing numbers of the poor, especially in the developing countries, place significant pressure on the natural resource base (Carter, 2001). The cumulative effect of environmental stresses caused by poverty is so extensive that it is considered as a major global scourge (WCED, 1987).

Pearce *et al.* (1989) maintain that environmental protection and improvement of environmental quality are indispensable components of intragenerational equity, especially when the productivity of ecosystems is essential to the livelihoods of the poor. They further argue that this course of action allows "*an appropriate balance to be struck between the need for the poor to gain better livelihoods against the needs of future generations, or alternatively, the future needs of the present generations*" (*ibid.*:40). It is evident that "*sustainable development must rest on political will*" (WCED, 1987:9).

2.1.3 Carrying Capacity and Environmental Utilisation Space

In 1991, IUCN published a new version of the conservation strategy entitled "*Caring for the Earth*", which proposes an alternative definition of sustainable development. It states that "*sustainable development improves quality of human life while living within the carrying capacity of supporting ecosystems*" (IUCN, 1991).

Carrying capacity has become a key concept in the sustainable development debate. It can be defined as a measure of the amount of renewable resources in the environment in units of the number of organisms these resources can support (Dresner, 2002). It is therefore a function of area and organisms. The concept of carrying capacity suggests that increasing throughput of matter and energy, in other words, increasing consumption of environmental sources and sinks for man-made pollution and waste, decreases the number of people who can enjoy it (Vanclay and Bronstein, 1995).

It is difficult to estimate the carrying capacity of the Earth due to different levels of affluence and technology (Dresner, 2002). The most apparent means of reducing environmental impacts of human activities upon the environment include limiting population growth, limiting affluence, and improving technology by reduced throughput-intensive production (Vanclay and Bronstein, 1995). Ironically, apart from advocated technological progress, the suggested measures are highly controversial.

The Brundtland Report draws attention to the fact that established environmental management practices have primarily aimed at repairing damage, for instance reforestation, reclaiming of desert lands, rebuilding urban environments, restoring natural habitats and rehabilitating wild lands (WCED, 1987). Yet the awareness of limited carrying capacity of the natural system requires shifting the focus to the ability to anticipate and prevent environmental damage (*ibid.*). An alternative approach to environmental management is to consider and estimate a level of activity that could be supported by ecosystems without irreversible damage (Dresner, 2002). This idea is embraced by the concept of *environmental utilisation space*.

The concept of environmental utilisation space (or environmental space) was introduced in 1982 by the German economist, Horst Siebert (Dresner, 2002). Siebert argued that environmental services, such as resource generation and pollution absorption, can be considered as a constraint on an economic activity. The concept of environmental space implies that there are limits to the amount of pressure that ecosystems can withstand without irreversible damage to these systems or to their life-support functions (*ibid.*).

Weterings and Opschoor (1994) advocate a search for threshold levels beyond which ecosystems might become irreversibly damaged, which would set operational boundaries of environmental space. The following areas require establishing such thresholds (*ibid.*):

1. Pollution of natural systems with xenobiotic (unnaturally occurring) substances or natural substances in unnatural concentrations;
2. Depletion of natural resources (renewable and non-renewable); and
3. Loss of inherent attributes such as integrity or diversity, among others.

Environmental space reflects the view of scarcity or limitedness that the natural environment entails. According to the notion of sustainable development, the environmental impacts of broadly defined development and lifestyle should not exceed the limits of environmental space available (Dresner, 2002). This prompts vital questions about sustainable consumption patterns and necessary lifestyle changes (*ibid.*).

2.1.4 Defining Sustainability Using Systems Thinking

Although the terms *sustainable development* and *sustainability* are often used interchangeably, they have somewhat different connotations. According to Dresner (2002), the idea of sustainability originally emerged out of *limits-to-growth* thinking. In 1972, a group of scientists from the Massachusetts Institute of Technology (MIT) published a report entitled "*The Limits to Growth*". Based on the results of computer modelling, the authors argued that if current trends of exponential growth in population and demand for non-renewable resources continued, the world would face severe shortages of food and non-renewable resources by the middle of the 21st century (Meadows *et al.*, 1972). The report was heavily criticised, as its main assumptions regarding the rate of technological progress and the availability of natural resources were seen as being too pessimistic (Dresner, 2002). Nevertheless, the existence of physical limits to growth on Earth is hardly ever questioned.

The limits-to-growth perspective led to the understanding that sustainability is best articulated in terms of functioning within the limits of a system's carrying capacity. According to Holdren *et al.* (1995:3), sustainability implies a continuous process or condition "*that can be maintained indefinitely without progressive diminution of valued qualities inside or outside the system in which the process operates or the condition prevails*". This systems-based approach suggests that seemingly discrete activities (e.g. projects) are in fact a part of many interacting or interdependent social, ecological and economic systems, which form one complex global system (Sustainability Now, n.d.).

In more general terms, sustainability refers to the ability of a society and ecological systems to continue functioning into the indefinite future. Sustainability can be also regarded as a relationship between dynamic economic systems and larger, also dynamic but slower-changing, ecological systems that allows for an indefinite survival and development of human beings (Norton, 1992). This relationship requires that the effects of human activities "*remain within bounds so as not to destroy the health and integrity of self-organising systems that provide the environmental context for these activities*" (*ibid.*:25).

The knowledge of key concepts that emerge from *systems thinking* is crucial in establishing adequate management approaches and practices that can help shape a sustainable future. Meadows (2002) argues that the future cannot be predicted but can be envisioned and possibly realised. This assumption underlies the concept of sustainable development.

O'Riordan (2000) states that self-regeneration and self-reliance of ecology, economy and society are central to sustainability. Viewed from a systems perspective, sustainability is associated with the notions of holism, integration, quality, context, self-sufficiency, balance, regeneration and adaptation.

In order to comprehend the complex dynamics and relationships within sustainability, i.e. between social, economic and ecological systems, it is worthwhile to study the behaviour of ecosystems. One of key concepts that help describe how ecosystems respond to environmental change is *resilience*. Resilience indicates the ability of an ecosystem to maintain its structure and patterns of behaviour in the face of external disturbance (Pearce *et al.*, 1989). Resilience is therefore a function of adaptive capacity. *Stability* is another crucial property of the ecosystem. It is a measure of an ecosystem's ability to maintain equilibrium in terms of its species composition, biomass, and productivity in response to normal fluctuations and cyclical changes in the supporting environment. Apart from productivity, stability, and resilience are the basic properties of ecological and social systems (*ibid.*).

Walker *et al.* (2002) emphasise the importance of focusing on maintaining the system's capacity to cope with external disturbance to avoid undesirable changes. This requires maintaining or increasing the level of resilience. For example, the sustainability of an economic system can be examined in terms of its ability to maintain productivity when subjected to stress that may make it less resilient over time (Pearce *et al.*, 1989). In this context, conservation of the natural resource base and the Earth's waste assimilation capacity, as well as the maintenance of essential ecological functions, are essential in minimising the stress imposed by environmental degradation on the economic system (*ibid.*).

Resilience management can be applied to socio-ecological systems in order to prevent them from moving into undesirable configurations (Walker *et al.*, 2002). This approach requires "*understanding where resilience resides in the system and when and how it can be lost or gained*" (*ibid.*:14). It is assumed that socio-ecological systems contain thresholds and can exhibit irreversible changes, and are thus characterised by certain carrying capacities. Therefore, the challenge lies in understanding the biophysical and social components of resilience and taking them into consideration in decision-making (*ibid.*).

Walker *et al.* (2002) maintain that sustainability provides certain assumptions or preferences about which system configurations are desirable. The functional goals of sustainability, which may help communicate a system's desired configurations, are usually determined by social values (Voinov and Smith, 1994). However, social values are based on constantly changing perceptions and priorities (*ibid.*). Meppem and Gill (1998) argue that it is extremely difficult to change social perceptions and priorities through deliberate efforts. Yet a participatory approach to sustainability planning and decision-making can significantly facilitate the evolution of stakeholder perceptions through the process of learning based on dialogue (*ibid.*).

Perhaps the most important lesson from systems thinking is that the function of the complex global system is more than a sum of functions of its social, economic and environmental subsystems viewed from the regional or local scale (Voinov, 1998). Hence, it is necessary to ensure that any efforts to foster sustainability at local and regional levels are guided by, and linked to, a global perspective. Otherwise, the diversity of priorities and interests held in different locations would make it difficult to implement a common vision and develop a sense of mutual responsibility worldwide. Moreover, there can be a risk that any local sustainability-related initiative might be undertaken irrespective of the cumulative effects of our actions, which become apparent at the global scale.

Consequently, sustainable development requires us to '*think globally, but act locally*' taking cognisance of the *cause-effect* relationships between socio-economic and ecological systems.

2.1.5 Understanding Relationships within Sustainability - The Daly Triangle

According to the Balaton Group, an international network of scholars and activists working on sustainable development, sustainable development is a social construct that ensures a "*long term evolution of the human population and economy embedded within the ecosystems and biogeochemical flows of the planet*" (Meadows, 1998:7). This statement evidently points to the dependency of future social and economic development on the carrying capacity of the natural environment; in other words on the availability and condition of the natural capital.

Herman Daly, in his exploration of interactions and dependencies between different types of *capital* (e.g. natural capital, built capital and human capital), proposed to situate human economy within a hierarchy, which rests on the foundation of natural resources and reaches to the height of its ultimate purpose, i.e. human and social wellbeing. This hierarchy is commonly known as the *Daly Triangle*, which he presented in his book entitled "*Toward a Steady State Economy*" (Daly, 1973).

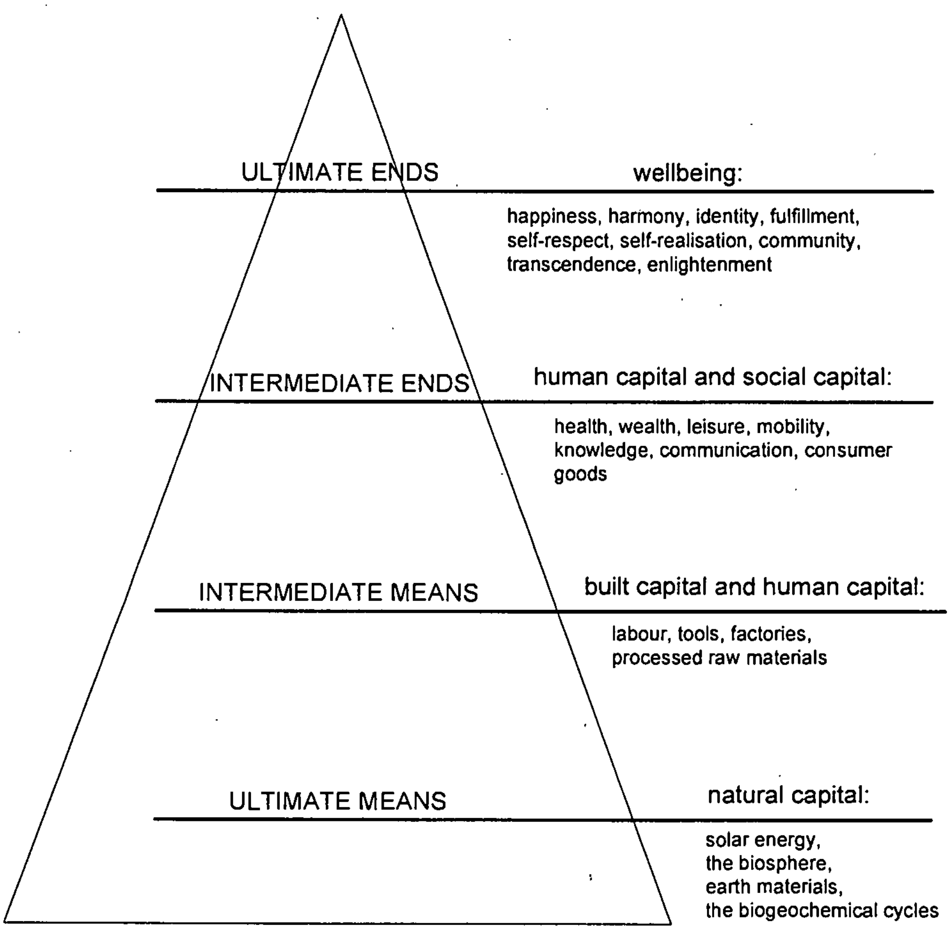
Daly argued that everything is based on *ultimate means*, which provide for and sustain all life and economic activities (see Figure 1). The ultimate means represent natural capital that embraces all energy and matter, the biochemical cycles, life-support systems, genetic information encoded in all species and the human being as an organism. They consist of stocks and flows in nature that provide sources of energy and matter for the human economy and sinks for its waste. Daly emphasised that ultimate means are not created by human beings, but are inherited and passed on to future generations.

Natural capital is converted through technology into *intermediate means*, which embrace all built and manufactured capital, human capital and raw material including tools, machines, factories, skilled labour, processed material and energy. All of these components represent economic inputs and define the productive capacity of economy.

The intermediate means help achieve *intermediate ends*, which represent basic societal goals, but are not ends in themselves. Intermediate ends are outputs of economic processes and may include consumer goods, health, wealth, knowledge, leisure, communication or transportation.

At the top of his triangle, Daly placed *ultimate ends* that are desired for themselves and do not constitute any means to achieve any other end. Daly's definition of ultimate ends remains quite vague due to the very intangible nature of this concept.

Figure 1: The Daly Triangle (source: Meadows, 1998:42)



According to Daly (1973:7-8), "*our perception of the ultimate is always cloudy, but necessary nonetheless, for without a perception of the ultimate it would be impossible to order intermediate ends and to speak of priorities*". The qualities proposed by Daly and expounded by others (e.g. Meadows, 1998) include happiness, harmony, identity, fulfilment, self-respect, self-realisation, community, transcendence and/or enlightenment.

The Daly Triangle has been criticised for being too hierarchical, too anthropocentric, too vague or too static. However, it has been useful in depicting the idea that economy is borne out of nature and draws on nature to serve higher goals, and is not an end in itself (Meadows, 1998). In addition, it intuitively suggests that a primary goal of a sustainable society is to produce the greatest possible ends with the least possible means (*ibid.*).

2.1.6 Weak and Strong Sustainability

This extended definition of capital that encompasses also natural and human capital is used by economists in a debate on the sufficient conditions for sustainability, which in turn provides grounds to speculate about alternative approaches to the attainment of sustainable development. Environmental economists define sustainability in terms of non-depleting capital. In this context, sustainability is attained if capital is non-declining (Dresner, 2002). If natural capital is counted together with man-made (manufactured) capital, then the increase in man-made capital can compensate for depletion or degradation of natural capital (*ibid.*). The argument about whether man-made capital and natural capital should be considered together or separately in the economic equation is controversial. Goodland and Daly (1995) maintain that consumption of natural capital implies its liquidation, which logically supports Schumacher's (1994) argument that natural capital is becoming the limiting factor for further economic development.

Economists and scientists disagree about the extent to which advancing technology enables man-made capital to replace natural capital, and how far the idea of non-depletion of natural capital should be taken. This disagreement has prompted the emergence of two alternative approaches to sustainability, namely *weak* and *strong* sustainability.

Dresner (2002) lists two major departure points between the advocates of weak and strong sustainability. The concepts of weak and strong sustainability differ with regard to whether profits from the use of natural capital should be invested directly in substitutes for relevant resources (e.g. investment in solar power technology to substitute oil reserves), or in other forms of capital (e.g. education). There are also differing opinions about the existence of critical natural capital that cannot be substituted for by technology and must be therefore preserved by all means (*ibid.*). Hence, the key issues within the sustainability debate are about the extent to which different types of capital can be substitutable, and the extent to which they are complementary.

Weak sustainability is achieved with non-declining total capital. It is assumed that technological progress will allow for almost infinite substitutability of natural capital with man-made capital (Dresner, 2002; Vanclay and Bronstein, 1995). However, there are presently many environmental assets for which there are no current substitutes, e.g. the ozone layer, the pollution cleaning and nutrient-trap of wetlands, and the climate regulating functions of ocean phytoplankton, to mention a few. There is no certainty that substitution of these assets will be ever possible through technological innovation.

Pearson *et al.* (1989) argue that the waste-sink characteristics of natural capital compose its most critical resource. Similarly, Meadows *et al.* (1992) maintain that the sink constraints (such as waste assimilation, air and water pollution, greenhouse gases and ozone depletion) are more stringent than limits to environmental resources. Therefore, this should be another focal point in any discussion about the substitutability of environmental assets. Sustainability is strongly rooted in the precautionary principle, which states that "*when there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation*" (United Nations, 1990: Article 7). This perspective is not explicitly embodied in weak sustainability.

Strong sustainability assumes that natural capital should not decline over time. Moreover, it does not allow any element of natural capital to be depleted (Pearce *et al.*, 1994; Costanza *et al.*, 1991). However, a moderate strong sustainability accepts some depletion of natural capital on condition that it is compensated for in another way (Dresner, 2002). For instance, Hediger (1999) accepts the need for the depletion of non-renewable resources in order to enhance the stock of renewable resources.

Daly and Cobb (1990) argue that the substitutability of natural capital is critically limited as man-made capital is not used up in the production processes as intensively as are natural resources. They explain that it is far easier to accumulate capital with sustainable use of resources to enable such use to continue in the future than to accumulate enough capital that allows meeting basic human needs through the unsustainable use of resources (*ibid.*).

Natural capital is being used unsustainably if sources are declining or sinks are increasing (Meadows, 1998). Efforts should be channelled into enhancing the stock of renewable resources and an intensified use of waste materials through recycling processes. These efforts have to be accompanied with investment in technological progress and human capital, and improvement of institutions and social organisations (Hediger, 1999). Strong sustainability is achieved when the following conditions are met (Daly, 1991):

1. Human scale production (throughput) is limited to that which is within the Earth's carrying capacity;
2. Technological progress is efficiency-increasing rather than throughput-increasing;
3. Harvesting rates do not exceed regeneration rates (sustainable yield) for renewable resources and waste emissions should not exceed the assimilative capacities of the receiving environment; and
4. Non-renewable resources are consumed no faster than the rate of regeneration of renewable resources.

These principles call for sustainable use of natural capital and encourage its accumulation by reducing the levels of current exploitation, investing in projects that relieve pressures on natural capital stocks by recovering renewable resource base and by increasing the end-use efficiency of products (Vanclay and Bronstein, 1995). Consequently, new development trends will inevitably require lowering throughputs (i.e. greater degree of dematerialisation through higher efficiency in energy and material use and reduced output of waste and pollution), managing renewable resources employing a long-term perspective, and rehabilitating previously degraded areas.

Beder (2000) points out that the concept of weak sustainability is not compatible with the notion of intergenerational equity, as it assumes that future generations will not suffer from environmental losses as long as they are compensated for this loss by wealth creation. The precautionary principle dictates that anything less than strong sustainability does not guarantee future generations the ability to maintain their welfare in a worst-case scenario (Dresner, 2002).

Although strong sustainability is more difficult to operationalise (i.e. to translate into a practical action) than weak sustainability (Dresner, 2002), there is no doubt that sooner or later the natural environment will have to be treated as a *vital stakeholder* in the development process. However, any effort to enhance the quality of natural capital will only be successful by departing from the traditional way of measuring economic growth (Pearce *et al.*, 1989) and embedding it in a set of values, which underlie the philosophy of sustainable development.

2.1.7 North versus South - Different Priorities in the Quest for Sustainable Development

The economically underdeveloped countries of Asia, Africa, Oceania and Latin America are often considered as an entity with common characteristics such as poverty, high levels of population growth, and economic dependence on the advanced economies of the industrialised counties (Chaliand, n.d.). They are commonly referred to as *developing countries*, *Third World countries*, or more recently as *the South*. In contrast, *the North* or *the First World* encompasses a group of countries which are technologically advanced, highly urbanised and wealthy. They are often referred to as *developed countries* (Wikipedia, 2005).

It is frequently argued that most of the present environmental damage, in particular the adverse global impacts, is the direct consequence of economic growth and development of the North. The developed nations emphasise the necessity to address global environmental issues that appear to threaten them directly (O'Riordan, 2000). These impacts include climate change (with its complex implications for agriculture, water supply and coastal protection), ozone depletion, and the loss of species and habitats. Global impacts also pose a potential threat to the South, but addressing them is not accepted as a priority (*ibid.*). The developing countries, which accommodate the majority of the world's poor, are more concerned with such problems as the common scourge of disease, inadequate sanitation, inadequate nourishment of people, localised pollution from cars, household and industrial waste, and domestic fuel burning (Dresner, 2002). Moreover, environmental management in developing countries is a challenging task, as the relationships between environmental problems and the resources available to solve them result in a widespread need to improvise and substitute in response to the most acute shortages of manpower and finance (Barker and Kaatz, 2001).

However, there is an ongoing political debate about the type and scope of necessary actions to be taken by both the developed and developing countries, in order to secure a sustainable future. Sustainable development acts as a platform for mediation to reconcile the concern for environmental protection with the desire for economic development in the South and economic growth in the North (Dresner, 2002).

There is no dispute between the North and the South about the fact that a healthy economy requires a healthy environment. Pearce (1995) argues that assimilative capacities of the environment, which help to deal with the problems of waste and pollution, have become scarce. Since they are shared globally, the North and South have a mutual interest in protecting these crucial environmental functions. Therefore, sustainability seems to demand global agreements about the use of environmental space (Dresner, 2002).

The difficulty in pursuing a common sustainability agenda is that the North is more likely to be concerned with the carrying capacity of the environment and physical limits to economic growth, whereas the South emphasises the need for intragenerational equity. Carter (2001) maintains that putting intragenerational equity into practice might generate significant political tensions between the North and South. A key question is whether the North will take on political and financial responsibility for addressing global environmental problems (*ibid.*). Furthermore, the notion of *sustainable consumption* has drawn attention to the enormous disparities between mass consumption in affluent countries and over a billion poor people in the South whose basic needs are not being met at all (UNDP, 1998).

Further, different perceptions of the value of the natural environment form a central obstacle in establishing a common developmental agenda for the North and South. In the developing countries, where the majority of people lack basic human needs and society's interests are judged in terms of immediate benefits, many do not perceive humans as posing a threat to the environment, but often view the environment as posing a threat to humans (Fuggle and Rabie, 1992). The aesthetic, scientific, educational and future needs, which are shared by affluent nations, are considered an unaffordable luxury (*ibid.*).

Poverty is recognised as one of the major causes of habitat destruction, as the poor are often forced to practice environmentally destructive activities to ensure their short term survival (Dresner, 2002). At the same time, poverty is listed as one of the most important causes of vulnerability to environmental threats due to the fact the poor have lower coping capacities and, consequently, bear a disproportional burden of environmental impacts (UNEP, 2002). Thus, in fostering sustainable development in the South, priority should be given to food security, land stabilisation, energy availability and civil rights for minorities and women (O'Riordan, 2000).

Direct poverty alleviation and improved quality of living of the poor could begin with low-tech, labour-intensive job creation and the provision of training programmes (Hill and Bowen, 1997). Vanclay and Bronstein (1995) emphasise the continuing importance of social safety nets and directly targeted aid. As poverty alleviation requires economic growth in order to increase the scope of provided services, the South argues its ethical right for adequate environmental space for the necessary future development (Dresner, 2002).

Meanwhile, the North is expected to adopt the challenge to ensure an ongoing technological enhancement. Pearce (1995) argues for a change of current consumption patterns in the North towards less resource intensive products. Similarly, Vanclay and Bronstein (1995) maintain that in the reality of global environmental limits, the necessary economic growth in the South should be balanced by decreasing throughput growth in the North.

To conclude, attaining a sustainable future involves the overall readjustment in the levels and patterns of consumption in the North, decreasing throughput in production and the political will to address global environmental impacts, as well as the provision of basic needs to the poor in the South. The dialogue continues.

2.2 PURSUING SUSTAINABILITY IN THE BUILT ENVIRONMENT – THE COMMON SENSE REALITY

The increasing levels of human population have contributed to accelerated rates of resource consumption and waste discharge. While it was easier for previous human societies to live in a state of balance between demand for and supply of the Earth's resources, the modern world faces the threatening consequences of current demand for resources exceeding the available supplies (van Wyk, 2004).

As a major component of contemporary life, the built environment is partly responsible for reinforcing our consumptive lifestyles (van Wyk, 2004). Poorly designed structures of low quality require higher consumption of materials and energy to build and operate, not to mention the potentially detrimental effects they may have on human health and safety. Furthermore, the built environment affects how people feel and perform (Talbot, 2003). Arguably, people are creators of the built environment, and their lifestyles are affected by the quality of the built environment. This means that people can influence the environment in which they live, and so influence how they live.

Roodman and Lessen (1995) estimate that about 2 billion people live and work in resource-intensive buildings, and that in the next 50 years this number may reach 8 billion. As the construction sector continues to use virgin materials (40% of total extractions) at rates that exceed their re-deposition, it contributes significantly to the problem of resource depletion (*ibid.*). Inefficient resource consumption is one of the areas within construction, which requires urgent intervention since it is directly linked to the increasingly acute problem of construction waste. According to Talbot (2003), construction waste makes up to 40% of municipal solid waste that is destined for local landfills.

One of the solutions to this problem would be to redirect construction waste back into the material sourcing loop whenever it is possible and practical. Hampton (n.d.) claims that waste is a human-centred concept that does not occur in nature, as in nature everything is reused. In this regard, the creation of the built environment would be considered unsustainable in terms of material displacement rather than material wastage, which further exacerbates resource depletion. van Wyk (2003) argues that the use of elementary materials, such as timber, sticks, rocks and stones represents the displacement of the material as opposed to its consumption, as the material is not lost in the process. Therefore, considering material consumption from a perspective of quality control and application of appropriate construction techniques can help alleviate the problem of material depletion and waste generation in construction through the disassembly and reuse of building products. Shifting towards the use of renewable and secondary materials will also make a significant positive change to current building practices without decreasing the quality and economic viability of construction goods and services.

Excessive use of resources is not the only problem related to the erection of the built environment. Extraction of materials and their reprocessing into usable building products often results in landscape destruction, toxic runoff from mines and their tailings as well as air and water pollution (Roodman and Lessen, 1995). Construction uses up to 25% of virgin wood worldwide, thus, significantly contributing to deforestation and consequent biodiversity loss, flooding and siltation (*ibid.*). Adding in the fuels and power used in construction, buildings consume at least 40% of the world's energy, account for two fifths of acid rain, and have a significant share in green house emissions (*ibid.*). It may be concluded that the construction industry operates largely indifferent to the available environmental space and the Earth's carrying capacity.

Hampton (n.d.) points out that the built environment is also a key part of the solution due to the enormous opportunities it provides for human development. Much of the progress achieved today would not have been possible without the built environment and the infrastructure we depend on (*ibid.*). van Wyk (2004) also maintains that the escape from the '*economic jail*' of the poor is impeded by the lack of infrastructure.

The built environment has a direct impact on living standards, and the construction industry has a considerable share in most national economies. Almost a half of the world's population (47.2 %) is now urbanised, and it is estimated that by 2050 that proportion will have reached two-thirds (van Wyk, 2004). Construction constitutes more than 50% of the total national capital investment in most countries, and construction can amount to as much as 10 percent of GDP. It is estimated that the construction industry employs about 111 million people globally, accounts for almost 28% of all industrial employment, and is the biggest industrial employer worldwide (*ibid.*). Moreover, construction accounts for 7% of total employment with 75% of all construction workers located in the developing countries. Another important characteristic is that small and medium sized enterprises (SMEs) constitute 97% of all construction firms internationally (*ibid.*). As the construction industry proves to be an employment-intensive sector, its sustained development is desirable as a vehicle for social advancement and economic upliftment, especially in the developing countries.

The above-mentioned statistics indicate significant scope of opportunity to foster socio-economic goals of sustainable development by the construction industry and within the built environment. The transformation of the built environment and the construction industry is inevitable, as the current typical practice of construction and operation of buildings "*inflict grievous harm upon the environment, threatening to degrade the future habitability of the planet*" (Roodman and Lessen, 1995:5). Due to the complex relationships between society and the natural environment, developments that are harmful to the natural environment also impact negatively on the quality of life of humans. Fortunately, there is an increasing awareness of the enormous direct and indirect social, economic and environmental consequences associated with the current practices of design, building, operating, maintaining and ultimately disposing of buildings and their support systems (Talbot, 2003). For instance, the wide-spread adoption of modern construction technologies (homogeneity) and the use of materials with no reference to the context, climate and culture are indicated as legitimate contributors to unsound construction practices (Ofori, 1998). van Wyk (2004) argues that there is an urgent need to develop the culture of performance measurement in the built environment and construction activities, so that the efficacy of innovations can be evaluated and continuous improvements promoted in cost, time, quality, durability, adaptability, maintenance, reuse and environmental performance.

More importantly, the achievement of sustainable development necessitates changes in thinking, behaving, producing and consuming (Hawken, 1993). Perhaps the most significant challenge facing the construction industry is to acknowledge and accept the scope of actions required to shift its development onto a sustainable path.

2.2.1 Sustainable Development as a Driver of Change in Construction

The construction industry can no longer afford to ground its vision of development solely on the prospect of growth (du Plessis, 1999). It is in the best interest of the industry to acknowledge its duty of caring towards human beings and towards the environment, as the environmental and social values and problems "*do not merely set external limits to development, but can inform the very character of development*" (Dower, 1998:774).

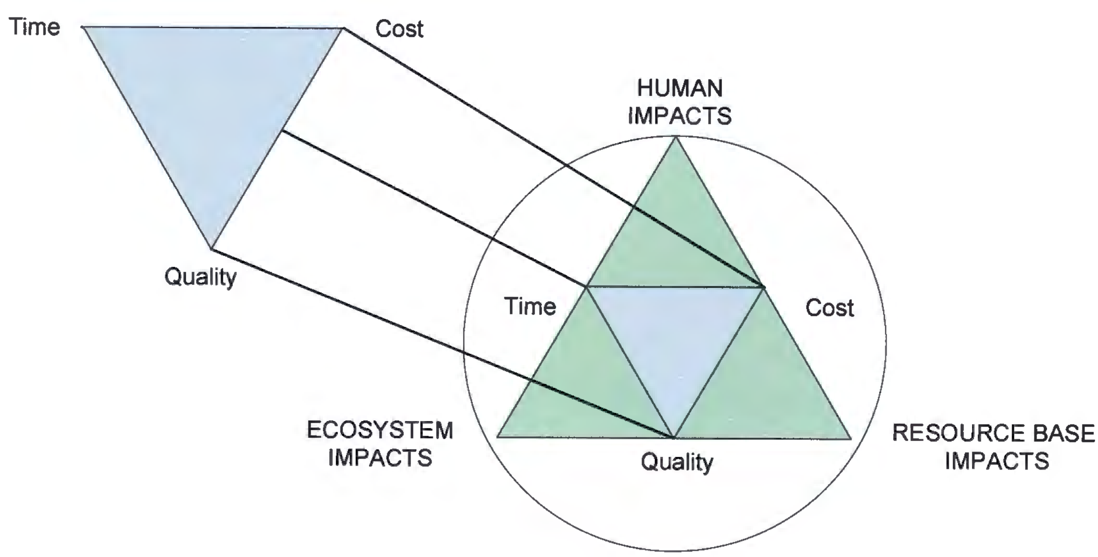
Many construction organisations have already acknowledged the immense opportunities that sustainability provides for further business development. Hampton (n.d.) quotes Sir Neville

Simms (the CEO of Carillion – a leading UK business and construction services company) stating that "*sustainability underpins future profits*". It is evident that the companies that operate in more environmentally and socially sensitive ways will gain the benefits of an enhanced brand and new opportunities for market leadership.

The business sector is faced with the challenge of delivering legitimacy and good governance, as stakeholders increasingly look for evidence of good stewardship (King Committee on Corporate Governance, 2002). Cole (1999) argues that the construction sector will be increasingly scrutinised and required to develop approaches and practices that address immediate environmental concerns and adhere to the emerging principles of sustainable construction.

Traditional approaches to determine efficiency and effectiveness of construction projects tend to focus on the competitive factors of cost, quality and time (Bourdeau, 1999). The construction industry remains largely cost-driven, focusing primarily on capital cost minimisation and meeting the implementation time. Quality and performance goals have been seen as secondary objectives, while minimisation of negative impacts of construction projects has been given certain attention (Pearce and Fischer, 2001). However, as the transformation of the construction industry is taking place through the infusion of principles of sustainable development, the traditional objectives of construction are embedded in a larger context of sustainability-related life cycle objectives. The latter bring to the fore the need for avoiding and minimising adverse environmental impacts on any resource base and ecosystems while promoting social equity and meeting the needs of stakeholders (see Figure 2).

Figure 2: Infusion of Sustainability Agenda in Construction (adapted from Pearce and Fischer, 2001:7)



The alignment of the construction industry with the philosophy of sustainable development is not just a fashionable trend or a sophisticated marketing strategy, as it has now become a mainstream concern (CIRIA, n.d.).

2.2.2 Sustainable Construction

Birkeland (2002) argues that any technology, building or other construction product must function within an existing social, political and institutional context as well as within its natural environment. However, technology, buildings and construction products should also transform their contexts, as the existing social, political and institutional systems often militate against the quality of life, social justice and healthy, symbiotic relationships. Birkeland (*ibid.*) advocates a paradigm shift from viewing the built environment and construction sector as *transforming nature* to that of viewing them as *transforming society* towards sustainability by improving the quality of life and the relationships between all living things, communities and the natural and built environments. This paradigm shift underpins the sustainability agenda in construction.

The adoption of the sustainability agenda by the construction sector has led to the introduction of a new term, namely, *sustainable construction*. If construction is defined as a process or mechanism of delivering human settlements and creating infrastructure that supports development (du Plessis, 2002), then it may be argued that the ultimate aim of implementing sustainable development in construction is to institute a shift in practices to those necessary to deliver a sustainable built environment and, ultimately, sustainable settlements. Therefore, any rationalisation of the concept of sustainable construction should be based on, or at least linked to, the definition of sustainable human settlements and the concept of sustainable society (Ofori, 1998).

A key objective of sustainable human settlements, as specified in the Habitat Agenda by the United Nations Human Settlements Programme, is to facilitate developing "*societies that will make efficient use of resources within the carrying capacity of ecosystems and take into account the precautionary principle approach* (...) *by providing all people* (...) *with equal opportunities for a healthy, safe and productive life in harmony with nature and their cultural heritage and spiritual and cultural values, and which ensures economic and social development and environmental protection*" (UN-HABITAT, 1996: Section IIIB, 42). This offers a holistic perspective within which sustainable construction can be discussed.

Hence, the sustainability agenda for construction needs to highlight the issues of resource consumption within the carrying capacity of ecosystems and the application of the precautionary principle in environmental protection, while fostering socio-economic development. Pearce and Vanegas (2002) also suggest that in making any decisions with respect to selecting a sustainable course of action in the construction context, it is necessary to consider the impacts and possible contributions of construction practices on the satisfaction of stakeholder needs, resource consumption within the regeneration rates and the preservation of the carrying capacity of natural systems affected.

In other words, sustainable construction represents a process of restoring and maintaining "*harmony between the natural and built environments, while creating settlements that affirm human dignity and encourage economic equity*" (du Plessis, 2002:8). According to Graham (1998), the concept of sustainability in construction should be articulated in terms of principles and goals rather than by any empirical interpretation. The principles of sustainable construction are discussed in the following paragraphs according to a classification provided by Hill and Bowen (1997), who group them as social, economic, biophysical, technical and process-orientated.

2.2.2.1 Principles of Sustainable Construction

The social principles of sustainable construction focus on the notion of equity and social justice in terms of the distribution of social benefits and costs resulting from construction activities (Hill and Bowen, 1997). Social sustainability is enhanced through stakeholder capacity-building that allows for a more meaningful participation in construction projects while contributing to the development of human capital. Hill and Bowen (*ibid.*) emphasise that no significant costs of building developments should be passed on to future generations. The criteria of social wellbeing that are also considered in sustainable construction include respect for local culture and tradition (van Wyk, 2004).

The principles of economic sustainability in construction address the issues of viability and affordability (Hill and Bowen, 1997). They promote full cost accounting and real cost pricing for construction goods and services, which help reflect social and environmental costs of construction. Employment-intensive construction practices and the potential for job creation are imperative to sustainable construction. Creation of employment opportunities is especially important in developing countries. Hence, a significant portion of the building project investment should remain and circulate in local hands, thus offering prospects for the desired social advancement. Sustainability also requires investing profits from the use of non-renewable resources into the development of renewable substitutes or other forms of capital (*ibid.*).

The issues of resource consumption, environmental quality and pollution prevention form the domain of environmental sustainability in construction. The principles refer to the extraction of resources respecting their regeneration rates and the substitution of non-renewable resources with renewable resources whenever possible (Hill and Bowen, 1997). They promote a reduced throughput of energy and materials in construction processes and throughout a building's life cycle by the means of dematerialisation, resource reuse and recycling. Detailed principles of environmental stewardship include improving air quality, reducing the emission of global warming gases, protecting the ozone layer, protecting fresh water and groundwater sources, limiting the consumption of land, planting tress and reinstating an indigenous landscape (van Wyk, 2004). Furthermore, linked to the concern over the adverse impacts of the built environment and construction activities on the Earth's carrying capacity are the principles regarding biodiversity conservation and rehabilitation to maintain natural life-support systems and restore ecological processes of purification and nutrient regeneration (Hill and Bowen, 1997). These principles are strongly promoted by the Environment Agency of the United Kingdom, which calls for location of developments in the right place and in a right way (Environment Agency, 2004). This approach requires considering the environmental space of a given area in terms of the availability of resources, especially water, and utilising appropriate waste management options to support new construction projects. In addition, the principles of sustainable construction require the delivery of non-toxic and healthy working and living environments and enhancing the exiting built environment and urban infrastructure in order to create more integrated and resource efficient human settlements (Hill and Bowen, 1997).

Sustainability is also echoed in the technical aspects of construction activities. Emphasis is placed on high performance of facilities and high quality of construction services (Hill and Bowen, 1997). The construction industry needs to internalise the slogan: '*built for quality and fit for purpose*' to meet the needs of stakeholders more efficiently and to enhance the industry's competitiveness. In this way the industry can contribute to a more efficient use of resources while avoiding any delivery of obsolete structures. Consequently, more attention should be paid to flexibility and adaptability in structural designs to meet the changing needs of building occupiers. Furthermore, building designers should be encouraged to provide increased user-control over the indoor environmental conditions and avoid reliance on centralised control points (e.g. central air conditioning units) (*ibid.*).

Process-orientated principles of sustainable construction help establish and inform best practice by enhancing process management and communication between construction professionals and other stakeholders, as they impact significantly on the final outcomes of construction operations and play a role in shaping the construction industry. These principles call for a prior assessment of construction activities to integrate information concerning social, economic, biophysical and technical factors in decision-making (Hill and Bowen, 1997). They promote interdisciplinary and stakeholder partnerships between government, industry, consultants, contractors, non-governmental organisations and the general public, in other words, all interested and affected parties. Construction practitioners are encouraged to utilise a life cycle framework that considers the principles of sustainable construction during the planning, assessment, design, construction, operation and decommissioning stages of construction projects (i.e. the whole procurement and usage process).

The process-orientated principles are also concerned with recognising interconnections between facilities and their surroundings, i.e. interactions between facilities and their contexts as well as between different components of the facilities using a systems perspective (Hill and Bowen, 1997). Hill and Bowen (*ibid.*) draw attention to the implementation of the precautionary principle in construction by exercising prudence in the face of uncertainty, unpredictability and risk. Moreover, since sustainability calls for taking a long-term view, established goals and targets are based on assumptions. The uncertainties associated with these goals must be treated with caution. In addition, the process-orientated principles of sustainable construction promote voluntary commitments to the continual improvement of environmental performance that go beyond compliance with legal requirements.

It is evident that sustainable construction is not the practice of '*business as usual*' with more investment directed towards environmental management. A paradigm shift requires a proactive stance in terms of assessing and addressing the opportunities and constraints that the environment places on development (i.e. environmental space) instead of mitigating the impacts of development on environment (van Wyk, 2004). In this context, design becomes an indispensable tool for social and environmental problem-solving and prevention (*ibid.*).

Arguably, sustainable construction can be viewed as a catalyst for ongoing improvement in construction industry's performance and its future viability (Barker and Kaatz, 2001). According to Ofori (1998), the continuing confusion on concepts and lack of agreement on causes, effects and remedies of environmental and socio-economic problems associated with construction results from a lack of adequate guidance for good practice. Such guidance forms the topic of the following section.

2.2.2.2 Operationalising Sustainable Construction

In order to shift towards sustainable development, the construction industry needs to adopt policies and activities that target the primary dimensions of sustainability, namely, ecological integrity, social equity, and economic vitality (Barker and Kaatz, 2001). Moreover, it is essential to infuse the agenda of sustainable construction at a number of levels, i.e. from sector- and profession-specific to project-specific policies and practices. Addressing this problem, Vanegas and Pearce (2000) developed a strategic approach to the implementation of sustainability in construction that can be successfully implemented by architectural, engineering and construction organisations.

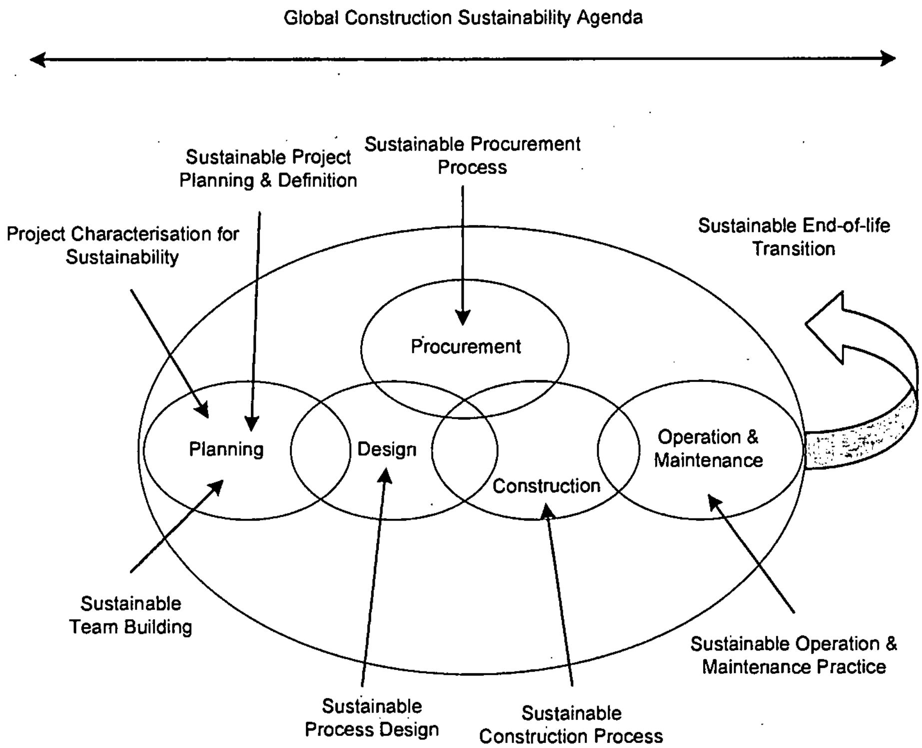
A strategic approach to the implementation of sustainability in construction requires establishing a global construction sustainability policy that would articulate sustainable development objectives for the built environment and construction industry as a whole. As proposed by Vanegas and Pearce (2000), the global policy would underlie any sustainability vision established by architectural, engineering and construction organisations, and consequently professional practice, as well as for individual construction developments. Vanegas and Pearce (*ibid.*) list the following five principles as main considerations in developing the global construction sustainability policy:

1. Internal and external contextual compatibility;
2. Environmental benign-ness;
3. Long term sustainability;
4. Enhanced life cycle product and process performance; and
5. Planned end-of-service life.

Ideally, these principles should govern construction decision-making and assist in defining a number of practice- and project-specific strategic objectives that would address elements of the global construction sustainability policy (Vanegas and Pearce, 2000) (see Figure 3).

Subsequently, it is necessary to establish measurable goals to evaluate the progress towards the strategic objectives for the planning, design, procurement, construction and operational stages of construction projects. The final task involves the development of a clear execution plan for each goal, which would be suitable for application in projects.

Figure 3: Integrated Project Sustainability Framework (adapted from Vanegas and Pearce, 2000:7)



The practice- and project-specific strategic objectives of sustainable construction should address the following stages of construction projects (Vanegas and Pearce, 2000):

- *Project characterisation*, which involves the systematic specification of the attributes, characteristics and qualities of a given project from a sustainability perspective in terms of the industry sector represented (e.g. real estate development, residential, civil infrastructure or industrial construction) and the type of a project (e.g. new construction, rehabilitation or retrofit). This stage determines the degree, breadth, and depth of sustainability efforts throughout the whole process.
- *Team building* to ensure that key stakeholders have a common understanding of sustainability principles and concepts, and adequate training to operate as high-performance teams. All stakeholders are effectively involved in establishing strategic objectives, measurable goals, and execution plans for project sustainability.
- *Project planning and definition*, which includes an initial need assessment and setting of preliminary objectives, analysis and definition of project scope, and possibly the development of the conceptual design. This stage also involves a preliminary planning and funding approval. It provides the most significant opportunities to influence project

sustainability at the lowest cost. Specific elements include site selection, framing of project needs and compatibility of project scope with contextual requirements.

- *Design*, which entails detailed design and development of contract documents and in some cases elements of the tendering process. Project sustainability can be still greatly influenced before any actions begin on site. Specific elements include integration of building systems, passive design strategies, material selection and indoor environmental quality.
- *Procurement*, which involves sourcing of materials, construction resources and facility components. Project sustainability may be enhanced with sustainable sourcing of materials and their transport to-site. Attention is paid to reduction or elimination of packaging, recycling content, waste minimisation, and environmental benign-ness of manufacturing processes.
- *Construction*, which includes construction planning, execution and commissioning. Sustainability objectives aim at minimising and avoiding site disturbance, recycling, construction health and safety and contribution to good indoor environmental quality through appropriate construction practices.
- *Operation and maintenance*, which refers to full operation and maintenance of a facility until its end-of-service life. Sustainability interventions, concerned mainly with effective planning and allocation of resources, include indoor air quality; thermal comfort; light quality; energy, water and resource conservation; and waste management.
- *End-of-service-life*, which deals with disassembly/reuse of building components, material recovery/recycling and site reclamation. It is crucial that all stakeholders give due consideration to this final stage of the facility life cycle and make provisions for appropriate decomissioning actions during planning and design stages.

The first two aspects, namely, project characterisation and team building, are fundamental in establishing the sustainability vision for the project, which is meant to guide all decisions in the following stages of the project's life cycle. They also form the starting point for establishing strategic objectives, goals and execution plans for project sustainability (Vanegas and Pearce, 2000). Project planning and definition, design, procurement and construction dictate project delivery in terms of sustainability criteria established in the global sustainability policy. It is necessary to involve key stakeholders throughout the project life cycle to ensure that any decisions taken during operation and disassembly are also based on the established project values.

2.2.2.3 *Agenda 21 on Sustainable Construction – A Plan of Action towards the Common Vision*

The construction industry has responded to the challenge of sustainable development by attempting to establish a common and consolidated vision of sustainability within the built environment and the construction sector. Following the example of *Agenda 21* – the action plan for global sustainable development agreed upon by world leaders during the Earth Summit in Rio in 1992); the International Council for Research and Innovation in Building and Construction (CIB) proposed a similar framework of actions towards sustainable construction (CIB, 1999). The sector-specific "*Agenda 21 on Sustainable Construction*" defines the links between the global concept of sustainable development and the construction industry. It also facilitates the comparison and coordination of sustainability initiatives implemented at the local level (van Wyk, 2004).

The Agenda provides a detailed overview of concepts, issues and challenges of sustainable development and sustainable construction, and is intended to be used as a source document for defining research and development activities related to sustainable construction (du Plessis, 2002). Acknowledging the ever changing interpretation of sustainability, the Agenda indicates the significance of socio-cultural and economic dimensions of sustainable construction and the need for an explicit treatment of these non-technical issues (often called soft issues) in any construction policies and management practices (CIB, 1999). The main challenges of sustainable construction listed in the Agenda include the following (CIB, 1999):

- *Management and organisation* – The challenge lies in aligning these key aspects of construction with the objectives of sustainable development by integrating technical, social, economic, environmental, legal and political matters within design processes. Further, by improving environmental quality of construction, re-engineering building process and developing new building concepts.
- *Product and building issues* – The characteristics of buildings and building products should be optimised in order to improve sustainability performance, taking into account such factors as climate, culture, building traditions, and the stage of industrial development.
- *Resource consumption* – The problems of excessive resource consumption and decreasing environmental quality due to construction activities should be addressed by promoting resource-efficiency through demand management, increasing use of renewable and secondary materials and protection of life-support functions of affected ecosystems.

- *Impacts on sustainable urban development* – Progressive urbanisation should reinforce the importance of creating sustainable built environments for future generations. Major issues that need to be taken into account include environmental quality, life quality, dwelling quality, governance as well as urban growth and waste management.

Recognising the contexts in which the construction industry operates in developed and developing countries and the ensuing need to implement context-appropriate measures to achieve the objectives of sustainable construction, the CIB and United Nations Environment Programme (UNEP) have developed a separate research and development agenda and a strategy for achieving sustainable construction in the developing world. The resulting discussion document, published in 2002, is entitled "*Agenda 21 for Sustainable Construction in Developing Countries*" (du Plessis, 2002).

This document identifies a number of challenges and opportunities shared by developing countries including rapid urbanisation; high demand for low-income housing; inadequate infrastructure; the need for further rural development, education and gender equity, financing, procurement and institutional capacity as well as the value of tradition and the spirit of innovation. It is acknowledged that implementation of the principles and objectives of sustainable construction in the developing world will require the creation of an enabling environment. Hence, efforts should be directed towards the provision of a variety of technological and institutional enablers, a value system for the construction sector that supports sustainability and different tools to facilitate its adoption (du Plessis, 2002).

The "*Agenda 21 for Sustainable Construction in Developing Countries*" states that sustainability ultimately depends on the decisions people make regarding their own behaviour (du Plessis, 2002). Therefore, it is the responsibility of various stakeholders to create an enabling environment that is supportive of sustainable construction. This would entail developing measures that help optimise construction processes through better knowledge sharing and integration of project planning, design and implementation. Such measures should also assist in establishing and internalising project values aligned with the principles of sustainable construction (*ibid.*).

2.2.3 Measures for Promoting Sustainability in the Construction Sector

While striving for the long-term sustainability of its practices and products, the construction industry faces an environmental challenge that is – in absolute terms – greater than that of any other industrial sector (The European Commission, 2001). In its "*Final Report on Sustainable Construction*", published in 2001, the European Commission acknowledged that individual states have been remarkably slow in recognising the scale of difficulties involved in achieving sustainability in the built environment. Moreover, the Commission recognised that the issues of sustainability in the built environment are global in extent and need to be addressed via a collaborative effort of various states, the public and business sectors, and various role-players within the construction industry. The partnership between government and industry is especially significant for the support of research and development and technology diffusion (*ibid.*). Therefore, it is necessary to bring together all stakeholders and agree on a wide range of steps including information dissemination, education, legislative change, economic instruments, target setting, and accountability to achieve a desired transition towards sustainable construction (UK Government Sustainable Development, n.d.).

The European Commission has proposed two approaches to achieving the objectives of sustainable construction. The first approach seeks to develop a more competitive construction industry, and the second approach aims to establish a number of environmentally focused strategies for the sector (The European Commission, 2001). These strategies would require the development of policies and performance indicators, and improved co-operation and exchange of information within the construction sector. The suggested policy instruments may focus, for instance, on reducing carbon dioxide emissions from buildings, minimising construction and demolition waste and preventing indoor air pollution (OECD, 2003). These efforts could be reinforced by the introduction of regulations on the quality of building materials and environmental labelling schemes. Economic instruments could also play a crucial role in promoting sustainable practices in the construction industry through fiscal measures (such as VAT, carbon taxes or landfill taxes) to encourage energy efficiency investments, or taxes on virgin materials (UK Government Sustainable Development, n.d.).

Experts in the field of sustainable construction have suggested that sustainability goals are achieved more efficiently through market orientated policies than by regulation (Chau *et al.*, 2000). However, the market will stimulate demand for sustainable buildings more effectively if consumers are provided with credible information derived from sustainability assessments. Such assessments must be produced in a format that caters for the attitudes and interests of developers and financial institutions (*ibid.*).

However, Hill (1999) argues that given the general lack of demand for sustainable building from end-users, it is hard to predict who will take the lead in pulling or pushing the construction industry towards sustainability. The construction business has been split into many specialised roles, e.g. an architect, engineer, quantity surveyor, financier, supplier, builder, inspector, broker, buyer, insurer or even tenant. As a result, those actors who have the most influence over the ultimate form of construction products have become increasingly removed from the buildings they deliver and from the experience of living in them. Instead, participants in the building process focus on their particular problems (e.g. minimising up-front costs, maximising commission, meeting deadlines) (Barker and Kaatz, 2001). Occupants often lack the knowledge and tools to assess important characteristics of modern buildings such as healthy interiors and low service rates. Since consumers do not know what to ask for, they do not get it.

The construction industry is slowly coming to terms with the fact that it is charting an unsustainable course. At some stage the industry will be held accountable for its environmental liabilities, so it is in its interest to be proactive in reforming its approach to sustainability and to take control of the process of moving onto a sustainable path. The development and use of appropriate building assessment methods is one way of reforming building activities (Barker and Kaatz, 2001).

2.3 BUILDING ASSESSMENT METHODS

Building environmental assessment methods emerged in the early 1990s as a means to evaluate building performance across a broad range of environmental considerations (Hill *et al.*, 2002). They have been developed as a result of an increased general environmental awareness and in response to a growing concern among construction practitioners about the adverse environmental impacts of the industry's activities, services and products. However, as the field of building assessment evolves towards a fuller integration of the premises of sustainable development, building assessment methods also begin to provide a means of evaluating building performance and the building process with respect to social and economic considerations.

The following sections provide a brief discussion of key aspects of building assessment methods and their potential application areas. Distinction is made between *green* and *sustainable* approaches to building assessment by explaining the underlying conceptual and methodological differences between green (environmental) and sustainable building assessment methods (or building sustainability assessment methods). Selected examples of established building assessment methods are also presented.

2.3.1 Key Roles of Building Assessment Methods

Increasing market competitiveness and the emergence of the sustainable development agenda have stimulated building developers and designers to produce buildings with higher levels of environmental performance. This means that buildings are expected to achieve high performance levels in the areas of resource consumption (i.e. land, water, materials or fossil fuels), liquid and solid waste generation as well as indoor environmental quality, with minimal negative environmental impacts exerted during each stage of a building life cycle.

By promoting environmental efficiency and enhancing market competitiveness using green labelling, building environmental assessment methods provide a platform for developers and building owners to demonstrate their efforts in striving for high environmental performance (Cole, 2000). They also act as support-systems for building design and delivery by identifying the required levels of environmental performance and providing a common and verifiable set of performance targets and criteria. Building environmental assessment methods are also valuable in that they highlight priority issues and suggest possible trade-offs between options early in the design stage (Cole, 1999).

The increasing application of building environmental assessment methods has provided considerable theoretical and practical experience on their potential contribution towards enhancing environmentally responsible building practices. Cole (1999) observes that their most significant contribution has been to clearly acknowledge and institutionalise the importance of assessing buildings across a broad range of considerations. According to Cole (*ibid.*), building environmental assessment methods objectively assess the environmental impacts of buildings by evaluating the energy flows between built and natural systems, and they provide a common yardstick to measure progress towards sustainability in the construction sector.

More recent developments in the design of building assessment methods have been marked by the inclusion of socio-economic considerations into assessment frameworks (e.g. SBAT and SPeAR). Moreover, new methodological approaches to building assessment have increased the potential of building assessment methods to play an effective role in directing the construction sector onto a sustainable path of development.

2.3.2 Green versus Sustainable Building Assessment

Morse *et al.* (2001) propose two alternative perspectives of implementing sustainability in construction. The first perspective involves evaluating the sustainability of building practices relative to one another, and measuring progress towards sustainability through the implementation of good practice (*ibid.*). This concept is embraced by *green* (environmental) building assessment methods, which acknowledge good practice and in this way provide information about the progress achieved towards enhancing sustainability of new building developments (and new refurbishments) (Barker and Kaatz, 2001). However, it seems to be an overly simplistic approach to achieving sustainable construction if green building assessment methods are used as the only measure.

The second perspective outlined by Morse *et al.* (2001) assesses the progress in implementing sustainability in terms of meeting specific goals and pre-set targets. It requires a clear definition of the desired environmental state of a system (e.g. a construction industry or a building system) and an effective way of monitoring the ability of that system to deliver expected output (e.g. products and services) over time (*ibid.*). More importantly, this perspective tends to identify linkages between the built environment and the natural, social and economic systems. This way of thinking has prompted the development of *sustainable* building assessment methods. However, this perspective presents some difficulties in defining a building system, its boundaries and scale as well as in monitoring progress towards sustainability (*ibid.*). This is apparent in the attempts to operationalise sustainability assessment for buildings (Cole, 1999). Cole (*ibid.*) argues that sustainability, due to its complex nature, cannot be measured at a building scale at all. However, this problem could be partially resolved by designing a building assessment method that promotes sustainability within a building development aiming at the delivery of a structure well-suited to its context. This would require giving due consideration to the process, product and service dimensions in building assessment.

Apart from the fact that green building assessment methods evaluate building performance with respect to a broad range of environmental considerations organized into assessment criteria, these methods are also based on relative assessment. This means that they measure improvements in environmental building performance in relation to typical practice or requirements. An underlying assumption in implementing green building assessment is that a cumulative positive environmental impact of continually improving the environmental performance of individual buildings will be sufficient to fully address environmental problems (Cole, 1999). However, it has yet to be proven whether taking incremental improvement in construction practice is a sufficient response to the challenges identified in the sustainability agenda for the construction industry.

Cole (1999) argues that sustainable building assessment methods, which by definition incorporate socio-economic factors alongside the environmental, should be conceptually based on an absolute assessment and measure the absolute amount of energy and mass flows associated with buildings. If that could be achieved, then the performance of buildings in different environments, regions and countries around the world would be compared using a common yardstick of sustainability targets (*ibid.*). This means that sustainability assessments should be based on the knowledge of absolute building environmental impacts (both positive and negative). Moreover, in order to ensure that building developments remain within the assimilative capacity of affected ecosystems at the local, regional and global scales, the complex links between building activities and the environment must be quantified (*ibid.*).

Furthermore, green building assessment methods tend to focus on a product (i.e. a building) in terms of its performance standards and physical structure by assessing building performance parameters (such as water consumption or thermal comfort) and technologies applied (e.g. the type of a ventilation system). However, a sustainable approach to building assessment places greater emphasis on the processes and transformations that occur within a building system (R.J. Cole, 2002, pers. comm., 5 April). Moreover, while green building assessment methods continue to primarily mitigate building environmental impacts, sustainability assessment seeks for the opportunities for adaptation and restoration (for instance through a climate-responsive design). In addition, green building assessment methods aim to reduce building costs, whereas building sustainability assessments methods help to add value to the produced structures, for instance through increased user satisfaction (*ibid.*).

2.3.2.1 Setting Goals and Targets

For Levin (1996), the assessment of improvements over current practice is not an effective contribution towards sustainability in any situation. He argues that the only meaningful evaluation of sustainability is that of measuring distance to pre-set targets. Hence, sustainability assessment is based on a number of goals which direct the necessary actions towards desired results. Goals are used for the purposes of defining desired end-points (outcomes) without assigning numerical values. Targets, which are often quantifiable measures, are employed to provide a more detailed information about what needs to be achieved and when (*ibid.*).

In sustainability assessment targets are established for individual assessments and they account for levels of resource consumption, pollution, land encroachment and other socio-economic goals. In the context of an individual building assessment, sustainability targets define a framework for solutions and do not constitute any measurement themselves (Hedehus, 2002). Therefore, several very different measures could be devised to achieve a particular target. According to Persson (2002), sustainability targets represent detailed and measurable units of sustainability objectives at the level of a building system and the system's single components. These objectives need to be established during building assessment according to the interests of all stakeholders as well as specific project conditions related to its purpose and siting. This allows for the optimisation of the overall efficiency of building performance and the project's sustainability. The challenge lies however in defining sustainability targets at a building scale with reference to the wider global context

(Cole, 1999) and in defining targets for qualitative aspects of building developments (e.g. socio-cultural considerations).

The measurement of distance to targets used in sustainability assessment to illustrate the progress achieved towards desired end-points requires deriving appropriate indicators for each target. The choice of indicators is one of the most critical aspects of building sustainability assessment.

2.3.2.2 Sustainability Indicators

Indicators are widely used to raise awareness and understanding, inform decision-making and to measure progress towards established goals and targets (Veleva *et al.*, 2001). They are defined as measurable attributes, which represent complex and variable phenomena (Eigenraam *et al.*, 2000). Indicators are distinct from statistics and primary data in that they represent more than the data upon which they are based (von Schirnding, 2002). They are used as pointers that reveal conditions and trends in a particular development process. Thus, they help to follow a change of phenomena in time, or in relation to stated objects (Häkkinen, 2001).

A key challenge in the context of sustainability assessment is the need to integrate quantitative and qualitative data. Objective (quantitative) indicators are more easily verified by others and expressed numerically. As they are more easily communicated and validated, they tend to be preferred in any assessment situation. Subjective indicators are sensed only within the individual by means that may not be easily explained and in units that are probably not numerical (Meadows, 1998). These indicators are used primarily to measure quality, which is at the centre of sustainable development philosophy.

Arguably, all indicators are value-laden (Meadows, 1998). The very choice of an indicator is based upon some value, according to which a decision is made about what is important to measure. The choice of what is important is inherently subjective (*ibid.*).

Traditionally, indicators have been used to measure conditions that exist, describing the state of environment or specific ecosystems. More frequently, they help to measure activities that are causing the state to exist (i.e. the pressure) and effects of certain actions or phenomena (i.e. the response) (Hart, 1997). The Balaton Group distinguishes between three types of indicators (Meadows, 1998):

- Warning signs to signal obstacles or dangers ahead;
- Indicators of health, comfort and safety; and

- Measures of direction and distance towards the desired end-points.

It is important to include and integrate all of these three types of indicators while measuring the progress towards sustainability.

The Balaton Group highlights the usefulness of system dynamics, which helps develop an understanding of the unfolding behaviour of whole systems over time, in developing and selecting indicators for sustainability assessment (Meadows, 1998). This requires distinguishing between *stock* and *flow* indicators. Stocks are indicators of the state of a system and its response time. The size and lifetimes of stocks provide useful indicators of response rates, for instance how long it will take a system to correct a problem, adjust to a change, or take advantage of a new opportunity (*ibid.*). Flows may be leading indicators of change and represent the inputs or outputs measured per time unit that increase or decrease stocks. Advance warning comes from the balance of flows affecting a stock (*ibid.*).

The *stock-flow* approach is related to the commonly used *pressure-state* framework of indicators (OECD, 2003; Meadows, 1998; Hart, 1997; Azar *et al.*, 1996). Simmonet (1998) provides a more comprehensive categorisation of indicators:

- *Driving force* indicators describe human development and changing lifestyles, levels of consumption and production patterns;
- *Pressure* indicators describe developments in terms of emissions, use of natural resources and land;
- *State* indicators describe physical, biological and chemical phenomena in qualitative and quantitative terms;
- *Impact* indicators describe impacts caused by the changed state of environment, for instance impacts on biodiversity or availability of resources; and
- *Response* indicators describe mitigation measures undertaken to prevent, compensate or adapt to changes in the environment.

The application of system dynamics to develop indicators for sustainability assessment suggests that sustainability indicators differ from common environmental indicators. They require introducing the dimensions of time and/or thresholds (i.e. limit or target) (Jasch, 2000; Durban Metro, 1999; Gilbert, 1996). The Balaton Group emphasises the fact that where sustainability indicators are not expressed in units of time, they should be related to the carrying capacity, or to the threshold of irreversible change (Meadows, 1998). Furthermore, the Group points out that the development indicators should be more than growth indicators, as they should address the issues of efficiency, sufficiency, equity and quality of life (*ibid.*).

The process of selecting and defining indicators provides an explicit expression of the participants' values. It is a subjective process often based on value-judgements, which requires some sort of negotiation. It can be validated, however, through a participatory approach, which allows for multiple interpretations and examination of the purposes that guide the selection process (Meadows, 1998).

2.3.3 Overview of Established Building Assessment Methods

Existing building assessment methods vary in scope, structure, format and complexity. All provide the means to evaluate buildings across a broad range of environmental considerations (Hill *et al.*, 2002). However, recently developed *sustainable* building assessment methods also address socio-economic building issues and evaluate building performance based on a distance from pre-set targets.

Buildings assessment methods are perceived as potent instruments of communicating product information to potential clients and relevant decision-makers. They also provide the means for highlighting priority issues and identifying desired levels of building performance – crucial information for any design team. In addition, if applied to existing buildings, assessment methods guide facility managers in setting targets for improved building performance. Building assessment methods also help eliminate and/or manage risks (i.e. potential environmental, financial or legal liabilities) (Carlson and Lundgren, 2002). This is achieved by setting appropriate assessment benchmarks and/or by indicating building performance deficiencies. Most importantly, building assessment methods help inform all stakeholders (e.g. building owners and managers, architects, builders, designers, landscape architects and community planners) in construction about the benefits of environmentally conscious choices. Therefore, they are important agents of change and provide significant educational and empowering opportunities to their users. They aim at changing personal attitudes and practices that might prevent society from pursuing sustainable paths of development.

Graham (1998) argues that the major role of buildings assessment methods is to help decision-makers to implement sustainability in the built environment and during construction. Yet their ability and effectiveness of performing this role has often been questioned based on the assumptions and approaches currently used in the development of building assessment systems (Cole, 1999; Levin, 1996).

Sections 2.3.3.1 to 2.3.3.5 provide a brief discussion of a number of established *green* and *sustainable* building assessment methods.

2.3.3.1 *Building Research Establishment Environmental Assessment Method (BREEAM)*

In the early 1990s, the Building Research Establishment (BRE) developed the first green building assessment methods, namely, the Building Research Establishment Environmental Assessment Method (BREEAM). Different versions of BREEAM cater for various building types, including industrial buildings, office buildings, schools and shopping centres.

Early versions of the BREEAM assessment framework (e.g. BREEAM'93) addressed the environmental impacts of buildings in terms of scale; differentiating between global, local and indoor environments. The latest versions, i.e. BREEAM'98 for offices and EcoHomes, introduced new classification of building environmental impacts and a weighting system. The environmental issues are grouped under the following classifications (BRE, 2004):

- Management (overall policy and procedural issues);
- Health and Comfort (indoor and external issues);
- Energy (operational energy and CO_2 issues);
- Transport (transport related CO_2 and location issues);
- Water (consumption and leakage related issues);
- Materials (environmental implications of materials selection);
- Land Use (greenfield and brownfield site issues);
- Site Ecology (ecological value of the site); and
- Pollution (air and water pollution excluding CO_2).

The weighting system is an outcome of research carried out by the Centre for Sustainable Construction at the BRE between 1997 and 1998. The environmental weights reflect a consensus reached by a range of interest groups including government policy-makers, construction professionals, local authorities, material producers and academics in the process of assigning importance to different sustainability issues included in the assessment framework (Rao *et al.*, 2000).

It is intended that the following objectives will be achieved through the use of the BREEAM assessment (Baldwin *et al.*, 1998):

- Distinguishing buildings of reduced environmental impact in the market place;
- Encouraging best environmental practice in building design, operation, management and maintenance;
- Setting targets beyond standards required by laws and regulations; and

- Raising the awareness of building owners, occupants, designers and operators about the impacts of building developments on the environment.

An important feature of BREEAM is that it enables assessment of environmental issues within three broad areas: design and procurement issues, core building issues (i.e. potential environmental impacts during a building's operation), and management and operation issues (Baldwin *et al.*, 1998). In this way, BREEAM provides the means of guiding the planning and design activities and assessing building practices throughout a building's life cycle. A positive quality of BREEAM is that it caters for existing and new buildings, allowing for the retrofit of environmental technologies in old buildings and intelligent design of new structures (Barker and Kaatz, 2001).

BREEAM uses the often quoted and valid argument that improved environmental performance makes good business sense. Hence, it is designed as an eco-labelling system, which can be used for marketing purposes. Building assessment ends with a rating of building environmental performance, which may be rewarded as *Excellent*, *Very Good*, *Good* and *Fair* (BRE, 2004).

Although countries outside of the United Kingdom have adopted BREEAM (e.g. Hong Kong and Canada), it was not originally designed to be that flexible. Many countries use BREEAM as a reference document, reflecting the fact that the system was not designed to accommodate national or regional variations (Larsson, 1998).

2.3.3.2 Leadership in Energy and Environmental Design (LEED)

The Leadership in Energy and Environmental Design (LEED) was launched by the US Green Building Council (USGBC) in an effort to supply an environmental labelling system that would define and rate green buildings (USGBC, 2002). LEED is a green rating system, which is voluntary, consensus-based and market-driven. The following LEED standards are available or still under development (USGBC, 2003):

- New construction and major renovation projects (LEED-NC);
- Existing building operations (LEED-EB, Pilot version);
- Commercial interiors projects (LEED-CI, Pilot version);
- Core and shell projects (LEED-CS, Pilot version); and
- Homes (LEED-H).

Unlike other assessment methods, LEED is a self-assessment system for new and existing commercial, institutional and high-rise residential buildings. It uses a simplified checklist format that facilitates its use in the design process and is supported by a reference guide suggesting strategies for achieving each criterion. The assessment undergoes third-party certification and assessed buildings are rated according to their degree of compliance with the credit system (USBGC, 2002).

LEED provides a set of prerequisites that are required to be met in the following assessment areas (USGBC, 2003):

- Sustainable Sites;
- Water Efficiency;
- Energy and Atmosphere;
- Materials and Resources;
- Indoor Environmental Quality; and
- Innovation and Design Process.

Depending on the total amount of credits, the building obtains a rating level of *LEED Certified*, *Silver*, *Gold* or *Platinum* (Crawley and Aho, 1999).

The main development objectives of LEED are to assist the project and design team in green design by establishing a common standard of measurement and to stimulate green competition (USGBC, 2003). LEED may be successfully applied as a method for product marketing, design guidelines and environmental auditing of existing buildings (Crawley and Aho, 1999). As with BREEAM, LEED links its criteria to existing performance standards established by other bodies such as the Environmental Protection Agency. Since LEED has been developed to address the specific needs of the construction industry in the United States, it lacks the adaptive capacity necessary for its successful application in other countries, and particularly in the developing world.

2.3.3.3 Green Building Tool (GBTool)

The Green Building Challenge (GBC'98) was launched in an effort to bring together experts in sustainable building to collate existing building assessment methods and develop a system that could be used worldwide to test the environmental performance of buildings. GBC'98 was a two-year process of international cooperation that eventually led to the generation of the Green Building Tool (GBTool) (Cole and Larsson, 1999). GBTool was developed as a *second-generation* assessment method, building on the limitations of existing methods and confronting those areas of building performance that were previously either ignored or poorly defined (Cole, 1999).

GBTool has emerged as an environmental assessment framework applicable to different types of buildings, such as commercial, multi-residential and schools (Todd *et al.*, 2001). The method has the ability to handle a broad range of applications, both in terms of building type and scale, and can be utilised as a performance assessment method or a design guideline method (Barker and Kaatz, 2001).

The assessment framework of GBTool is hierarchically structured using a nesting approach. The higher levels of assessment are logically derived from the weighted aggregation of the lower levels (Cole and Larsson, 2002). The assessment framework of GBTool encompasses performance issues, categories, criteria and sub-criteria. Building performance is assessed in terms of seven performance issues, namely (*ibid.*):

- Resource Consumption;
- Loadings;
- Indoor Environmental Quality;
- Quality of Service;
- Economics;
- Pre-Operations Management (under development); and
- Commuting Transportation (under development).

Like other methods, GBTool is designed to assess relative improvements over typical practice in building design and construction. However, it enables its users to reflect national priorities, technologies, building traditions and cultural values that exist in different countries (Cole and Larsson, 2002). This is achieved by customising assessment benchmarks and weightings. A tailored GBTool assessment framework incorporates building standards and typical practice of a particular country or region, thus establishing benchmarks against which all other buildings are evaluated (Todd *et al.*, 2001). Hence, the customisation of benchmarks and weightings provides opportunities to make GBTool suitable and highly relevant to the South African context.

As the development of GBTool was not constrained by the need to be commercially viable, the number and scope of performance criteria included in the framework is greater than in other assessment methods (Cole, 1999). However, its developers admit that a flip side of this feature is the method's complexity and the negative implications this has on user-friendliness (Larsson, 1998). Larsson (*ibid.*) argues that the issues of comprehensiveness and complexity are not easy to solve. Although reducing the number of performance factors being assessed would simplify the assessment process, it could result in a too simplistic and superficial evaluation of building performance.

Experience shows that many South African buildings lack the environmental information required to complete the assessment. Although GBTool allows for different levels of assessment detail depending on the amount and quality of available information, its application is neither practical nor cost-effective (Barker and Kaatz, 2001).

2.3.3.4 Sustainable Project Appraisal Routine (SPeAR)

Arup Environmental developed the Sustainable Project Appraisal Routine (SPeAR) to assess the sustainability of different products and processes. SPeAR provides an appraisal methodology to review the sustainability of projects, products and organisations. The method allows for a graphical illustration of sustainability of a particular project while demonstrating a continual improvement and evolution of the project over time.

The graphical representation of the method is in the form of a rose diagram. It combines social, economic, natural resources and environmental issues, and visually represents performance in terms of all these categories. The category of natural resources is separated from the environmental issues in order to emphasise its importance. In addition, the diagram indicates both positive and negative building-related impacts (Arup, 2000). The assessment quadrants encompass the following issues (*ibid.*):

- *Environment*: Air Quality, Land Use, Water, Ecology and Cultural Heritage, Design and Operation, and Transport.
- *Natural Resources*: Materials, Water, Energy, Land Utilisation and Waste Hierarchy.
- *Societal*: Form and Space, User Comfort and Satisfaction, Health and Safety, Access, Amenity and Inclusion.
- *Economic*: Social Benefits and Costs, Transport, Employment and Skills, Competition Effects, and Viability.

The assessment process is based on extensive consultations with the client to provide him/her with the sense of ownership over the project. This results in a deeper commitment and effectiveness in implementing measures to attain the project's sustainability targets (A. Campbell, 2002, pers. comm., 26 August 2002). The assessment and design teams derive actual targets with the client and set quality levels. The SPeAR method is then employed to produce mini-diagrams at each stage of the project to ensure that the targets are achieved.

Consequently, SPeAR is primarily used as a tool to communicate assessment results. It aids communication with the client and the design and project teams. The assessment itself becomes a process of discovering hidden values within the project. More importantly, the method aims to increase the overall quality of the project by identifying opportunities for a positive change (Arup, 2000).

Moreover, SPeAR enables to chart the implications of alternative design choices. It is self-referential and hence the objects or initiatives that are appraised using this method are not meant to be compared. Consequently, SPeAR offers a more qualitative assessment.

SPeAR has not been developed as a building assessment method *per se* and thus is very general in nature. However, it can be easily tailored for the purposes of building assessment through the selection of appropriate assessment indicators. SPeAR was developed in accordance with the UK government's sustainable development agenda, and is therefore not readily applicable in a South African context. However, it offers an innovative approach to sustainability assessment, elements of which should be incorporated in any new model for building sustainability assessment in South Africa.

2.3.3.5 Sustainable Building Assessment Tool (SBAT)

The Sustainable Building Assessment Tool (SBAT) was designed by the Sustainable Building Group of the CSIR (Council for Scientific and Industrial Research) in South Africa in 1999. SBAT considers environmental, social and economic dimensions of sustainability and applies an alternative approach to building assessment based on target-setting. This method was specifically developed for a developing world context. Therefore, it includes unique aspects of buildings projects, such as impacts on the local economy, affordability as well as the participation of, and control by, the local community (CSIR, 2001).

SBAT can be used to assess the design of new buildings, or in the refurbishment of existing buildings. In addition, SBAT is a generic method that can be applied on a variety of buildings, and has been designed for easy use (CSIR, 2001). The assessment framework comprises social, economic and environmental components, each including 5 performance criteria (*ibid.*):

- *Environmental*: Water, Energy, Recycling and Reuse, Site and Landscaping, and Materials and Components.
- *Social*: Occupant Comfort, Inclusive Environments, Access to Facilities, Participation and Control, and Education, Health and Safety.
- *Economic*: Local Economy, Efficiency of Use, Adaptability and Flexibility, Ongoing Costs and Capital Costs.

During the assessment, certain scores are assigned to each performance criterion. All of these criteria are discussed with regard to context and user requirement. By involving interested and affected parties in the development of sustainability performance targets that form the basis of SBAT, the method caters for specific regional conditions and cultural values. Therefore, it is difficult to compare the performance of similar buildings because benchmarks and sustainability targets are different in each assessment and performance measurements are not standardised. However, each building is rated in terms of its sustainability, which aids the comparison of buildings to each other and to benchmarks (CSIR, 2001). The assessment results are presented in a graphical form using a rose diagram.

SBAT can be used in a number of ways depending on the level of detail required in the assessment. It can be used as a design-support tool by providing a checklist of the main 'rules of thumb' and assessment criteria, which assist in the design for sustainability. It can also be used to make a rapid and rough assessment of building performance, which provides the framework for a more detailed analysis if required (Gibberd, 2003). SBAT can also support project decision-making by assisting in briefing the design team.

Whilst SBAT operates primarily as a problem-identification tool (CSIR, 2001), it is unable to provide a thorough assessment of building sustainability issues. As the method is based on a framework consisting of a fixed list of assessment criteria, SBAT may not be sensitive enough to particular assessment contexts and needs (e.g. in the assessment of urban vs. rural building developments). Although sustainability assessment by definition focuses on a limited number of issues that are identified as most significant in a particular context, only a limited number of environmental considerations are highlighted by SBAT compared to green building assessment methods.

2.3.4 Emerging Trends in the Development of Building Assessment Methods

It is evident that the methodology and approaches used in building assessment have evolved, and in doing so, undergone considerable change. The so-called *second generation* assessment methods, e.g. GBTool, recognise the need to offer different levels of building assessment and cater for regional differences in environmental priorities, construction traditions and available technology. Necessary modifications include the opportunities to set region-specific benchmarks and adjust the weightings of different environmental criteria. Additionally, the emphasis is now placed on the ability of building assessment methods to inform the design process in a more effective manner.

Further developments in the field of building assessment result from a quest to address more strategic aspects of sustainability. Sustainable construction requires more than applying green methods and technologies. It challenges the very basis of decision-making, which occurs during the building process, so that decisions are guided by sustainability targets that are context-specific and link global and local assessment issues.

SPeAR and SBAT have extended the scope of building assessment beyond environmental issues to also cover social and economic dimensions of sustainable development. They focus primarily on understanding the specific context of building assessment and setting targets for each issue in order to make the overall building development more sustainable. In addition, these methods offer a more participatory approach to building assessment by involving design teams and the client in setting assessment targets. In so doing, and by addressing a number of relevant social issues, the methods are more culturally sensitive.

Building assessment methods are not intended as *stand-alone* instruments for providing answers to questions of how to address sustainability issues in the construction industry. However, they will continue to play a significant role in providing market incentives for high environmental building performance, stimulating innovative building design, and suggesting sustainability targets for building designers, owners and users to strive towards (Barker and Kaatz, 2001). Above all, they are expected to bring the needs of clients and end-users to the fore, encouraging the industry to change its practices towards more adaptable and to shift towards demand-driven management.

2.4 IMPLEMENTING SUSTAINABILITY IN THE SOUTH AFRICAN CONSTRUCTION INDUSTRY

South Africa is a country of widening economic disparities, which remains the single greatest challenge in agreeing upon and achieving sustainable paths of development. Economic inequality is also reflected in the nature of construction projects that are being undertaken in South Africa. These range from provision of low-cost housing for which demand is still rising, often based on minimum acceptable standards, to multimillion developments such as the Cape Town International Convention Centre (CTICC) that are expected to showcase developed world standards of best construction practice. Moreover, it may often seem that environmental considerations compete with socio-economic objectives in the hierarchy of priorities that drive the South African construction industry. Thus, excellence in environmental performance of construction projects might not be perceived as an important competitive advantage (Shakantu *et al.*, 2002).

As a country aspiring to a higher level of economic development, South Africa is expected to improve the quality of human life for both present and future generations, without depleting natural capital and preserving sustainability conditions (RSA: GCIS, 2001). At the same time, the country is faced with many problems experienced by developing world, in which rapid industrialisation, population growth and urbanisation pose major threats to the quality of the environment.

It is widely acknowledged that the construction industry has a responsibility to help direct the development of South Africa onto a sustainable path due to its significant contribution to national socio-economic development and potentially significant environmental impacts (van Wyk, 2003). For example, the South African construction industry delivered output that constituted almost 30% of total investment in the country in 2002 (*ibid.*).

However, the construction sector in South Africa is also faced with numerous internal challenges. A review of the construction industry undertaken by the CSIR between 1999 and 2003 reveals that the sector employs the fourth largest number of people with no formal education and has the fourth smallest percentage of employees with higher education qualifications (van Wyk, 2003). van Wyk (*ibid.*) reports that this situation is coupled with poor management and low levels of management expertise. The review also indicates serious concerns related to the high rate of enterprise failure and the potential consequences of this on the industry's ability to deliver construction projects. Furthermore, according to the findings of a recent international productivity survey (referred to in the review) South African businesses used only 59% of their time productively due to poor planning and inadequate management (*ibid.*).

Many building developments in South Africa do not take proper account of their effects on the natural, social, economic and cultural environment (Barker and Kaatz, 2001). Lowest price tender practices often compromise environmental standards (e.g. opting for air-conditioning units rather than climate-conscious design and construction) in the quest for short-term financial gains, at the expense of more sustainable building design options. In a situation where life cycle costs of buildings are not generally considered, design costs are seen as a burden on capital budgets (Talbot, 2003).

In South Africa, the economic performance of construction developments was traditionally viewed in terms of the initial cost of a development and its return over a fixed period. More often, emphasis is placed on economic opportunities, such as the potential for SME development, minimising life cycle costs, reducing material consumption rates, minimising energy consumption and waste generation together with the disposal costs, factoring in transportation costs and impacts, and measuring efficiency (van Wyk, 2004). Arguably, the attainment of sustainability in construction will not only contribute significantly to the alleviation of poverty, but also to the conservation and management of ecosystems and biodiversity, and the enhancement of the international competitiveness of the South African economy.

2.4.1 Creating an Enabling Environment for Sustainable Construction in South Africa

The commitment of South Africa to achieve sustainable development is not merely a reflection of a worldwide trend, since it is deeply rooted in the country's legislation. The 1996 Constitution (Section 24 of the Bill of Rights) guarantees citizens a right to ecologically sustainable development and the use of natural resources that also promotes socio-economic development (RSA, 1996). Moreover, the natural environment is to be protected and conserved for the present and future generation. A minimum standard requirement set in the constitution provides a right to the environment that is not harmful to human health and wellbeing (*ibid.*).

In addition, the attainment of sustainable development is an explicit goal of the National Environmental Management Act (RSA, 1998). This and other contemporary legislation and policies of the South African government explicitly incorporate the philosophy of sustainable development. For instance, the *Housing Act No. 107* of 1997 (RSA, 1997a) and the *National Housing Code* (RSA: Department of Housing, 2000) state that the delivery of housing should uphold and implement the principles of sustainable development.

The South African government has developed key programmes that set out its position on the socio-economic development of the country in the Reconstruction and Development Programme (RDP) (RSA, 1994) and the Growth, Employment and Redistribution Strategy (GEAR) (RSA: Department of Finance, 1996). These documents attempt to address key developmental priorities in South Africa and support further socio-economic transformation of the country (Gibberd, 2003; van Wyk, 2003).

The RDP focuses on creating a sustainable and environmentally-friendly growth and development path while ensuring representation and participation. It states that people-driven development "*is not about the delivery of goods to a passive citizenry*", but is about "*the involvement and growing empowerment*" (RSA, 1994:8). The programme calls for stakeholder participation in key decisions, for instance regarding where projects should be executed and how they should be managed.

GEAR is a macro-economic strategy for the country developed by the South African Department of Finance that builds on the principles of RDP (van Wyk, 2003). The strategy aims to transform the South African economy in order to promote sustainable employment and equal access to opportunities for all South Africans, and to create secure and productive living and working conditions (RSA: Department of Finance, 1996). It is evident that the construction industry is expected to play a significant role in delivering the government's objectives.

Attaining sustainability is a key objective in the future development of the construction sector in South Africa (van Wyk, 2004). The challenge lies in the provision of adequate management instruments that will facilitate empowerment and capacity-building among building stakeholders and that will help to address the environmental, social and economic consequences of construction initiatives in an integrated manner.

2.4.2 South African Building Assessment Methods

As building assessment methods reconcile legislative and market-driven approaches (i.e. by reference to standards and eco-labelling) in promoting sustainable construction practices, they may prove to be effective agents of change in the South African construction sector. However, the key to success lies in the appropriate design of building assessment frameworks based on an explicit set of objectives that these methods should serve.

South Africa has attempted to adapt the established building environmental assessment methods to the local context. In 1997, the CSIR produced the Building Environmental Assessment and Rating System (BEARS), which was adapted from BREEAM (Grobler *et al.*, 1997). BEARS was the first building assessment method to be used in the CSIR's *Green Buildings for Africa* project aimed at supporting and promoting environmentally responsible use of facilities by property owners, managers and tenants. The method was criticised for its inflexibility in addressing the environmental challenges specific to the South African built environment (e.g. water scarcity), as no effort was made to modify the BREEAM assessment framework. Consequently, BEARS addressed issues pertinent to the UK's construction context and failed to make a significant positive impact in South Africa. BEARS was an example of a doomed practice of adopting definitions and remedies of sustainability in the form of strategies and assessment methods from the developed world, which often takes place in developing countries (du Plessis, 2001).

BEARS was proposed as a *one-fits-all* approach to building assessment, where *de facto* an international assessment method was applied to different buildings in different localities (Hill *et al.*, 2002). The failure of BEARS also revealed that a green building assessment method offers a fragmented approach to development that ignores other crucial dimensions of sustainability. Incremental improvements in environmental performance of individual buildings are insufficient to drive the construction industry onto a sustainable path of development. Sustainability cannot be measured only in terms of energy and matter flows within the built environment without due consideration of the socio-economics, cultural and political components of the South African context.

The CSIR responded to this concern by developing the Sustainable Building Assessment Tool (SBAT) specifically for the South African context (Gibberd, 2002). SBAT attempts to introduce sustainable development considerations into the building and construction process. It offers a novel approach to the assessment of building sustainability, where social and economic aspects are equally important as building environmental performance. Arguably, whilst striving for simplicity, SBAT makes compromises in terms of the comprehensiveness of environmental issues covered in the assessment.

The development of SBAT was primarily driven by the need for the assessment of building performance in terms of sustainability. However, Gibberd (2002) argues that a building assessment method should be also capable of assessing the contribution of buildings in supporting and developing more sustainable social, economic and environmental systems in their localities. A building assessment method that addresses the unique sustainability challenges and needs of the South African built environment and construction industry should provide a comprehensive and flexible assessment of building products and processes, easily adjusted to different assessment situations (i.e. different urban or rural settings and different building types).

In addition, building assessment should explicitly aim to change building stakeholders' personal attitudes as well as construction practices (i.e. building design and production) that might prevent the South African construction sector from pursuing sustainability. Therefore, it is desirable to maximise the significant educational and empowering opportunities offered by building assessment in order to change current behaviours and building culture. This can be achieved by ensuring direct stakeholder involvement in the building assessment process, which empowers the participants through hands-on experience.

2.5 ENHANCING BUILDING ASSESSMENT PRACTICE IN SOUTH AFRICA

Implementation of sustainable development at global, regional and local levels involves innovation, changes in behaviour patterns, stakeholder perception, procedures, and technologies (Devine-Wright *et al.*, 2001). Building assessment methods have an important role to play in integrating the premises of sustainability into construction practices. However, this will only be possible when building assessment methods effectively influence the decision-making processes at every level and stage of a building process (i.e. planning, design, construction, operation and decommissioning).

It is apparent that the established building assessment methods focus primarily on the aspects of *green* or *sustainable* building (i.e. building as an end-product), but that contributions towards a sustainable product delivery (i.e. a building process) are rarely explored and achieved. An effective implementation of the sustainable construction agenda requires that the principles of sustainable development are reflected in a building process. By addressing the issues of equity and participation through stakeholder-orientated sustainability assessment, building assessment methods could significantly enhance the overall sustainability of project delivery in the construction sector.

Although the present trend in research in sustainable construction focuses largely on achieving better environmental performance of buildings through technical innovation and improved efficiencies of building materials and components (Uher, 1999), the key challenge facing the construction industry lies in the ability to operationalise the principles of sustainable development (e.g. the inter- and intragenerational equity and the carrying capacity of the natural environment). Building assessment methods can assist in this if more emphasis is placed on the development of a value-adding process of building assessment.

When describing the concept of sustainable development in 1987, the Brundtland Commission emphasised the need to develop new approaches to assess progress towards sustainability. In 1996, an international group of measurement practitioners and researchers produced a set of principles ("*The Bellagio Principles for Sustainable Assessment*") intended to guide the process of developing sustainability (sustainable) assessment methods irrespective of their nature (i.e. application purposes) (Hardi and Zdan, 1997). These principles provide valuable terms of reference for the development of a specification for the building sustainability assessment model suited to the South African built environment, specifically with respect to the challenge of operationalising sustainability within the assessment process.

2.5.1 Adopting the Bellagio Principles in Building Assessment Methodology

The Bellagio principles have a universal character and can be applied to any sustainability assessment situation. They serve as practical guidelines for the whole of the assessment process. The principles address four aspects of assessing progress towards sustainable development (Hardi and Zdan, 1997):

- The starting point of any assessment (i.e. a guiding vision and goals);
- Assessment content (i.e. holistic perspective, essential elements, adequate scope and practical focus);
- Key issues of the assessment process (i.e. openness, effective communication and broad participation); and
- The need to establish a continuing capacity for assessment (i.e. ongoing assessment and institutional capacity).

Since sustainability is achieved through an ongoing process of improvement, identifying a vision (i.e. direction of a desirable change) and developing realistic goals are imperative for sustainability assessment. According to the Bellagio principles, the assessment of progress toward sustainable development should be guided by a clear vision, which is articulated through a set of goals and reflects the values of a particular community or region. In the building assessment context, the vision needs to be established by building stakeholders involved in the assessment process and be aligned with the agenda of sustainable construction.

The assessment of sustainable development requires the adoption of a holistic perspective. The object of sustainability assessment is perceived as a system that adequately responds to and co-evolves with changing environments (Hardi and Zdan, 1997). Building assessment should therefore acknowledge the diversity of interconnected environmental, social, economic and technical factors, which shape the context of building developments. The emphasis of the assessment should be placed on seeking opportunities to improve the condition of social, ecological, and economic systems affected by any proposed construction project. It is also important that building assessment considers both positive and negative consequences of human activity in a way that reflects the costs and benefits for human and ecological systems, in monetary and non-monetary terms (*ibid.*).

Moreover, the assessment of sustainability needs to recognise the cause-effect linkages between the built environment and the social and ecological systems (Hardi and Zdan, 1997). Most building assessment methods focus almost exclusively on the environmental dimension of sustainability. Possibly the main reason for this is the difficulty of tackling socio-economic dimensions of sustainability, particularly at the scale of individual buildings (Graham, 1998). Yet social equity, cultural considerations and economic factors are of particular importance in South Africa. Sustainability assessment should play a significant role in enhancing human and social wellbeing, for example by ensuring that the benefits of economic development in construction sector are equitably distributed. The opportunities for human upliftment and the empowerment of building stakeholders need to be rigorously identified.

In terms of its scope, building sustainability assessment should offer a comprehensive evaluation of a building project life cycle adopting a time horizon long enough to capture both human and ecosystem time scales (Hardi and Zdan, 1997). In this way, the assessment model could strive to respond to the needs of future generations, and at the same time demonstrate more immediate benefits associated with sustainable building.

Another important issue is to adopt an adequate spatial scale in building assessment incorporating a micro-urban context, which enables the users to identify crucial interactions between the built and natural environments. Although building assessments address global environmental concerns (e.g. resource efficiency), practitioners must be wary of neglecting the indirect and cumulative impacts that buildings can have at the regional or local scale.

In terms of its methodology, sustainability assessment is based on an explicit set of categories and an organizing framework that links vision and goals to indicators and assessment criteria (Hardi and Zdan, 1997). The construction industry's vision of sustainability should guide the selection of building sustainability assessment criteria and targets. As assessment would have to focus on a limited number of key sustainability issues (*ibid.*), the building sustainability assessment model should minimise the number of criteria analysed in any assessment situation without compromising its effectiveness. A scoping stage would therefore play a critical role in this regard, as it provides a means for agreeing on a limited number of indicators or indicator combinations that will form a basis for the subsequent building assessment.

Furthermore, sustainability assessment methods should permit comparison by standardising measurement wherever possible (Hardi and Zdan, 1997). The structure of the building sustainability assessment model needs to make rating and scoring scales explicit for the purposes of consistency. Building assessment should be also based on comparing indicator values to targets, reference values, ranges, thresholds, or direction of trends, as appropriate.

The development of a methodology for the building sustainability assessment model must be an open process accessible to all role players within the construction industry and other affected and interested parties. Transparency and accessibility are key features that can increase the credibility of building assessment amongst the public and within the construction industry. It is also necessary to make the methods and data used in building assessment accessible to all. Thus, methods of evaluating building performance, scoring/rating systems and weighting of criteria should be clearly stated in assessment results. In addition, all judgements, assumptions and uncertainties regarding data and their interpretations have to be clearly communicated to decision-makers. Building assessment has to optimise the processes of information exchange and knowledge transfer, as it would be of little consequence if their results do not change the way buildings are designed, constructed and used.

In addition, any building sustainability assessment method should be designed to address the needs of the audience and users. Building assessments that produce technical results in a format that is only intelligible to experts will be ineffective in practice. To make the construction process sustainable, all role players in building development need to be able to comprehend the results of building sustainability assessments and their implications. Therefore, aiming for simplicity in the structure and use of the building sustainability assessment model, the method must allow for the simple presentation of useful information without omitting important details. Results should be structured to allow users to view the overall score of complete building assessment as well as the ratings of categories and sub-categories. Furthermore, the performance of a building should be able to be assessed with reference to the different stages of its life cycle.

Any building sustainability assessment method should also be dynamic in nature in order to remain relevant. It needs to be iterative, adaptive and responsive to change and uncertainty. As it is necessary to adjust assessment goals, frameworks and indicators when new insights are gained, such a method has to be flexible and adaptable. Most importantly, it should promote the culture of collective learning and provide a feedback mechanism to enhance construction practices in South Africa.

The Bellagio principles place strong emphasis on the value of participation in sustainability assessment. A lack of well-defined objectives that reflect stakeholder values would considerably reduce any support for the assessment process (Johnson, 1999). Therefore, stakeholder participation should constitute a critical feature of any building sustainability assessment method.

Broad participation in building assessment would definitely enhance decision-making and thus secure a firm link between adopted policies and resulting actions. However, participation should go beyond placating and informing interested and affected parties, and seek to actively engage them in providing practical input. In fact, the scope of building sustainability assessment should be determined by all interested and affected parties and not only by a panel of experts. The value-based nature of sustainability underlines the importance of this assertion (Hardi and Zdan, 1997).

Participatory approaches to sustainability planning and decision-making can facilitate the evolution of stakeholder perceptions and develop shared values through dialogue-based learning (Meppem and Gill, 1998). This key premise underlies efforts to secure effective stakeholder participation in building assessments and, hence, attain sustainability in the built environment and construction sector.

2.5.2 Promoting Equity and Capacity-Building in Construction through Participatory Building Assessment

It has been mentioned that human and social dimensions of sustainable construction are especially important in developing countries. By addressing the issue of equity through stakeholder-orientated sustainability assessment, building assessment methods have the potential to significantly enhance the overall sustainability of project delivery in the construction sector. The dominant technical focus of the building project diverts attention from the actual building process taking place to the physical aspects of a building product. Yet a product view holds only a limited capacity for any performance improvement in the building process necessary to deliver products of desired quality and fitness for purpose.

Experience has shown that there is a direct link between the sustainability and success of projects and effective participation, which allows the views, perceptions, interests, values, and needs of interested and affected parties (stakeholders) to be integrated into project decision-making (World Bank, 1999; Davis-Case *et al.*, 1992). The commonly recognised benefits and contributions of participation to the implementation of sustainability in projects include the promotion of equity and fairness, distribution of power, empowerment and capacity-building, integration of stakeholder knowledge, better understanding of contextual issues, greater commitment to project goals, as well as enhanced process legitimacy through transparency and credibility of the decision-making (Paavola and Adger, 2002; Barraclough, 1990).

Participatory approaches shape public perception of the possible costs related to environmental risk and the *willingness to pay* (Toth, 2001), which often favours a responsible course of action over individual interests. Public participation also mobilises cultural values and traditional wisdom in the transition to a sustainable development path (Nishioka, 1999). Toth (2001) argues that perspectives on environmental and social problems and management strategies differ between developed and developing countries, and that it is important to identify and accommodate localised and culturally bounded perceptions and interpretations of global environmental risks and their local repercussions. This can only be achieved through participation.

There is a clear need for effective mechanisms to integrate internal and external stakeholders to share and own the building process. Such stakeholder management measures should provide a platform for dialogue, mediation and reconciliation of potentially conflicting stakeholders' views of the building process. Building assessment methods have a central role to play in this endeavour.

There are obvious benefits of applying a participatory approach in building assessment. Stakeholders provide valuable input into the process of identifying significant issues to be assessed, setting targets and, most importantly, establishing project values. Empowerment through participation and knowledge exchange is another significant spin-off from stakeholder involvement. Moreover, catering for stakeholder participation can make a building assessment method more context-sensitive, effective and practical.

The opportunities for a more direct stakeholder input and involvement in the assessment process have been explored in SBAT and SPeAR. Both methods recognise stakeholder participation as a necessary component in setting the assessment context. SBAT and SPeAR encourage integrated design by involving the design team and the client/end-users in target-setting. However, the broader benefits of integrated collaborative design and learning are not explicitly addressed by these methods.

2.5.3 Searching for New Approaches

In order to improve on the existing practice of building assessment in South Africa, it is necessary to seek out valuable approaches to participation and the assessment of sustainability at a project level applied in different fields. This research proposes that valuable lessons can be drawn from Environmental Assessment (EA) and the Process Protocol (PP) to inform the development of a functional specification for the model for building sustainability assessment. Both EA and PP offer an integrated and complementary way of enhancing building sustainability assessment for the South African built environment.

The extensive experience of public participation in EA provides a significant source of participation practices, tools and workshop techniques that can be readily applied in building assessment. EA can also inform the process of prioritising assessment issues and optimise the learning opportunities throughout the building assessment process. The Process Protocol is proposed as a potential source of solutions to overcome technical barriers to participation in terms of conceptualising the building process and establishing a common language both within and beyond the construction industry. The Process Protocol can also facilitate the articulation, structuring and management of the assessment process.

2.5.3.1 *Learning from Environmental Assessment (EA) to Inform the Practice of Building Sustainability Assessment*

The aim of Environmental Assessment (EA) is to introduce an effective and systematic consideration of biophysical, social and economic issues into all important decision-making stages (Bisset, 1996). The key challenge is to deliver a process that reflects the different value sets that are at play in a given project context (Mulvihill and Jacobs, 1998). Therefore, EA is inherently participatory in nature (Post *et al.*, 1998).

EA can provide a means for stakeholder definition and identification, which is a crucial but often problematic component of participation. Susskind (1983) maintains that the key to success is to shift the focus from the number of participants involved to the categories of interests to be considered. However this requires defining in advance interests with a legitimate stake and finding ways of injecting new participants into an ongoing assessment process.

A *scoping* procedure, which constitutes an integral part of environmental assessment, reduces the amount of data collection and analysis by identifying key issues and variables of the project assessment and implementation (Noble, 2000). Incorporating the scoping procedure in building assessment should improve its effectiveness by identifying potential conflicts and opportunities, and significant assessment issues. Moreover, scoping can improve building assessment by addressing the issue of assessment philosophy, methodology and its content (Mulvihill and Jacobs, 1998).

The interpretation and translation of information into effective decision-making occurs through a filter of values (Cole, 2004). As the values and perspectives that people hold are shaped during a discourse in which they engage, EA fosters greater personal and social responsibility, and it aims to increase the importance of long-term environmental considerations in decision-making (Wilkins, 2003). The process of selecting and defining assessment indicators and targets, which involves negotiation amongst participants, provides an explicit expression of their values. The resulting sustainability targets represent detailed and measurable units of sustainability objectives at the level of a building system and the system's single components (Persson, 2002). Similar objectives need to be established, according to the interests of all stakeholders and the specific project conditions, in building assessment.

EA is a powerful tool for collective learning and building consensus. Initially, the role of public participation in EA focused on obtaining information about public concerns and educating the public about a proposed development (Saarikoski, 2000). However, its application has evolved into a system for producing knowledge, as it offers a forum for different stakeholders to deliberate and exchange views and their knowledge on the anticipated impacts of the proposed development (*ibid.*). By adopting an EA-type approach, building assessment can similarly become a vehicle for stakeholder capacity-building by providing participants with a platform to exchange information and produce knowledge based on dialogue and mediation.

2.5.3.2 Using the Process Protocol (PP) to Enhance Building Assessment Process

The Process Protocol is a generic process map for design and construction, which provides a framework for carrying out any construction project (Kashyap *et al.*, 2003). It is essentially a common set of definitions, documentation and procedures that provides the basis to allow a wide range of organisations involved in a construction project to work together seamlessly (Lee *et al.*, 2000a).

The Process Protocol was developed to provide a common set of understandings and to identify the generic activities that comprise the building process without reflecting the interests of particular industry groups (Cooper *et al.*, 1998). There are a number of advantages of adopting the Process Protocol in the construction industry (Lee *et al.*, 2000a). The Process Protocol provides a whole project view recognising the interdependency of activities that occur throughout the project and focuses on the identification, definition, and evaluation of a client's requirements. It also encourages a team environment and appropriate and timely communication and decision-making by enabling the coordination of the participants and activities in construction projects and identifying their responsibilities (*ibid.*).

Transparency and clear communication of information are key to a successful and meaningful outcome of building assessment. Arguably, alignment with the Process Protocol can make the information received from building assessment more adequate and suitable to all decision-makers in the construction sector. It can also enable the assessment methodology to be presented in a language understandable to the construction industry that will be required to apply it in practice. At the same time, it can make the assessment process more accessible to lay stakeholders by presenting it in a language that is independent of the technical terminology of the industry.

Furthermore, the Process Protocol provides useful insights into the requirements of a building assessment method to correspond to different patterns of the building process, where procurement paths may vary and where the roles and responsibilities of particular stakeholders may differ. These include the coordination of activities and tasks, allocation of responsibilities and definition of the formats of input and output information packages.

Hence, the building sustainability assessment model proposed in this thesis is mapped against the Process Protocol using process mapping to facilitate the presentation of the assessment methodology and the interfaces between building assessment and building activities. This can assist stakeholders in understanding where they fit into the process and what is required of them, and improve communication.

2.6 CONCLUDING REMARKS – LESSONS FOR THE BUILDING SUSTAINABILITY ASSESSMENT MODEL

This chapter outlines the principles that should be incorporated into the practice of building assessment if it is to meaningfully advance the ideals of sustainable development in construction. Arguably, any building sustainability assessment needs to promote inter- and intragenerational equity and aim to preserve the carrying capacity of the natural environment. More importantly, the notion of sustainability requires that emphasis in building assessment is placed on process-related aspects of construction, and that a systems thinking is used in the conceptualisation of building projects. Building assessment should also foster the identification of interdependencies and interactions between human and environmental systems at different levels (e.g. between the built and natural environment or between a building and its occupiers). Another key challenge that needs to be addressed in the practice of building sustainability assessment is posed by the paradigms of weak and strong sustainability. The consideration of these two alternative approaches to attaining sustainable development should be made explicit in establishing values that form basis for decision-making during building assessment and the building process. In addition, the Daly Triangle can guide building stakeholders in the discussion of any construction initiative in terms of its purpose and implementation approach. In this way, the consideration of *means* versus *ends* during building project conceptualisation can be effectively introduced via building sustainability assessment.

Further, the chapter presents building assessment methods as important means of changing building practices. With the introduction of sustainable development agenda in construction, building assessment methods are expected to help to facilitate the required transition in this sector. The review of key challenges in addressing sustainability in construction reveals that building assessment methods can play a significant educational and empowering role in promoting sustainable construction practices.

The discussion of *green* and *sustainable* building assessment practice and the review of established building assessment methods (i.e. BREEAM, LEED, GBTool, SPeAR and SBAT) allow for the identification of the necessary qualities of the building sustainability assessment model (see Table 1). Sustainable construction represents a challenge to the basis of decision-making within the building process, thus the model needs to integrate social, economic and environmental aspects of a building development. As this extends the scope of building assessment, the model should provide means for the identification and selection of the most significant issues. The assessment methodology should also be based on pre-established goals, targets and indicators. In addition, building assessment needs to be aligned with a strategic approach to the implementation of sustainability in construction while proposing context-sensitive solutions.

Table 1: A Summary Table of Selected Established Assessment Methods

SELECTED ESTABLISHED BUILDING ASSESSMENT METHODS	CHARACTERISTIC FEATURES OF BUILDING ASSESSMENT METHODS	REASONS FOR INCORPORATING INTO THE MODEL'S SPECIFICATION
Building Research Establishment Environmental Assessment Method (BREEAM)	- BREEAM addresses a very wide range of biophysical building impacts differentiating between global, local and indoor environments. The method provides the assessment within three broad areas: design and procurement issues, core building issues (i.e. potential environmental impacts during a building's operation), and management and operation issues. - Its weighting system reflect a consensus reached by a range of interest groups including government policy-makers, construction professionals, local authorities, material producers and academics in the process of assigning importance to different sustainability issues included in the assessment framework. - The method caters for existing and new buildings, allowing for the retrofit of environmental technologies in old buildings and intelligent design of new structures. - BREEAM was designed as an eco-labelling system, which can be used for marketing purposes. Building assessment ends with a rating of building environmental performance, which may be rewarded as *Excellent*, *Very Good*, *Good* and *Fair*.	- BREEAM highlights the importance of ensuring that building assessment method should provide means of guiding the planning and design activities and assessing building practices throughout a building's life cycle. - A participatory approach in the development of an assessment weighting system (or the prioritisation of significant assessment issues) is a valuable quality of a building assessment method.
Leadership in Energy and Environmental Design (LEED)	- LEED offers a very comprehensive assessment of biophysical building-related issues. Assessment criteria are grouped according to the type of impacts (e.g. water, energy, materials), but	- An important and valuable feature of LEED is that building owners and users (self-assessors) are provided with information on different strategies that help avoid negative environmental impacts

	it also distinguishes criteria related to innovation and the design process. - LEED is a self-assessment system for new and existing commercial, institutional and high-rise residential buildings. It is supplemented with a reference guide, which explains how credits can be achieved (i.e. using particular methods or practice). This can be considered as a very useful educational feature of this building assessment method. - LEED was established as an environmental labelling system that defines and rates green buildings Depending on the total amount of credits, the building obtains a rating level of *LEED Certified*, *Silver*, *Gold* or *Platinum*. - The objectives of LEED are to assist the project and design team in green design by establishing a common standard of measurement and to stimulate green competition. LEED links its criteria to existing performance standards established by other bodies such as the Environmental Protection Agency.	and enhance the building's performance. All building assessment methods should focus on stakeholder leaming and capacity building.
Green Building Tool (GBTool)	- GBTool is a product of an international initiative to collate existing building assessment methods and develop a system that could be used worldwide to test environmental performance of buildings. - GBTool is applicable to different types of buildings, such as commercial, multi-residential and schools. The method handles a broad range of applications, both in terms of building type and scale, and can be utilised as a performance assessment method or a design guideline method - The assessment framework of GBTool is hierarchically structured using a nesting approach. The higher levels of assessment are logically derived from the weighted aggregation of the lower levels. - GBTool is designed to assess relative improvements over typical practice in building design and construction. It enables its users to reflect national priorities, technologies, building traditions and cultural values that exist in different countries through the customisation of benchmarks and weightings.	- Any building sustainability assessment method needs to be comprehensive, yet simple and easy to use. Building assessment method should allow for the identification of the most significant building-related issues in the context of particular assessment.

	- The method is very comprehensive and complex, which has negative implications on user-friendliness.	
Sustainable Project Appraisal Routine (SPeAR)	- SPeAR was developed to assess the sustainability of different products and processes. This method allows for a graphical illustration of sustainability of a particular project/process while demonstrating a continual improvement and evolution of the project over time. - SPeAR combines social, economic, natural resources and environmental issues. The graphical representation of results indicates both positive and negative building impacts. - SPeAR is self-referential so the objects or initiatives that are appraised using this method are not meant to be compared. Consequently, SPeAR offers a more qualitative assessment. - The assessment and design teams derive actual assessment targets with the client, and set quality levels. The SPeAR method is then employed to produce mini-diagrams at each stage of the project to ensure that the targets are achieved. In this way it aids communication with the client and the design and project teams - SPeAR has not been developed as a building assessment method *per se* and thus is very general in nature.	- Any building sustainability assessment needs to integrate biophysical, social and economic (positive and negative) implications of a building development. - Since many of diverse building-related issues are qualitative in nature, building sustainability assessment cannot be limited by relative, quantitative measurements. Similarly to SPeAR, the assessment methodology should rather be based on pre-established goals, targets and indicators. It should also help appraise the sustainability of any building project over time. - Building sustainability assessment method should focus primarily on understanding the specific context of building assessment and setting targets for each issue in order to make the overall building development more sustainable. - Building sustainability assessment method needs to incorporate a participatory approach to building assessment by involving building professionals and lay stakeholders (e.g. the client and end-users).
Sustainable Building Assessment Tool (SBAT)	- SBAT considers environmental, social and economic dimensions of sustainability and applies an alternative approach to building assessment based on target-setting. This method was specifically developed for a developing world context, which is reflected in some of its assessment criteria (e.g. issues of stakeholder empowerment). - SBAT can be used to assess the design of new buildings, or in the refurbishment of existing buildings. - By involving interested and affected parties in the development of sustainability performance targets that form the basis of SBAT, the method caters for specific regional conditions and cultural values.	- While striving for simplicity, a building assessment method cannot be compromised in terms of the scope of issues to be assessed. - It is important that the method provides a comprehensive and flexible assessment of building products ad processes, and can be easily adjusted to different assessment contexts (i.e. urban or rural settings, different building types). - Participation of building owners and users as well as building professionals in the assessment activities should explicitly aim to change building stakeholders' personal attitudes as well as construction practices. The educational capacity of building assessment methods needs to be

	- SBAT can be used as a design-support tool by providing a checklist of the main 'rules of thumb' and assessment criteria. It can also be used to make a rapid and rough assessment of building performance, which provides the framework for a more detailed analysis if required. In addition, SBAT can support project decision-making by assisting in briefing the design team. - As the method is based on a framework consisting of a fixed list of assessment criteria, SBAT may not be sensitive enough to particular assessment contexts and needs.	actively capitalised upon. - Building assessment methods should effectively influence decision-making at every level and stage of a building process.

Moreover, the advancement in the practice of building sustainability assessment can be achieved by the incorporation of the Bellagio principles. In this way, building assessment methods can draw upon the expertise of international research and practice in assessing sustainable development.

Perhaps the most significant difficulty in promoting sustainable development in construction is the operationalisation of its principles (so that they can be easily applied in practice) in building assessment and, through this, in the building process itself. The issues of sustainable development are fundamentally political in the sense that they are embedded in the access to power and resources. Addressing the issue of equity becomes an urgent priority of the sustainable construction agenda in the developing world.

Equity, which forms a fundamental pillar of the social dimension of sustainability, is often addressed through participation. Arguably, a stakeholder-orientated building assessment process can positively contribute to the sustainability of building projects. Therefore, stakeholder participation should constitute a fundamental component of any building assessment that seeks to be appropriate for the South African built environment.

To avoid abortive work, the building sustainability assessment model is built on the positive qualities of established *sustainable* building assessment methods (i.e. SPeAR and SBAT). Where the model differs is in the way in which it seeks to broaden participation drawing on the lessons learnt from environmental assessment (EA). This is supplemented by insights gained from the review of the Process Protocol (PP).

Having identified EA and PP as two valuable resources to enhance the quality of building assessment, it is necessary to examine them in more detail. The origins of EA and PP, the philosophies that underpin them, their evolution, how they can contribute to building assessment and how they complement each other in this regard, are discussed in Chapters 4 and 5. The next chapter presents methodology adopted in this research.

Chapter 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION – ADVANCING THE PRACTICE OF BUILDING ASSESSMENT

Knowledge is the outcome of any research undertaking. Research can be viewed as *disciplined* inquiry aimed at creating or extending knowledge (Frick, 1998). The purpose or intent of research determines what kind of knowledge is created, and it subsequently influences the choice of appropriate inquiry methods (*ibid.*). Together these purposes or intents reflect a number of philosophical assumptions about the nature of knowledge. Collectively these assumptions are referred to as epistemology. Furthermore, these assumptions inform the investigative frameworks or methodologies that are used to govern and provide rigour to academic inquiry.

The purpose of this chapter is to present the logic of inquiry and the processes by which knowledge has been generated and justified in this thesis (Blaikie, 1993). In other words, it describes the way in which the arguments produced in this inquiry can be justified (Faludi, 1986). Methodology refers to the logic of decision-making process (Mouton and Marais, 1990) in producing reliable and valid knowledge (Livesey, n.d.). Consequently, this chapter presents the researcher's epistemological position and the methodology applied to address the research problem put forward in this thesis. Furthermore, the process of conducting a workshop with practitioners to validate the logic of research argumentation is also presented. This workshop forms an integral part of the research methodology.

The underlying purpose of this research is to contribute to the improvement in the practice of building sustainability assessment. This contribution comprises a conceptual model for building assessment that incorporates the premises of sustainable development. More specifically, the research proposes the development of the functional specification for the building sustainability assessment model that is relevant to the South African built environment. Therefore, this inquiry seeks to add to the *theory of practice* (i.e. praxiology) in the field of building assessment. This is achieved primarily by synthesising relevant lessons from the theory and practice of Environmental Assessment and construction management for the practice of building sustainability assessment. The research outcomes emerging from this inquiry, which are embedded in the functional specification of the model, relate directly to the matters of utility and invention (i.e. design and development) with an aim to advance the theory and, through this, influence the practice of building assessment.

By definition theoretical research is concerned with theory building. The importance of theory building is depicted by Lawrence (1997:84) who states that *"theory building is a means to achieve an enhanced environment, better decision-making and improved practice"*. The theory constructed through this research does not only engage with practical aspects of building sustainability assessment, but also includes theoretical claims regarding the future evolution of the practice of building assessment.

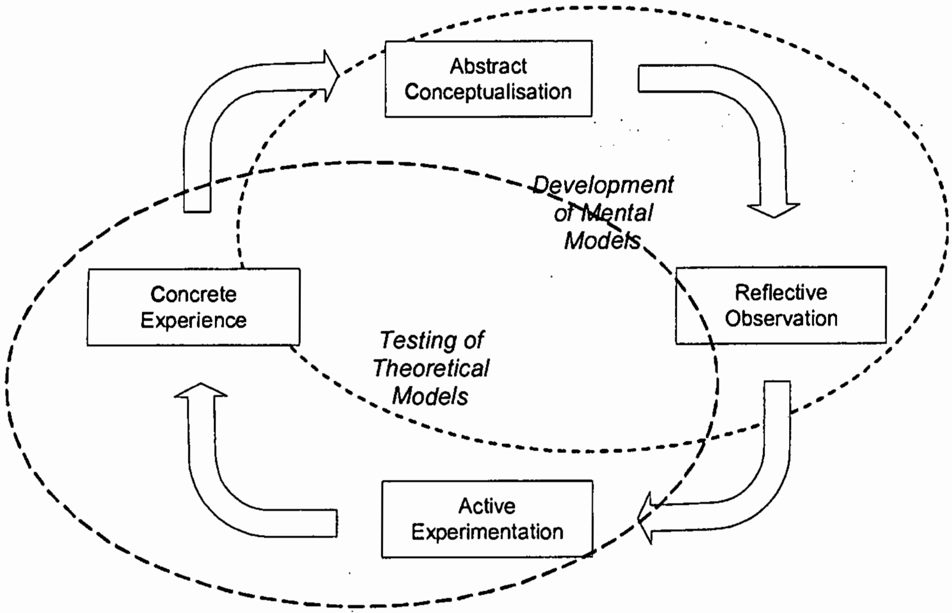
3.2 EPISTEMOLOGICAL POSITION

Before discussing the research methodology any further, it is necessary to lay out the epistemological position that supports the inquiry, generates new knowledge and underpins the validation of the arguments made in this thesis. Epistemology has been defined as "*the theory of science of the method or grounds of knowledge*" (Blaikie, 1993:6). In other words, epistemology is a theory of knowledge and includes assumptions about the possible ways of gaining knowledge (*ibid.*). Thus, epistemology provides a "*general orientation as to how the research is conducted*" (Dawson, 2003:326).

It has been mentioned in the beginning of this chapter that the purpose of all research is the generation/discovery of knowledge. Any research process becomes, in operation, a learning process (Root, 2000). If academic research is viewed as a formalisation of the learning process then the "*epistemological position is merely a statement as to what aspect of the learning cycle is the focus of study*" (*ibid.*:122). Kolb (1986) describes the learning cycle as a process that consists of four stages, namely, concrete experience, abstract conceptualisation, reflective observation and active experimentation (see Figure 4). Within this learning, there is a cyclical pattern: from Experience through Conceptualising and Reflection to Action and on to further Experience.

Root (2000) points out two general aspects of the learning cycle, namely, the testing of theoretical models against reality, and the experience of reality allowing the development of mental models. One or other of these general aspects is given greater emphasis within most research methodologies. For example, grounded theory (Glaser and Strauss, 1967 cited in Root, 2000) is concerned with the construction of theory grounded in the data, and so it concentrates on the development of mental models. In contrast, scientific method places greater emphasis on the testing of models through active experimentation.

Figure 4: Root's Modification of Kolb's Learning Cycle Process (source: Root, 2000:122)



These aspects constitute continuous, indivisible parts of the whole learning process and ought not to be viewed as discrete entities of the overall learning process (Root, 2000). Nevertheless, any research enquiry can apply itself to a specific part of the cycle (e.g. the application of an existing research tool or theory to a different context) without detracting from the overall learning process. The purpose of this research is the development of a mental (conceptual) model for the building assessment process. Therefore, the research approach is sourced from methodologies that emphasise that aspect of the learning cycle.

Theory cannot be fully divisible from practice, just as "*thought is not independent of existence and experience*" (Lawrence, 1997:83 citing Mannheim, 1936). Thus, theory cannot be free from empirical elements. According to Lawrence (*ibid.*), *deductive* (theory-practice) and *inductive* (practice-theory) reasoning constitute the two iterative and complementary routes to theory-building. The deductive route implies a reasoning "*toward observations*", whereas the inductive route relies on a reasoning "*from observations*" (Babbie, 1995:55). These two approaches to theory-building are not mutually exclusive (Mouton and Marais, 1990). If theory is inherently inductive, i.e. constructed from empirical sources, it "*is also deductive in that from a knowledge of one part, aspect, sequence, or difference, the mind can deduce through logic the probable characteristics of other aspects or even, daringly, entire sequences or structures*" (Peet, 1998:5). Arguably, all types of research (quantitative and qualitative) are based "*upon a complex admixture of deductive and inductive procedures*" (Turner, 1988:111). This research entails a deductive theory construction as arguments are built and conclusions drawn through *logical reasoning* (Ghauri and Grønhaug, 2002).

Popper (1974 cited in Faludi, 1986) argues that it is not possible to actually establish whether theories are in fact true. For Popper *truth* means correspondence with the facts, and facts are descriptions of observed states of affairs. The only possibility is to eliminate theories which are false (Blaikie, 1993). However, knowledge should be justifiable through the consistency of logic in the arguments made.

The research presented in this thesis does not entail any empirical work in the traditional sense of experimentation and observation. In addition, it does not aim to operationalise and measure the theories that are advanced. This thesis has a philosophical character as it presents "*a sustained rational reflection about general principles that has the aim of achieving a deeper understanding*" (Magee, 1998:230 cited by Hill, 2004:19) of building assessment. Hence, the theory in this thesis is constituted or constructed through a deductive process of reasoning - *methodological reflection* (Faludi, 1986).

The methodology applied in this research involves a critical description of the state of knowledge and the review of experience and practices in the fields of building assessment, environmental assessment and construction management, as documented in literature. This methodological reflection informs the development of a conceptual model for building sustainability assessment. Communicated through its functional specification, this model is subsequently subject to validation by building professionals during a validation workshop (refer to Section 3.4). In this way the theory constructs advanced in this thesis are laid open to be challenged by others – using a critical rationality approach. More importantly, final conclusions and recommendation of this research can be informed by the practical experience of building practitioners (i.e. participants of the workshop) and their expectations of such a model.

According to Hoch (1984 cited by Lawrence, 1997), theory building is a practical and moral undertaking. It needs to be directed consciously toward a purpose that is external to both theory and action (*ibid.*). Again, this differs from the tradition of scientific method which is expected to be value free (de Beer, 1994). More often this is now recognised to be an idealised notion in that even research in the hard sciences is inherently a social process (Kuhn, 1970). In this case, the research is guided by a specific and explicit purpose, namely, to improve the existing practice of building assessment. For this reason, the philosophical underpinning adopted for this research is provided by *praxiology*.

3.2.1 Applying the Philosophical Approach of Praxiology

The theory that is mostly advanced in this thesis can be classified as praxiology of building assessment. The term *praxiology* is derived from the Greek words *praxis* (activity) and *logos* (science). While referring to praxiology as a *theory of practice*, theory is not necessarily understood as "*a system of formal hypotheses that generate explanations and predictions*" (Stern, 2003:187). In this context, theory could be depicted as "*a general or systematic way of approaching a given subject matter*" through the provision of models and development of conceptual frameworks or categories (*ibid.*:187).

Praxiology is regarded as the most general of practical sciences (Grygianiec, n.d.). It can be defined as a normative "*study of practical activity and knowledge*" (Petrina, *in press*:58). Praxiology thus contains descriptive and normative theses. Descriptive theses explain and clarify fundamental concepts in praxiology and their relationships. The theses of a normative nature indicate appropriate directives that make a certain action efficient and effective in respect to a desired end-point (Grygianiec, n.d.). Therefore, the primary values of interest in praxiology are effectiveness and efficiency, which determine the rationality between means and ends (Petrina, *in press*).

Praxiology also deals with the values and ethical considerations (axiology) inherent in putting theory into practice (Dawson, 2003). Praxiology is concerned with how practitioners and researchers should act, and how they solve practical problems and implement concrete plans of action (*ibid.*). It has been proposed that praxiology implies a *Triple E* analysis (Dawson, 2003; Gasparski, 1996):

1. *Effectiveness* as related to the result of action;
2. *Efficiency* as related to the process of action; and
3. *Ethics* as related to the values that guide this action.

Praxiological theoretical sentences express universal generalisations about instrumental value, i.e. what means are effective, instrumentally good in bringing about an end, or ends (Steiner, 1988).

Praxis (acting) provides a developmental link between theory and practice, as it focuses on "*rational activities directed towards what to do*" (Steiner, 1988:4). However, Steiner (*ibid.*:47) emphasises that "*praxiology is distinct from development because it is theoretical, whereas development is the domain of applied theory and models of theory are developmental requirements*". The specification for the building sustainability assessment model, presented in this thesis, falls into the theoretical domain of praxiology. Operationalisation of the model would be regarded as development.

The following sections present a brief discussion on theory building and introduce the concept of developing a conceptual *model-for theory.*

3.3 CONSTRUCTING A THEORY OF BUILDING ASSESSMENT

Theoretical research is concerned with theory building and conceptual analysis (Mouton and Marais, 1990). Theory is derived from the Greek *theoria*, which means contemplation or speculation (Steiner, 1988). "*Theory explains, guides and enhances understanding*" (Lawrence, 1997:81). It comprises interrelated constructs (concepts), definitions and propositions that present and explain phenomena (Kerlinger, 1986). Thus, theory has an explanatory and prescriptive power (Lawrence, 1997). According to Faludi (1973), explanatory theory focuses on identifying and explicating causal connection between variables that characterise a phenomenon, whereas prescriptive theory offers normative guidelines to future action.

Theoretical knowledge consists of theoretical facts about essential properties (of universals or any object of theorisation) and their relations (Steiner, 1988). Faludi (1973:21) points out that theory can be also conceptualised as a "*framework for thinking*". An invaluable consequence of providing such a framework is the ability to place experience into a context (*ibid.*). Theory affects the practice as it provides the principles for practice. Hence, theory is both *symbolic* (i.e. abstract or conceptual) and *empirical* (i.e. grounded in observation and experience) (Lawrence, 1997). However, Steiner (1988:8) emphasises that "*the requirement for all the* (theoretical) *statements to be empirically testable is not acceptable for a general definition of theory*". Steiner (*ibid.*) notes that the truth of certain theories (e.g. mathematical or philosophical) cannot be empirically tested, as they do not depend on observation. Therefore, empirical testability of theoretical statements cannot be regarded as a necessary condition for theory validation in all instances.

Theory building relies on both analysis and synthesis (Lawrence, 1997). Steiner (1988) argues that the construction of theory usually involves either correction of, or addition to already existing theories. Thus, theory building is an exercise of emendation and extension (*ibid.*).

Theory consists of concepts, which are abstractions that represent an object, property or phenomenon (Ghauri and Grønhaug, 2002). Concepts are "*symbolic constructs*" used when referring to phenomena (Mouton and Marais, 1990:58). Consequently, theory can be viewed as a system for ordering concepts in a way that produces understanding of insights (Zaltman *et al.*, 1977). Concepts and variables (characteristics of objects), which are the basic building-blocks of knowledge, are integrated to form theoretical statements (Mouton and Marais, 1990). Statements are, in turn, arranged into conceptual frameworks according to "*regulative interests or orientations*" (*ibid.*:136).

Concepts acquire meaning, or even gain new meaning, within a conceptual framework, such as a theory, a model, or a typology (Mouton and Marais, 1990). The nature of a conceptual framework is determined by its functions, more specifically (*ibid.*):

- *Typologies* have a classifying or categorising function;
- *Models* apart from classification also suggest new relationships heuristically; and
- *Theories* apart from the preceding functions (classification and heuristics) also fulfil an explanatory and interpretative function.

As previously stated, this thesis proposes the conceptual framework for building sustainability assessment that incorporates the philosophy and principles of sustainable development. As the framework attempts to classify concepts and indicates relationships between variables, it falls into the category of models.

3.3.1 Developing a Model for Theory

Under certain conditions theories can be referred to as models (Steiner, 1988). Models provide a partial representation of a phenomenon, as they illustrate relationships between the major elements of a particular phenomenon in a simplified form (Mouton and Marais, 1990). This means that certain aspects of the phenomenon can be excluded in a model, while the most obvious ones are intentionally emphasised (*ibid.*). Models are characterised by the following aspects (Ghauri and Grønhaug, 2002:44):

- *Representation*: a model represents an object or phenomenon;
- *Simplification*: a model simplifies by reducing the number of factors included; and
- *Relationship*(s) exist(s) between the factors included.

Models are used for the purposes of *description* (e.g. may include mapping); *explanation* (may present a thinking process, develop interesting implications and look for generality); *prediction*; and *guidance* of activities (Ghauri and Grønhaug, 2002). Models can be generally classified as physical and conceptual (Steiner, 1988). The conceptual models can, in turn, be viewed as models-*of* and *-for* something (*ibid.*). Theory models are conceptual and also models-for (Steiner, 1988). Models are most commonly devised from theory "*so that theories can impact* *upon practical decision-making*" (*ibid.*:9). However, theory can also be devised from models; modelling then becomes a part of theory construction. In this instance, a model offers propositions for theory (Blaikie, 1993). Thus, a set of propositions (to be tested) is derived from a model and, if successfully tested, will become a theory (*ibid.*). Consequently, theories can be *constructed* through models (i.e. models-for them) and be *used* through models (i.e. models-of them) (Steiner, 1988).

The model proposed in this thesis plays a descriptive function, as it describes the process of building sustainability assessment through process maps. It also provides guidance for the improvement of praxis. As the model has been developed from a different conceptual context than existing building assessment methods and also acts to extend the existing theory of practice in the field of building assessment, it is referred to as a conceptual model and a model for the theory of practice.

3.4 THE PURPOSE OF CONDUCTING THE VALIDATION WORKSHOP

It is possible to distinguish between internal and external validity of a research undertaking (Mouton and Marais, 1990). Internal validity includes theoretical validity (conceptualisation), measurement validity (operationalisation), reliability (data collection), and inferential validity (analysis and interpretation) (*ibid.*). External validity determines whether the research results are legitimate outside the specific settings of the study (Bolton Institute, n.d.). Due to the nature of this particular research, conducting a validation workshop can assist in addressing its theoretical and inferential validity. According to Mouton (1996), reasoning or argumentation leads to certain conclusions or judgements. Hence, the logic of argumentation needs to justify the conclusions reached in the research (Kaplan, 1964). One of the main aims of the workshop, conducted at the University of Cape Town, was to validate the logic of research presented in this thesis by subjecting the logic of argumentation (or reasoning) to a constructive criticism of the workshop participants.

The specific aims of the workshop included validation for the logical consistency, explanatory power and usefulness of the model's specification. The workshop provided a forum to explicate any assumptions and simplifications made in the development of the model. Furthermore, conducting the validation workshop with South African built environment practitioners provided valuable information on existing construction practice. Issues of language, terminology, or usability that may act as barriers to the adoption and implementation of building sustainability assessment could be compared against the perceptions and experiences of the practitioners. In this way the workshop also helped confirm whether the model is responsive to the context of the South African construction sector.

The validation workshop took place on 25 October 2005 in the postgraduate seminar room in the Department of Construction Economic and Management at the University of Cape Town (UCT) (refer to Appendix A). The workshop was facilitated by Dr. David Root and attended by the following persons:

- Gita Goven of ARG Design – a Cape Town based architect who specialises in sustainable design;
- Sandy Rippon – a self-employed architect who co-operates with the Environmental Evaluation Unit at the Department of Environmental and Geographical Sciences, UCT;
- Garth Blassoples of KFD Wilkinson – a civil engineer who specialises in infrastructure projects (e.g. the new Domestic Departures Terminal at the Cape Town International Airport), a director of KFD Wilkinson Consulting Engineers in Cape Town;
- Wayne van de Vent of Futuregrowth – a director of Futuregrowth Asset Management and a head of Property Team (Futuregrowth provides specialist fund management services in Southern Africa with a focus on quantitative investment and risk management processes applied to development funds, specialist equity and bond funds investments); and
- Dr. Richard Hill – a lecturer with a civil engineering background from the Department of Environmental and Geographical Sciences, UCT (also a co-supervisor of this thesis).

To ensure that participants understand the purpose, format and expected outcomes of the workshop, they had been provided with a set of pre-briefing notes (i.e. a précis of Chapter 6) prior to the workshop. The workshop was recorded on minidisks to ensure that all comments and observations were captured, and to allow for a detailed analysis of the debates between the participants after the workshop.

The workshop agenda comprised a PowerPoint presentation (see Appendix B) followed by a group discussion. The presentation introduced the functional specification of the model, its main outcomes, use scenarios (based on process maps) and user personas (refer to Chapter 6). Afterwards participants were requested to answer specific questions and to give critical feedback from their perspective on the information presented.

The model for building sustainability assessment has been developed in this thesis, as well as presented during the workshop, in the form of a functional specification. This allowed for the communication of the model's application and the underlying methodology of building sustainability assessment without referring to its design and operational details. The use scenarios of the model presented in this thesis, and during the workshop, do not represent any predictions, but rather serve as devices that support the discussion of possible applications of the model. The presentation of scenarios facilitated a debate during the workshop on potential improvements in the practice of building assessment through the description of the model's potential application situations. Subsequently, this discussion led to another debate on future trends in the evolution of the practice in terms of different emphasis in the application of building sustainability assessment methods and the discovery of their new roles.

Furthermore, the use of process maps, developed for each model's use scenario, helped visualise interfaces between building assessment and a building project's activities. This allowed for the estimation of the model's effectives in achieving its intended outcomes. Process maps not only illustrate the progression of building assessment with the building process, but also indicate how the potential outputs from building sustainability assessment can inform building process activities.

The workshop brought together different viewpoints from the research community and business perspective. Therefore, the conclusions reached and recommendations proposed in this thesis have been enriched with a relevant practical experience and perceptions of the South African academics and built environment practitioners. The summary of the workshop discussions is presented in Section 6.5.

3.5 CONCLUDING REMARKS

The research undertaking presented in this thesis can be characterised as a process of conceptualising and cognitive structuring. The model for building sustainability assessment reveals the relationships between distinct components and activities of the building assessment process. It can be depicted as a model for an *incipient theory* (*ibid.*), as it attempts to explain how building sustainability assessment should work. In this sense the theory presented in this thesis is normative. However, in a more fully developed form (i.e. after model's operationalisation) this theory could be subjected to empirical investigation in future research.

The model for building sustainability assessment is not amenable to empirical testing in its present form. Consequently, the theory it advances cannot be readily falsified, but can certainly be challenged in terms of the logical reasoning upon which it is founded. Such was the role of the validation workshop conducted with the participation of the South African built environment practitioners.

Chapter 4

ENHANCING BUILDING ASSESSMENT WITH LESSONS FROM ENVIRONMENTAL ASSESSMENT

4.1 INTRODUCTION – EXTENDING THE SCOPE OF CONSIDERATIONS IN DECISION-MAKING

Traditionally, a primary role of Environmental Assessment (EA) has been the "*provision of environmental advice to decision-makers*" (Hill, 2004:5). The effectiveness of EA is measured by the extent to which it influences the formulation of proposals and its subsequent influence on decisions (*ibid.*). This chapter explores in detail potential contributions from the field of EA towards the enhancement of decision-making in building assessment. This knowledge is drawn upon to strengthen the effectiveness of the building sustainability assessment model.

The EA procedure was first introduced in the United States following the growing demand for a comprehensive approach to anticipating and avoiding environmentally disruptive activities (Wood, 1995). EA became a formal policy requirement in the United States in 1969, under the provisions of the National Environmental Policy Act (NEPA) of 1969 (Sadler, 1996). Section 102 (2)(C) of NEPA calls for the preparation of an environmental impact statement (EIS) for major federal actions that can significantly affect the quality of the human environment (Wathern, 1988). An EA report is expected to include information on the environmental impacts of a proposed activity; adverse environmental impacts which cannot be avoided; alternatives to a proposed action; the relationship between short-term use and the maintenance and enhancement of long-term productivity; and any irreversible and irretrievable commitment of resources (*ibid.*). In general, NEPA encourages federal agencies and relevant decision-makers to consider environmental consequences of proposed actions before resources are committed (Canter and Clark, 1997).

More than 100 countries currently recognise EA as a formal process to help decision-makers consider the environmental consequences of proposed actions (Hill, 2004; Sadler, 1996; Wood, 1995). EA became a legal requirement in South Africa in 1997 (Hill, 2004). Previous to this it had been a voluntary practice with its application being strengthened by the publication of the "*Guidelines for Integrated Environmental Management*" in 1992 (Sowman *et al.*, 1995).

Over the 36 years of EA practice, the field has undergone significant evolution in philosophical and methodological approaches in response to growing expertise in its application and to satisfy the changing needs of society. These changes are reflected in an increasing level of public involvement in the EA process (Sadler, 1996).

The following sections present key definitions, objectives and the main stages of the EA process. Attention is paid to the role of EA in promoting sustainability and to how practitioners have responded to the challenge of implementing sustainable appraisals. Finally, the key areas of EA's relevance to building assessment are discussed, and particular lessons indicated.

4.2 THE DEFINITION OF ENVIRONMENTAL ASSESSMENT

Environmental Assessment (EA) is used as a general term to refer to the Environmental Impact Assessment (EIA) of projects and the Strategic Environmental Assessment (SEA) of policies, plans and programmes (Hill, 2004). EA aims primarily to facilitate an integrated decision-making process that incorporates environmental considerations (Hill, 2004; Eggenberger and Partidário, 2000; Sadler, 1996). This is achieved through the provision of comprehensive information on potential environmental effects, risks, and consequences of development options and proposals (Sadler, 1996).

More specifically, EIA aims to introduce the consideration of environmental issues into all important decision-making stages of proposed development undertakings (Bisset, 1996). In contrast, SEA is defined as a systematic process for evaluating the environmental consequences of proposed policy, plan or programme initiatives in order to ensure that they are appropriately addressed at the earliest stages of decision-making (Dalal-Clayton and Sadler, 2004). SEA has been developed as an attempt to overcome the limitations of EIA in considering certain development alternatives which are often precluded before a project level EIA is undertaken (Hill, 2004). In the context of SEA, EA is given a more strategic focus by shifting towards a "*practical policy- or programme-formulating role which analyses assumptions, defines priorities, and compares a variety of alternatives*" (O'Riordan and Sewell, 1981:298 cited by Hill, 2004:41). SEA and EIA are intended to be tiered or vertically integrated (Sadler, 1996). Noble (2000:210) describes the relationship between EIA and SEA in the following way:

> "*Ideally SEA and EIA are considered in sequence where SEA proactively examines a broad range of alternatives and selects the preferred course of action, and EIA is initiated "reactively" to determine in greater detail the potential impacts of the preferred alternative*".

The EA process focuses on the identification, prediction, evaluation and mitigation of the biophysical, social and other relevant effects of proposed projects and physical activities, while maximising their benefits, before major decisions and commitments are made (Sadler, 1996). For most projects, the output consists of predictions on how the environment may be affected if specified development alternatives were to occur, and how best to manage the anticipated environmental changes (World Bank, 1996).

However, EA is also viewed as a management tool to enhance the development process. In this way it moves beyond being a technical aid in project appraisal (World Bank, 1996). Ideally, the EA process should be incorporated into the project conceptualisation, preparation and implementation phases in order to effectively influence the delivery of environmentally sound projects (*ibid.*).

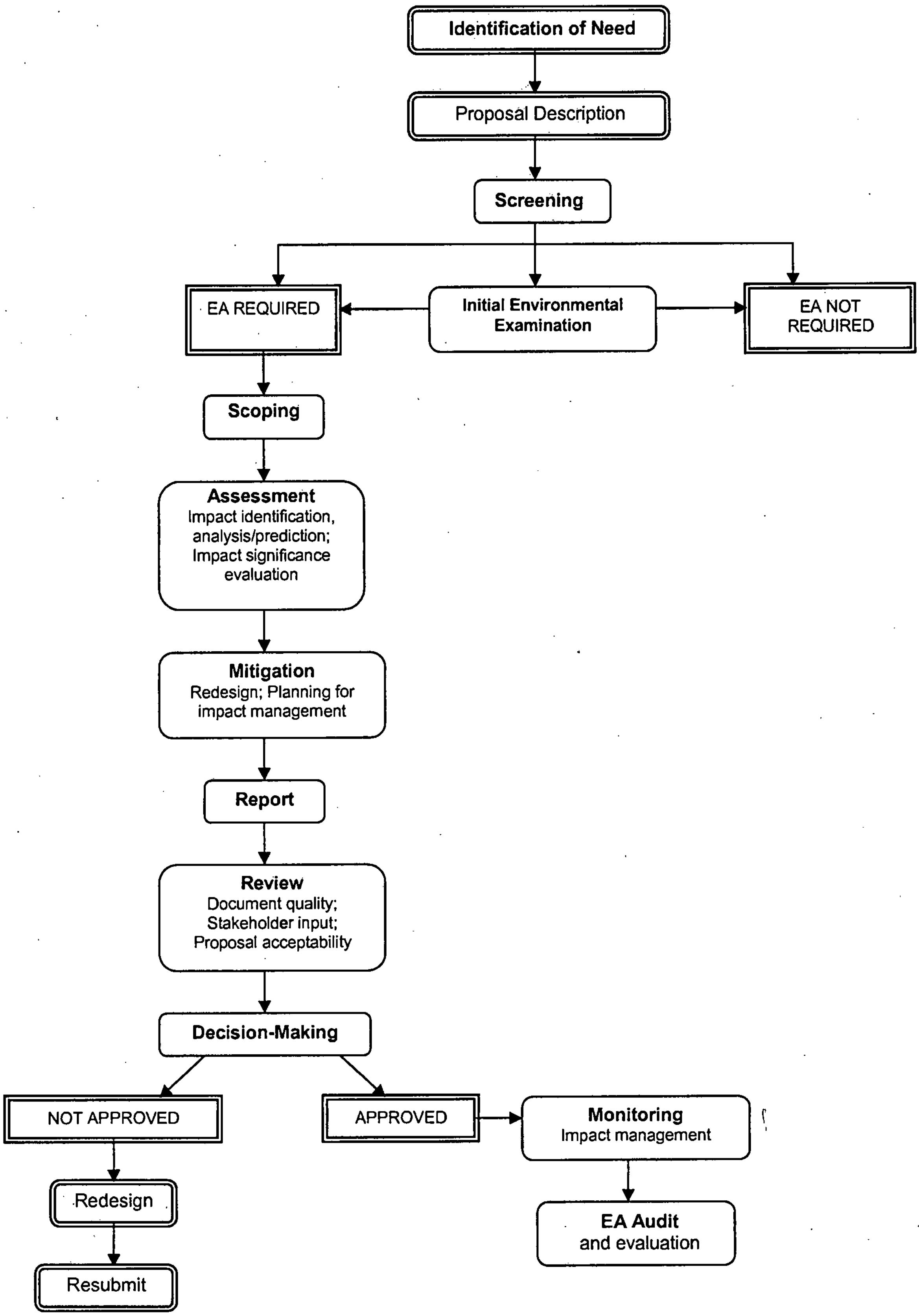
The key objectives in undertaking EA are to implement an effective EA process and produce a useful EA report (World Bank, 1996). The EA report, and its preliminary or interim versions, synthesises results and is a formal demonstration to key decision-makers, NGOs, and the public that the EA has been done according to good professional practice (*ibid.*).

Figure 5 depicts a generic EA process. EA commences by establishing the need for conducting an EA process. The procedure of selecting proposals that should undergo an EA is termed *screening* (Sadler, 1996). The most common approaches to screening include the use of a list of projects which are subject to or exempted from EA, and an initial environmental examination of a proposal to see if an EA is needed (Hill, 2004). Many countries have published lists with projects subject to EA, including South Africa (RSA, 1997b).

Factors determining the requirement for an EA study include the project type, the consequence of likely impacts, as well as the project's location (taking into account the sensitivity of the receiving environment) (Wathern, 1988).

Scoping identifies key issues and impacts to be addressed, and it establishes terms of reference for the assessment process (Sadler, 1996). The *assessment* stage involves collecting, organising, analysing, interpreting and communicating data required for making certain decisions (e.g. information regarding potential impacts and proposed mitigation measures) (Sadler, 1996; RSA: DEA, 1992a). The assessment stage of EA also entails *evaluation*, defined as the process of evaluating information on the consequences of alternatives (Hill, 2004).

Figure 5: Generic EA Process (source: Hill, 2004:36)



A monitoring programme is established, which usually correspond to the objectives of an Environmental Management Plan (EMP) for construction works (Hill, 2004; Sadler, 1996). This is followed by the process of *reporting* the results of EA, including recommended terms and conditions, in the form of an EA report (e.g. Environmental Impact Statement in the US and Environmental Impact Report in South Africa) (Sadler, 1996). The EA report is reviewed to ensure that EA meets terms of reference and standards of good practice. The report also serves as the main channel of communicating the results of the study phase to a wider audience including the affected public (*ibid.*).

The decision-making component of EA results in the *Record of Decision* (ROD), which should state the reasons for a decision being taken including the importance attached to environmental and other decision factors (RSA: DEA, 1992b). The EA process ends with *a follow-up*, which entails monitoring to check the compliance with terms and conditions of ROD, the accuracy of impact prediction, as well as an audit and evaluation of results. The EA audit provides an opportunity to learn from experience and enhance EA quality (Sadler, 1996). The main stages of an EA process are discussed in more detail in Section 4.4.

4.3 INDICATORS OF ENVIRONMENTAL ASSESSMENT EFFECTIVENESS

Hill (2004) lists key objectives that EA seeks to achieve. They are categorised as environmental planning and design objectives, decision-making objectives, institutional objectives and societal objectives. Despite this broad range of objectives, it is the extent to which EA improves performance in the areas of planning and design, and decision-making that determines EA's effectiveness at a project level.

EA aims primarily to better integrate proposed policies, plans, programmes, and projects into their environmental and social settings (Hill, 2004). It identifies and formulates alternatives and remedial measures that enhance benefits and minimise or avoid adverse environmental and social impacts (Brown and Hill, 1995). In order to ensure that adverse environmental and social impacts are avoided or minimised during proposal implementation, EA may involve the development of Environmental Management Plans (Brown and Hill, 1995; RSA: DEA, 1992b).

The reconciliation of environmental, social and economic objectives in decision-making is also a key challenge addressed by EA (Hill, 2004). EA helps legitimise environmentally sound proposals and prevent the implementation of the unsound proposals (Ortolano and Shepherd, 1995). It also facilitates the incorporation of environmental objectives and constraints into proposal formulation (Hill, 2004; Dalal-Clayton and Sadler, 2004).

EA can significantly improve the quality of decision-making, as it provides anticipatory information about the beneficial and adverse environmental and social consequences of proposals to proponents and multiple decision-makers (Hill, 2004; Shepherd and Bowler, 1997; Ortolano and Shepherd, 1995). The EA procedure is intended to provide early warning of cumulative effects and large-scale changes (*ibid.*). EA should also help internalise environmental costs in decision-making to ensure that the environmental and social costs of proposals are not imposed on society (Sadler, 1996).

Furthermore, EA aims to improve stakeholder and public participation in proposal formulation and decision-making, and through this it empowers individuals and communities (Sadler, 1996). Thus, EA should entail mechanisms for effective negotiation and conflict management. By encouraging stakeholder and public participation in decision-making, EA reinforces accountability and transparency of the process (Dalal-Clayton and Sadler, 2004; Wilkins, 2003; Brown and Hill, 1995). However, this requires that the assumptions used, the judgements made, and the objectives sought are made explicit in decision-making (Morrison-Saunders and Bailey, 2000).

Stakeholder participation in decision-making introduces changes in organisational values and behaviour towards the environment through mutual learning among participants (Hill, 2004). The process of social and collaborative learning, which is an important objective of EA, enhances environmental understanding and develops the environmental ethics of the participants in the EA process. In this way EA assists in balancing different values in development (Sadler, 1996).

The evolution of EA has comprised adjustments, modifications and improvements to the EA process and procedure (Sadler, 1996). Initial attempts were directed towards making EA more useful to decision-makers by focusing the assessment on real environmental issues and alternatives (Hill, 2004). Subsequently, in order to produce better decisions, the EA focus shifted from being overly product-orientated (EIS) to a more process-orientated approach (*ibid.*). Moreover, the scope of EA has been extended beyond environmental impacts to also explicitly address the environmental and social objectives of development (Sadler, 1996).

Significant emphasis has been recently placed on the applications of the EA process for problem-solving and, thus, on providing EAs that are relevant and *fit-for-purpose* (Dalal-Clayton and Sadler, 2004; Sadler, 1996). The two critical factors that are paramount to the overall effectiveness of the EA process include the effective allocation of responsibilities and communication. Hence, the EA process should be based on well defined roles, rules and responsibilities of key actors (Sadler, 1996). It also requires the provision of clear, concise and timely communication of information (Hill, 2004).

4.4 KEY COMPONENTS OF ENVIRONMENTAL ASSESSMENT

Wathern (1988) asserts that EA comprises three main components. These include the identification and collection of information for decision-making; determination of changes in environmental parameters resulting from proposal implementation in reference to the *no action* scenario; and the record and analysis of the actual change. In contrast, Hill (2004) in identifying four key stages of EA makes an explicit distinction between the assessment and evaluation stages in EA. According to Hill (*ibid.*), EA consists of scoping; assessment; evaluation and management, which are correlated with the planning; design; approval and implementation stages of a project's cycle. These four EA stages are discussed below.

4.4.1 Scoping

Scoping is the initial phase of EA that aims to narrow the scope of an assessment, so that subsequent stages of the EA process focus only on significant issues and impacts related to the proposed action (RSA: DEA, 1992a). This stage defines critical parameters of potential impacts associated with a proposed development, policy, program, or project (Mulvihill and Jacobs, 1998).

The key objectives of scoping are to facilitate a participatory, efficient, integrated, and timely EA process (Hill, 2004). The scoping procedure allows a reduction in the amount of data collection and analysis required in the process by identifying the key issues and variables of the project assessment and implementation (Noble, 2000). This increases the efficiency in the allocation of resources used, such as time and money, to conduct the EA, (RSA: DEA, 1992c). Moreover, by focusing on key issues and making provision for public and stakeholder participation, scoping ensures that EA process is relevant and responsive to the interests of participants (Hill, 2004; Huges, 1998). The consideration of impact/issue significance is based on institutional reference (e.g. regulations, plans, or policy standards), social values and expert judgement (Morgan, 1998).

The notion of scoping as primarily a social process is widely accepted (Hill, 2004; Beanlands, 1988). The participatory objective of scoping ascertains what environmental factors are more and less important to individuals, groups and society as a whole. Scoping provides an opportunity for a proponent and the EA team to identify and assess key potential impacts and issues of concern through consultation with decision-makers, stakeholders, and the public (Bond and Steward, 2002).

The principle guiding the choice of who to involve in EA evaluation is to provide equal opportunity to all interested and affected parties to participate in scoping (Hill, 2004). The exchange of information and concerns between participating parties is based on written communication and face-to-face meetings. Inclusion of mediation recognises that evaluation is concerned with the controversies that often arise in the process of weighing information for a decision (*ibid.*).

Hill (2004) describes scoping as *a preliminary situation analysis* that shapes the design and content of all subsequent stages of an EA process. In doing so, it has a significant impact on the resulting decision. The preliminary situation analysis entails a comprehensive consideration of the proposal need (i.e. a problem's substance and boundaries). The importance of this activity is that the need underlying the proposal determines the selection of alternatives which may satisfy the proposal's purposes. Subsequently, scoping proceeds with a description of alternatives and their expected consequences. These consequences are weighed according to a set of values held or established by stakeholders and process participants. Therefore, to be effective, scoping requires an early intervention of the EA team in the planning and decision-making process before proponents have committed to a specific alternative. Consequently, scoping partially establishes the context of the proposal by selecting significant issues (e.g. alternatives, impacts, or objectives) that are to be subjected to further inquiry in the assessment stage (*ibid.*).

4.4.2 Assessment

The culmination of scoping introduces a more technical focus in the production of a plan or guidelines for the assessment stage (Hill, 2004). The activities in assessment are characterised by the importance of contributions from specialists (*ibid.*), in contrast to the social focus of the scoping stage.

The assessment stage involves the analysis of information relevant to the impacts that were selected for study during the scoping stage (Hill, 2004). The impacts are assessed and predictions made in terms of the severity of any impacts, or their likely distribution in time and space (RSA: DEA, 1992b). Subsequently, mitigation measures are explored and significance of mitigated and unmitigated impacts assessed (*ibid.*). An important element of the assessment stage is the collection of baseline data on the social and biophysical environments and their dynamics (Morgan, 1998). This information is crucial for the prediction of changes resulting from the proposed activities.

Technical studies during the assessment stage are guided by the social concerns identified in scoping (Hill, 2004). The assessment stage of EA is primarily of a *multidisciplinary* nature, as experts from different disciplines work together without any pre-established inter-relationships (Canter, 1996). However, the quality of environmental assessment should be enhanced using *interdisciplinary* approaches. Erickson (1979) argues that interdisciplinary study is more than a summation of activities conducted by individual specialists. It is rather about identifying and understanding interdependencies and relationships in the human environment (social and biophysical) and about taking advantage of the multiplicity of perspectives available. This can be achieved when specialists from different disciplines work together, and involve the public, in providing information on the proposal to decision-makers (*ibid.*). Hill (2004) indicates the importance of interdisciplinary approaches in assessing the extent of interactions between impacts, determining the significance of impacts, identifying mitigation measures, and in the communication of findings.

4.4.3 Evaluation

Assessment, during which facts are presented for a decision, is followed by evaluation of the facts and values necessary to reach a decision (Hill, 2004). The boundaries of the evaluation stage are initially determined during scoping (*ibid.*).

Evaluation is a normative process in that it is value-led, and it should be undertaken by stakeholders (Hill, 2004; Morgan, 1998). At this stage, participants explore their preferences in the process of comparing alternatives. By weighing the available information and balancing potential trade-offs participants arrive at a mutually-supported recommendation.

4.4.4 Management

Environmental management in proposal implementation is a significant determinant of the overall effectiveness of the conducted EA. It is used as a surveillance mechanism to ensure that terms and conditions of the ROD are implemented (Hill, 2004). Environmental management entails the monitoring of impacts and management of unanticipated problems that occur during proposal implementation (Sadler, 1996).

Implementing a monitoring programme ensures that a project is operated in accordance with its design specifications (Beanlands, 1988). Monitoring also indicates whether the mitigation applied has been effective. Consequently, decisions can be taken to include additional mitigation measures, or to relax certain constraints (Wathern, 1988). Data collection also helps determine the accuracy of EA by comparing the predicted situation with actual conditions (*ibid.*).

4.5 ENVIRONMENTAL ASSESSMENT AND SUSTAINABILITY

Principle 4 of the Rio Declaration states that environmental protection should become an integral part of the development process (United Nations, 1992). Hence, environmental protection cannot be considered in isolation from development (*ibid.*). Therefore, the integration of environmental considerations into strategic decision-making is imperative in attaining sustainable development (Dalal-Clayton and Sadler, 2004; Pope *et al.*, 2004). EA can provide guidance for integrated decision-making[i] – "*the primary component of sustainable development*" (Sadler, 1996:35).

Any shift towards sustainability in the field of EA poses two key challenges. Firstly, a meaningful contribution to sustainability requires extending the scope of EA to explicitly include social and economic considerations (Pope *et al.*, 2004). In aiming to "*sharpen EA as a tool for sustainability assurance*" (Sadler, 1996:227), it is necessary to determine what factors must be addressed in the assessment (e.g. social, economic and environmental effects; positive and negative; specific and cumulative; immediate and long-term; primary and secondary) (Gibson, 2001). It is also imperative to specify how the individual and joint social, economic and environmental effects are to be evaluated and compared (*ibid.*). Secondly, it is necessary to change the emphasis away from minimising negative development effects and impact mitigation towards maximising positive contribution to sustainability (Gibson, 2001). EA is required to adopt a more proactive stance on impact minimisation using a philosophy of '*anticipate and prevent*' rather than a '*react and cure*' approach (Sadler, 1996).

Moreover, EA cannot be readily applied as a method for sustainable development unless the sustainability criteria (principles) are included in the assessment (Gibson, 2001; George, 1999). Setting sustainable development objectives in the context, and for the purposes, of EA application is not an easy task. It is not merely a matter of addressing a combined set of environmental, economic and social objectives during the EA process (George, 2001). George (*ibid.*) states that these should be the key objectives that define sustainable development. In addition, these objectives should help reconcile potential conflicts between social, economic and environmental goals of development.

Nevertheless, EA is one of the most widely used tools for making development sustainable (Sadler, 1996). Strategic EA (SEA) is gaining widespread recognition as a supporting tool for higher level decision-making towards achieving sustainable development (Pope *et al.*, 2004; Noble, 2002; Shepherd and Ortolano, 1996). In SEA, which addresses environmental concerns at a strategic level, environmental factors are automatically married with existing social and economic concerns (Buselich, 2002). Despite this, there is no guarantee that SEA provides for "*social, economic and environmental concerns to be assessed together in an integrated manner*" (*ibid.*:8-9).

Achieving integration of these diverse concerns has become central to enhancing the effectiveness of EA in influencing decision-making, and through this promoting sustainable development (Kirkpatrick and Lee, 1999). The procedures that attempt to evaluate impacts of particular activities in all three spheres of sustainable development (i.e. environmental, social and economic) are often referred to as a sustainability appraisal, sustainability impact assessment, or integrated impact assessment (George, 2001; Bond *et al.*, 2001).

4.5.1 Integrated Impact Assessment

Integrated impact assessment (or sustainability assessment) emerged from "*integration among assessment tools*" (Scrase and Sheate, 2002:278) and the *horizontal* integration of environmental, social and economic considerations in impact assessment (Lee, 2002 cited in Pope *et al.*, 2004). It is based on the presumption that an interdisciplinary, multi-sectoral approach to assessing the impacts of a development represents best practice (Pope *et al.*, 2004). Integrated assessment consists of a diverse collection of methods and practice for which the common goal is to integrate environmental, economic, social and other forms of impact assessment (Milner *et al.*, 2005).

Integration implies that this procedure should be more than the sum of separate environmental, social and economic assessments (Pope *et al.*, 2004). Thus, integration by definition aims to identify and establish new relationships and dynamics in impact assessment by combining the three dimensions of sustainability (*ibid.*).

More specifically, integration helps qualify, quantify and evaluate the effects of proposed activities on the environmental, social and economic systems and their inter-relations (Post *et al.*, 1998). Scrase and Sheate (2002) assert that integration and integrated approaches are often presented as a universal answer for effective sustainable growth. Hence, integration remains a matter of "*value judgements embedded in particular assessment design and in specific historical and socio-political contexts*" (Milner *et al.*, 2005:50).

Pope *et al.* (2004) distinguish between two models of integrated assessment, namely, an *EIA-driven* model and an *objective-driven* model. These are discussed below in more detail.

4.5.1.1 EIA-driven Integrated Assessment

EIA-driven integrated assessment tends to identify mitigation measures through which adverse impacts can be minimised or avoided (George, 2001). This approach to sustainability assessment aims to ensure that overall impacts are not unacceptably negative. This means that any proposal that does not lead to a less sustainable outcome is considered acceptable (*ibid.*).

The advantage of EIA-driven assessment is that it can allow for a more transparent examination of the social and economic implications of proposals (Pope *et al.*, 2004). Transparency of the process is enhanced as environmental, social and economic impact assessments are conducted simultaneously and not as discrete activities that are often based on different methods and theories of sectoral assessments (Lee, 2002 cited in Pope *et al.*, 2004).

However, EIA-driven integrated assessment is a reactive process that aims to evaluate the impacts of a policy, plan or programme against some baseline conditions for which the decision-making is already fairly advanced (Pope *et al.*, 2004). This is done in order to determine the acceptability of impacts and to identify potential modifications that can improve the expected outcomes (*ibid.*). Hence, it is applied quite late in the decision-making process.

Furthermore, EIA-driven integrated assessment incorporates three sets of data in order to ascertain that a proposal is acceptable within a sustainability context (Pope *et al.*, 2004). The integration may require *trade-offs* between environmental, social and economic issues and impacts of significance (Pope *et al.*, 2004; Gibson, 2001). Yet the assessment does not examine the inter-relationships between them (Pope *et al.*, 2004).

4.5.1.2 Objective-driven Integrated Assessment

Objective-driven integrated assessment examines potential impacts and consequences of proposals against a series of environmental, social and economic objectives that are often combined (Pope *et al.*, 2004). The assessment process determines the extent to which a particular proposal contributes to a particular vision or outcome defined by integrated environmental, social and economic objectives. Acknowledging that sustainability is about a positive change rather than reactive mitigation, objectives-led integrated assessment has more potential to contribute to sustainability than EIA-driven integrated assessment (*ibid.*).

The objectives-led approach embodies a concept of sustainability as a goal, or series of goals, to which society aspires (Pope *et al.*, 2004). An agreement on a broad set of objectives that reflect the needs of all stakeholders at the process outset is required (*ibid.*). Therefore, the key challenges in objective-driven assessment include conflict avoidance and the identification of objectives that are compatible with one another.

The major difference between EIA-driven and objective-driven integrated assessment is the mode of contributing towards sustainability. EIA-driven assessment focuses on the acceptability of environmental, social and economic impacts; whereas objective-led assessment inquires if the proposal contributes positively towards environmental, social and economic goals (Pope *et al.*, 2004). However, George (2001) argues that proposals should not be assessed for their contribution to sustainability, but whether or not they are in fact sustainable.

4.5.2 Assessment Based on the Principles of Sustainable Development

According to George (1999), a pitfall of relying on a set of objectives and indicators in integrated assessments is that unless every single indicator is positive, for every social group, it becomes impossible to ascertain whether sustainable development actually has been achieved. In this way, the assessment serves only to indicate progress towards or away from individual aspects of sustainable development (*ibid.*).

Rather than focusing on individual factors that contribute to sustainability, George (1999) proposes linking the principles of integrated impact assessment (or sustainability assessment) to the basic principles of sustainable development, such as intergenerational equity (a necessary condition for sustainability) and intragenerational equity (a necessary condition for development).

Development can be made sustainable, despite carrying capacity limits, simply by restricting the numbers of people who benefit from it (George, 1999). Therefore, the real challenge is making development both sustainable and equitable at the same. Extrapolating from this position, George (*ibid.*) argues that applying the equity principles in a global context would be the most important test for sustainable development.

The principle of intergenerational equity itself embraces environmental conservation even more strongly than the concept of carrying capacity (George, 1999). Even when the carrying capacity cannot be adequately defined, or is in no immediate danger of being exceeded, the environment should be conserved for future generations. Therefore, it is possible to restate the principle of intergenerational equity as the principle of conservation of capital (*ibid.*). The basic concepts of strong and weak sustainability provide a useful starting point (George, 2001).

One way of implementing the principle of intragenerational equity in EA is the mitigation of adverse impacts by the developer (George, 1999). In principle, intragenerational equity requires identifying all impacts (positive and negative) that are significant to interested and affected parties and ensuring adequate mitigation (*ibid.*).

George (1999) also advocates the implementation of the participatory principle in the assessment of sustainability (Principle 10 of the Rio Declaration). Participation in EA provides the public with an opportunity to decide on what is equitable through the publication of an EIA report, its review, public hearings, or public inquiries. The public should decide about the quality of life, and what constitutes an improvement in it (*ibid.*).

4.5.3 Shifting Away from the Triple Bottom Line Approach

In integrated impact assessment the concept of sustainability is typically based on the *three pillars* or *triple bottom line* (TBL) approach, which emphasises the need to consider environmental, social and economic issues (Pope, 2003). Gibson (2001:7) points out that the three pillars of sustainability "*reflect more or less conventional modern disciplinary categories*". The pillars help identify areas that should be improved and mitigated against any adverse changes.

The triple bottom line approach aims to balance environmental, social and economic considerations in decision-making. However, the TBL approach can be easily reduced to a list of social, environmental and economic concerns to be analysed during decision-making (Buselich, 2002). Thus, this approach is likely to highlight potentially competing interests and objectives rather than the linkages and interdependencies between the three dimensions of sustainability (Pope *et al.*, 2004; Gibson, 2001). If environmental, social and economic concerns are not integrated and analysed throughout the assessment process, then the trade-offs are likely to compromise the environment (Pope *et al.*, 2004).

Gibson (2001:12) suggests shifting away from the conventional areas of concern (environmental, social and economic) towards "*a list of the key changes needed in human arrangements and activities if we are to move towards long term viability and well-being*". This new approach must be complemented with a list of principles that emphasise interconnections and interdependencies between the areas of concern. Otherwise, it may simply become a cosmetic change to the assessment methodology.

A principle-based approach in sustainability assessment could help avoid some inherent limitations of the TBL approach, such as promoting conflicts and trade-offs (Gibson, 2001).

Gibson (*ibid.*:12-21) proposes the following principles as a basis for sustainability assessment:

1. Integrity – "*build human-ecological relations to maintain the integrity of biophysical systems in order to maintain the irreplaceable life support functions upon which human well-being depends*" (p.12);
2. Sufficiency and opportunity – "*ensure that everyone has enough for a decent life and that everyone has opportunity to seek improvements in ways that do not compromise future generations' possibilities for sufficiency and opportunity*" (p.14);
3. Equity – "*ensure that sufficiency and effective choices for all are pursued in ways that reduce dangerous gaps in sufficiency and opportunity (and health, security, social recognition, political influence, etc.) between the rich and the poor*" (p.16);
4. Efficiency – "*reduce overall material and energy demands and other stresses on socio-ecological systems"* (p.17);
5. Democracy and civility – "*build our capacity to apply sustainability principles through a better informed and better integrated package of administrative, market, customary and personal decision making practices*" (p.18);
6. Precaution – "*respect uncertainty, avoid even poorly understood risks of serious or irreversible damage to the foundations for sustainability, design for surprise, and manage for adaptation*" (p.20); and
7. Immediate and long term integration – "*apply all principles of sustainability at once, seeking mutually supportive benefits.*" (p.21).

These principles express key changes needed for successful strategies towards sustainability (Gibson, 2001). The categorisation departs from the conventional pillars emphasising the interconnections and interdependencies among the areas of concern.

Pope *et al.* (2004:595) propose an alternative notion of sustainability assessment, namely, "*assessment for sustainability*". This considers sustainability as a series of societal states, with particular characteristics or conditions, defined by sustainability criteria. Pope *et al.* (*ibid.*) argue that the criteria of the assessment for sustainability can be developed using *forecasting* and *backcasting* approaches. Forecasting is a bottom-up approach, as the goals and objectives are defined in relation to baseline conditions. Backcasting begins with conceptualising sustainability as a state to which society aspires. This state is then defined in terms of sustainability criteria.

To conclude, the most critical problem that needs to be tackled in sustainability assessment is the methodology of analysing, integrating and presenting environmental, social and economic information to decision-makers (Buselich, 2002).

4.6 KEY AREAS OF RELEVANCE TO BUILDING ASSESSMENT

There are many parallels between the approaches to sustainability assessment used in the field of EA and those used in building assessment. Established *sustainable* building assessment methods are based on the conventional distinction between the three main pillars of sustainability (environmental, social and economic). However, these are traditionally given equal emphasis and the opportunities to prioritise issues are not well explored. The assessment is based on the distance to targets, but the pitfall of this approach is that it encourages a tendency to go for easy wins, whereby high scores are achieved in those areas that are the easiest to resolve. This does not result in a meaningful contribution towards the overall sustainability of the development. Moreover, a rigid divide between environmental, social and economic disciplines raises barriers to the identification of interconnectivity and interdependency between factors.

The field of building assessment can significantly benefit from the existing discourse about sustainability assessment in EA and from the methodologies used to address the challenge of sustainable development at a project level. It emerges that building sustainability assessment should be driven by sustainability-based principles and criteria, promoting equity and the conservation of capital. Hence, a fundamental resetting of purposes and priorities is required (Gibson, 2001).

There are also more tangible and practical lessons to be sourced from EA practice to enhance the effectiveness of building assessment. For instance, a key indicator of the effectiveness of building assessment would be, just as in the case of EA, the extent to which a building assessment method influences the formulation of building design, and its influence on decisions made during the management of the building process. Therefore, it would be valuable to examine, and adopt where appropriate, the mechanisms that are used to improve the effectiveness of EA in these contexts.

The relevance of EA for decision-making is the value-adding function of the assessment process, which according to Sadler (1996) is synonymous with EA's problem-solving capability. Arguably, building sustainability assessment methods should be designed to fulfil this purpose as well. Consequently, the application of building assessment as a stand-alone activity, separated from planning, design and decision-making processes can no longer be condoned.

The efficiency and fairness in accommodating the needs, concerns and values of interested parties in EA (Noble, 2000) are also critical in the context of building sustainability assessment. Following the example of EA practice, building sustainability assessment could benefit by emphasising the learning process in which participation leads to positive changes in environmental attitudes and behaviour (Sadler, 1996). The following sections discuss the potentially useful contributions from EA towards the improved practice of building assessment.

4.6.1 The Value of Scoping in Building Assessment

Scoping is a critical foundation for effective EA (Sadler, 1996; Beanlands, 1988) as it focuses the assessment process on significant issues and reasonable alternatives. Employing scoping in building assessment should help avoid the processing of large amounts of data, much of which may have little significance. By identifying key issues, interests and values in the early stages of building assessment, the efficiency of building performance and the project's sustainability can be significantly enhanced.

Scoping workshops allow enough information to be collected about a project and its environmental setting and socio-economic context to understand the potential conflicts, issues, or opportunities (Noble, 2000). Moreover, scoping can provide a forum for building stakeholders to express their needs and incorporate their values in the process of determining significance. The process of identifying significant assessment issues (e.g. selecting and defining indicators) is an explicit expression of the participants' values.

Moreover, scoping offers immense opportunities to design an effective and relevant building assessment process that is highly context-specific. By involving stakeholders in defining the boundaries and terms of reference for building assessment, the quality of the overall assessment process will be improved. This is due to the fact that all stakeholders would have a better understanding of the objectives and values that drive the project and, hence, the building assessment process. Having secured stakeholders' support, building assessment can effectively assist in sustainable project appraisal.

4.6.1.1 Assigning Significance to a Project's Objectives and Impacts

The concept of *significance* in EA presents theoretical and practical difficulties (Hill, 2004; Gibson, 2001; Sadler; 1996; World Bank, 1996). The key challenge is to "*define significance clearly and defensibly*" (Gibson, 2001:37). Contrary to the process of impact quantification, which is an objective and technical task, the evaluation of significance is subjective and political (World Bank, 1996) in that it is based primarily on value judgements.

In EA significance is assigned to both positive and negative effects, enhancements and any interventions regarding ecological, economic, cultural, and other factors (Gibson, 2001). The analysis takes into account the sensitivity of the receiving environment; socio-economic and cultural context; characteristics of the impacts such as magnitude, duration and reversibility; and applicable environmental laws and regulations (World Bank, 1996).

Sadler (1996) provides indications for good practice in determining significance. Significance should be identified using a systematic approach with a clearly stated choice of method suitable to tackle a particular problem. This has to be explained in a straightforward, non-technical manner. It requires specifying criteria to assign significance in a rational, defensible and problem-relevant way. It is important that all assumptions and uncertainties are explicitly stated and the basis for judgement is identified. According to Sadler (*ibid.*), it is also crucial to distinguish between the ecological and social importance of issues.

Assigning significance should be a joint effort of the EA team and stakeholders (World Bank, 1996). This allows the values, special interest considerations and best professional judgment to be applied jointly. In these circumstances assigning significance becomes a socio-political process that entails discussion, argument, negotiation and compromise. It is important to note that significance often needs to be re-assigned depending on the knowledge available at the various EA stages and on the views of important stakeholders (*ibid.*).

As in EA, the concept of significance is likely to be applied in building sustainability assessment mostly as a means of priority-setting. It can be used to assist judgement about what process design elements are crucial, what undertakings must be assessed and how rigorously, what alternatives should be considered, what effects must be mitigated or enhanced, what proposals can be approved and what obligations must be imposed in implementation (Gibson, 2001).

4.6.1.2 Designing Assessment Methodology

Scoping has a significant influence on the focus and effectiveness of EA (Beanlands, 1988) as it shapes all subsequent phases of impact assessment. According to Mulvihill and Jacobs (1998), scoping produces a framework that informs the assessment process by addressing issues of EA content, philosophy and methodology. Conscious use of scoping as a design process should also result in building sustainability assessment that is more relevant and fit-for-purpose; thus increasing its problem-solving capacity.

When used to delineate the assessment methodology, scoping can ensure that EA reflects the different value sets and cultures represented by all stakeholders (Mulvihill and Jacobs, 1998). This requires an open, nondeterministic approach towards EA, while aiming for transparency and mutual understanding. This approach to building assessment can help address the problems arising when applying prescribed and rigid assessment frameworks that were developed for urban settings into a rural context, which are so pronounced in the developing world.

Mulvihill and Jacobs (1998) list three primary challenges of using scoping as an effective means to design the process methodology. These include addressing multiple knowledge systems, accommodating different modes of expression, and interpreting interventions that are not *guideline ready*. However, it is the problem-definition or reshaping that is at the centre of designing EA during scoping (*ibid.*).

EA aims to focus on a relatively limited and manageable set of issues (Morgan, 1998; Mulvihill and Jacobs, 1998). Issues and concerns are usually identified in the context of a problem or opportunity during the scoping stage (Mulvihill and Jacobs, 1998). However, in rare instances, scoping can address a certain type of undertaking instead of a defined one (such as in the case of SEA). In this situation, scoping is concerned with problem-definition and, consequently, EA is not reactive to the project proposal and its context.

In referring to the Great Whale project, which involved problem reshaping during scoping, Mulvihill and Jacobs (1998:367) point out that the proponent's task was to "*first understand the environment from multiple perspectives and only then to justify its project and impacts, with reference to a set of principal assessment criteria*". In this case problem reshaping was influenced more by the receiving environment than the project itself or its benefits and impacts. This poses an interesting alternative to building sustainability assessment that is not only context-sensitive, but also helps optimise the project's outcomes by referring to the original problem definition (e.g. need statement).

Using scoping as a design process is especially valuable where development solutions are imposed in contexts with diverse value systems (Mulvihill and Jacobs, 1998). Specialists and facilitators are encouraged to act as "*active inquisitors*", shaping public perception and enhancing their understanding of technical aspects involved (*ibid.*:362). Scoping, which entails problem-definition and reshaping, becomes a collaborative learning process. It requires establishing the basis for an intercultural approach to EA and anticipating and addressing cultural barriers to consultation and participation.

The prospect of customising any building assessment process during scoping, relying on stakeholder input, is a valuable proposition for building sustainability assessment methods. Stakeholders involved in the design of subsequent stages of building assessment would gain ownership of the process, which would subsequently be translated into their support for the sustainable outcome.

4.6.2 Decision-Scoping

EA has been criticised for an ineffective delivery of its planning and design objectives (Brown and Hill, 1995). EA's poor adaptation to project planning and design as well as proposal formulation is a major concern (Sadler, 1996). Beanlands (1988:42) points out the danger of assuming that there is "*a single point in time when the results of the environmental assessment are considered by those responsible for project planning*". This approach to impact assessment prevents a timely consideration of the concerns and recommendations made by EA in the appropriate stages of the project planning cycle (*ibid.*). Moreover, when EA is conducted as a one-time exercise, the process fails to "*recognise, or allow for, the iterative nature of engineering design*" (Ridgway and Codner, 1994:4 cited by Ortolano and Shepherd, 1995:15).

The delivery of environmentally sound projects requires a better integration of EA with project planning and design. Such integration should bring about a dynamic and iterative interaction. Brown and Hill (1995) propose a *decision-scoping* procedure to facilitate this process. Decision-scoping provides a framework for incorporating environmental constraints and opportunities directly into the planning and design of projects, prior to the final stage of decision-making (*ibid.*).

Project planning and design entails a series of decision-points, and various decision-makers require specific information and data at different points during this process (Beanlands, 1988). It is therefore necessary to match the output of EA to the information requirements in project planning and design. Furthermore, McDonald and Brown (1995) emphasise the need for a common language between the EA and design teams, so that environmental information can be easily translated into design constraints and opportunities.

According to Brown and Hill (1995:228), "*prior knowledge of the nature and timing of the decisions that have to be made in the planning and design of a project is the fundamental starting point for an efficient and effective EA*". Decision-scoping begins with the scheduling of all planning and design activities, and decisions that take place during the stages of project planning, design and approval. This task can be facilitated by project managers and designers who can identify the timing and nature of decision-points (Brown and Hill, 1995). Subsequently, the EA and design teams determine together what information on environmental constraints and opportunities will be necessary for each activity and each decision-point.

Decision-scoping is a critical supplement of the scoping process that can strengthen the effectiveness of EA. By implementing decision-scoping, the scoping stage of EA is more likely to produce suitable terms of reference for subsequent EA stages. Such terms of reference would cover priority impacts and issues to be addressed, a study approach and a schedule including timelines for information inputs for decision-making. Consequently, the implementation of decision-scoping in EA results in better integration of EA and project planning and design. This translates into better suitability and relevance of EA studies/interventions, and better learning opportunities among all participants.

4.6.3 Mutual Adjustment in Decision-Making

Leknes (2001) explores three theoretical perspectives on decision-making, namely, a rational, institutional and negotiation perspective, which are also echoed in EA practice. The rational perspective is a utilitarian approach, which assumes that decisions are based on evaluating the goal achievement of different solutions. Thus, decisions result from calculations and evaluations of how development concepts can achieve the highest level of goal fulfilment. In the institutional perspective decisions are explained by formal rules, legal frameworks, established patterns, norms and values. This is a "*rule compliance routine leading to rule application*" (*ibid.*:7).

The negotiation perspective presents decisions as the product of the participants' resources, interests, antagonisms and alliances. It is assumed that participants have different interests and levels of understanding concerning the issues, and that they have the ability to influence the decisions. According to Leknes (2001), this last perspective complements the previous two and, more importantly, it addresses the problem of conflicting interests in decision-making.

Hill (2004) asserts that *mutual adjustment*, which embodies the process of participants adjusting to each other's interests and engaging in social learning to balance competing social values, is the most important concept for EA theory. According to Hill (*ibid.*), mutual adjustment is most appropriate in the decision-making (or decision-shaping) stages of EA. He points to scoping and evaluation as being more social in nature than scientific. During scoping interested parties express their interests so that social values can inform the EA process. These values provide the basis for a decision made during evaluation by the relevant authority (*ibid.*).

Hill (2004:35) defines evaluation as making *"judgements about what change is acceptable, what is unacceptable and what can be made acceptable if subject to certain conditions*". These judgements are made by individuals and reflect their preferences. Hill (*ibid.*) argues that a practical approach to evaluation is one of extracting participants' preferences in an explicit manner. This means that these preferences should be used to formulate a set of purposes to be striven for in a decision-making process.

In the context of building assessment, the assessment process is commonly viewed as a predominantly technical exercise, where the emphasis is placed on quantification and objective judgements imposed by specialists. However, by proposing stakeholder participation in building sustainability assessment, it is implied that some form of multi-actor decision-making is required. Participants are expected to adjust to each other's interests in establishing project values and agreeing on a course of action. This is achieved in the process of social and collaborative learning. Therefore, it is important to explore the value of participation in arriving at optimum decisions and the opportunities offered by mutual adjustment.

4.6.3.1 Multi-Party Participation

Friedman (1998) argues that professionals cannot provide an exclusive source of knowledge in contemporary urban planning. Arguably, this is no different in environmental planning and management. Friedman (*ibid.*:30) stresses the importance of "*allowing for a variety of equal valid and equally limited ways of knowing*". This requires complementing professional knowledge with socio-cultural realities of all participating parties. Moreover, the prioritisation and integration of social, environmental and economic objectives (or even trade-offs) entail value-based judgements. Hence, stakeholder involvement is imperative in any sustainability planning and assessment situation (Bass *et al.*, 1995).

Monnikhof and Edelenbos (2001) list four key aspects (4 D's) of stakeholder input in environmental planning and decision-making. These are defined as the following:

- *Demand* – i.e. exploring different interests and needs of stakeholders in order to incorporate them into policy alternatives and the problem statement;
- *Design* – i.e. allowing for stakeholder participation in the creative process of (re)designing solutions and in (re)designing the problem statement;
- *Deal* – i.e. negotiating and bargaining about *solution packages*, aiming to achieve the highest number of *win–win* solutions through mitigation, combining a number of solutions for different problems and/or compensation; and

- *Decide* – i.e. participation in a range of decision-making levels, such as selection of participants, screening of information and problem-shaping.

Asserting stakeholder input in building sustainability assessment offers opportunities for social and collaborative learning. Social learning allows stakeholders to better understand their own interests and the concerns of others, to recognise previously unrecognised values and construct new preferences, as well as redefine problems and their solutions (Wilkins, 2003; Saarikoski, 2000; Bass *et al.*, 1995). To achieve that all stakeholders need to be empowered and involved in the design, negotiations and decision-making process at the critical stages of building assessment (i.e. scoping and evaluation).

According to Monnikhof and Edelenbos (2001), participatory processes enrich the quality of decision-making in many ways. Stakeholder involvement helps to improve information flows between proponents and different stakeholder groups, improving the understanding and ownership of a project (Huges, 1998; Shepherd and Bowler, 1997). Stakeholders are presented with information otherwise unavailable to them. They learn about the environment in which they live and gain some elements of professional knowledge. This empowers them to come up with innovative solutions not only in the context of the particular problem at hand, but also other areas of their life. Moreover, their values are better represented during the problem formulation (Monnikhof and Edelenbos, 2001).

4.6.3.2 Balancing Power and Conflict Management

Power can be defined as the ability to secure specific results or accomplish change (Mouton, 1990). The problem with power imbalance in any decision-making is that it can result in illegitimate and biased decisions (Saarikoski, 2002). Hill (2004) argues that addressing power imbalance does not imply the need to eliminate the effects of power. He proposes to focus on restricting attempts by powerful participants to gain control of a decision-making process. This requires that all participants should agree on the rules of decision-making at its outset. Hill (*ibid.*:151) states that later in the process "*a competition of knowledge offers some escape from control, in that the many people and institutions involved dispute each other, allowing a wider and better understanding to develop*".

There are four factors that contribute to a meaningful and effective public participation in EA (Del Furia and Wallace-Jone, 2000). These factors include the nature of the public involved; the amount of power the public is attributed in decision-making (by the inherent nature of techniques and methods used); when the public are involved in the procedure; and the ability to manage conflict. However, the two main measures that help address the issues of power and justice in EA include public participation in decision-shaping and explicit recognition that decisions are based on values (Hill, 2004).

Conflict is often unavoidable in multi-party decision-making, and it is usually managed using negotiation techniques. Negotiation can be defined as joint decision-making (and problem-solving) by parties with interdependent but incompatible interests (Pruitt and Carnevale, 1993). Shaping decisions collectively entails identifying actions that satisfy a whole set of constraints (Hill, 2004). Decisions reached represent a consensus to which participants subscribe although not necessarily for the same reasons. This necessitates an understanding of the motivations, perceptions and constraints that shape the behaviour of parties (Daniels and Walker, 1996).

Harashina (1995) proposes a model of a *dispute-resolution* process, which focuses on the behaviour of the parties involved in negotiation. The process consists of three stages: an issues confrontation stage, conditions bargaining stage and consensus-building stage. The last two stages reflect negotiation for dispute resolution. According to Harashina (*ibid.*), negotiation is a learning process. Parties examine their own premises and the attitudes of other parties. As participants gain new information, they may change their perceptions and make better judgements. Consensus is achieved gradually through the process of negotiation and joint inquiry focusing on shared problems (Bass *et al.*, 1995).

Negotiation, which includes the (re)discovery of values and deliberation of different points of view in order to achieve a collective solution, is therefore an adjustment process (Heifetz and Sinder, 1988). During this process participants also learn how to balance competing social values (Hill, 2004).

To conclude, the process of mutual adjustment offers immense learning opportunities for building sustainability assessment. It distributes power and capacity among participating stakeholders (Hill, 2004), which in turn can significantly enhance social and collaborative processes taking place throughout building assessment.

4.6.4 Reconciling Soft and Hard Inputs by Engaging in Collaborative Learning

Public participation in environmental decision-making is a powerful mechanism for fostering collaborative learning. Most of the time, good public participation is regarded as one that focuses on fairness and competence (Webler *et al.*, 1995). However, this view underestimates the social and collaborative learning that takes place during discourse between different parties.

The role of public participation in EA was initially limited to that of educating the public about a proposed project and obtaining information about public concerns (Saarikoski, 2000). A more cynical interpretation might be that public involvement is intended to "*reduce the likelihood of litigation*" (Wathern, 1988:26) However, its application has evolved into a system for producing knowledge by offering a forum to deliberate and exchange views of the proposed project goals and potential impacts (Wilkins, 2003; Shepherd and Bowler, 1997). Shepherd and Bowler (1997) argue that the public and stakeholders do not always need more information, but rather more meaningful involvement in creating a mutually acceptable project, which is better suited to a local context.

As the values and perspectives that people hold are shaped during a discourse in which they engage, EA fosters greater personal and social responsibility and has the capacity to increase the importance of long-term environmental (as well as social and economic) considerations in decision-making (Wilkins, 2003). It is the sense of social responsibility, developed or rediscovered through social and collaborative learning, that enables taking collective actions which "*support and reflect collective needs and understandings*" (Webler *et al.*, 1995:460).

Social learning facilitates changes in general awareness and the recognition of how individual interests can be linked with the shared interests of society (Wilkins, 2003; Webler *et al.*, 1995). Thus, social learning comprises cognitive enhancement and moral development. Cognitive enhancement is the acquisition of knowledge, and includes (Webler *et al.*, 1995):

- Learning about the state of the problem (information and knowledge);
- Learning about the possible solutions and the accompanying consequences (cause-effect relations, predictions);
- Learning about other peoples' and groups' interests and values (information, explanation);
- Learning about one's own personal interests (reflection);
- Learning about methods, tools, and strategies to communicate well and reach agreement (rhetoric, decision theory, small group interaction); and
- Practicing holistic or integrative thinking.

Kolb (1984:38), cited by Daniels and Walker (1996:76), defines learning as "*the process whereby knowledge is created through the transformation of experience*". Therefore, effective learning requires active interaction between, and the empowerment of, participants (Daniels and Walker, 1996; Sinclair and Diduck, 1995). Indisputably, learning is directly dependent on the quality of communication between the participants.

4.6.4.1 Communication Competence

Collaborative learning emphasises activities that encourage open communication, joint learning and systems thinking (Daniels and Walker, 1996). It relies greatly on communication competence, which is a measure of appropriate and effective communication between parties (Lustig and Koester, 1993 cited in Daniels and Walker, 1996). However, a common shortcoming of EA can be attributed to a lack of communication and coordination among experts and decision-makers (Noble, 2002), even before the involvement of the public is considered.

Very often the parties involved in data collection, decision-making, and management have limited opportunities for collaboration or sharing of ideas and values (Noble, 2000). Specialists may often be unaware of the information needs of other investigators. Moreover, the investigators may not know the needs and objectives of managers and decision-makers (*ibid.*). Post *et al.* (1998) argue that a key task of an integrated analysis is to attain interdisciplinary collaboration among specialists. The coordination of sectoral studies (in the social, economic and environmental fields) through organised inter-expert meetings is imperative to build awareness of differences in sectoral approaches and to adapt contributions accordingly (*ibid.*).

To achieve communication competence, it is necessary to address issues of accessibility, co-operation and inclusive ownership (Milner *et al.*, 2005). For instance, the use of *specialist language* may effectively limit the role of *lay* participants in negotiation and problem-shaping (*ibid.*). The transfer of technical information in a form that all stakeholders can understand remains one of the biggest challenges in EA (Morgan, 1998).

Enserink and Monnikhof (2003) note that participation and technical decisions are not given the same appreciation despite being considered as complementary. "*Public preferences are merely noted by experts who design and decide*" (*ibid.*:316). Yet project suitability depends on public opinions and needs and, therefore, cannot be valued solely on a technical basis (Shepherd and Bowler, 1997). Consequently effective communication is invaluable as a means for achieving meaningful stakeholder participation (Morgan, 1998).

4.7 CONCLUDING REMARKS – LESSONS FOR BUILDING ASSESSMENT FROM EA's EXPERIENCE IN ADDRESSING SUSTAINABILITY

Practitioners in the field of building assessment have been challenged with the need to promote sustainable development in the built environment. Their initial efforts have focused on the incorporation of environmental, social and economic issues into the scope of building assessment methods. The review of the practice of EA, marked by similar advancement, reveals a number of parallels with building assessment in tackling sustainability. Hence, the theory and practice of building sustainability assessment can be enriched with lessons gained from the examination of EA (see Table 2).

Table 2: A Summary Table with Key Features of Environmental Assessment that are Relevant to Building Assessment

KEY CONCEPTS IN ENVIRONMENTAL ASSESSMENT	DEFINITION AND CHARACTERISTIC FEATURES	REASONS FOR INCORPORATING INTO THE MODEL'S SPECIFICATION
Provision of Advice to Decision-Makers	- The effectiveness of EA may be evaluated by the extent to which it has an actual influence on the formulation of proposals and on decisions. - EA provides anticipatory information about the beneficial and adverse environmental and social consequences of proposals to proponents and multiple decision-makers.	- Building sustainability assessment method should effectively influence the formulation of building design, and decision-making during the building process.
Scoping	- Scoping is the initial phase of EA that aims to narrow the scope of an assessment by identifying key issues and impacts to be addressed. It also establishes terms of reference for the assessment process. - The scoping procedure allows for a reduction in the amount of data collection and analysis required in the assessment process by identifying key issues and variables of the project assessment and implementation. - Scoping as *a preliminary situation analysis* that shapes the design and content of all subsequent stages of an EA process. The preliminary situation analysis entails a comprehensive consideration of the proposal need (i.e. a problem's substance and boundaries). The importance of this activity is that the need underlying the proposal determines the selection of alternatives which may satisfy the proposal's purposes.	- Employing scoping in building assessment should help avoid the processing of large amounts of data, much of which may have little significance. By identifying key issues, interests and values in the early stages of building assessment, the efficiency of building performance and the project's sustainability can be significantly enhanced. - Since building sustainability assessment may be applied at different stages of the building process, the assessment would serve different purposes. It is imperative to provide mechanisms that allow for flexibility and adaptability of the assessment methodology. Scoping offers immense opportunities to design an effective and relevant building assessment process that is highly context-specific.
Stakeholder Participation & Collaborative Learning	- Stakeholder participation in EA enhances the quality of a proposal/project as it is developed and implemented based on more	- Greater emphasis needs to be placed on the learning process in building assessment, which leads to positive changes in

	extensive technical and non-technical knowledge base provided by various stakeholders. - Stakeholder involvement in EA promotes social and collaborative learning. Social learning allows stakeholders to better understand their own interests and the concerns of others, to recognise previously unrecognised values and construct new preferences, as well as redefine problems and their solutions. - Prioritisation and integration of social, environmental and economic objectives (or even trade-offs) in EA entail value-based judgements. Therefore, stakeholder involvement is imperative in any sustainability planning and assessment situation.	environmental attitudes and behaviour. - Participation in building assessment can help building professionals to develop an understanding of the environmental and social implications of their work. - Participation in building assessment cannot be limited to the sourcing of information and presentation of results. Preferably, building stakeholders should be directly involved in the assessment activities, which also contributes to their empowerment and collaboration. - The scoping stage in building assessment can provide a forum for stakeholders to express their needs and incorporate their values.
Decision-Scoping	- The delivery of environmentally sound projects requires a better integration of EA with project planning and design. Matching the output of EA with information requirements in project planning and design is of fundamental importance. - Decision-scoping provides a framework for incorporating environmental constraints and opportunities directly into the planning and design of projects, prior to the final stage of decision-making.	- Decision-scoping will improve the coordination of building assessment activities with critical project decision-points. As a result, the "*informed*" decision-making will guarantee enhanced quality of the building process.
Project Appraisal	- EA becomes more often used as a management tool to enhance the development process, in addition to providing a technical aid in project appraisal. - To effectively appraise a project, an EA process needs to be incorporated into the project conceptualisation, preparation and implementation phases. In this way, environmental, social and economic objectives can be more easily met by the project implementation.	- To address and attain its numerous objectives, building sustainability assessment should be viewed as a process rather than an activity, dynamically integrated with the building project cycle.
Mutual Adjustment	- EA embodies the process of participants adjusting to each other's interests and engaging in social learning to balance competing social values.	- Broader stakeholder participation in building sustainability assessment will lead to a multi-actor decision-making that is required in any sustainability context. During the process of mutual adjustment, participants are expected to adjust to each

		other's interests in establishing project values and agreeing on a course of action. - It is important that building stakeholders develop shared project values during building sustainability assessment in order to mitigate potential power imbalances and conflicts.
Problem-solving capacity	- Significant emphasis has been placed on the application of the EA process for problem-solving and, thus, on providing EAs that are relevant and *fit-for-purpose*.	- Scoping enables a problem-based approach to building sustainability assessment, whereby a proposed building development is analysed in terms of the opportunities and challenges posed by its specific socio-economic and biophysical settings.
Communication Competence	- Communication competence is a measure of appropriate and effective communication between parties. This requires adequate communication and coordination of responsibilities among experts and decision-makers.	- Communication competence does not only require overcoming language barriers (especially in the transfer of technical information) between lay and professional stakeholders, but also establishing information needs, including information content, timing and form. Such practice is necessary to improve the effectiveness and efficiency of the building assessment process.
Sustainability Assurance	- The emphasis in EA has been shifted away from minimising negative development effects and impact mitigation towards maximising positive contribution to sustainability. - EA has begun to integrate environmental, social, economic considerations in a project proposal. It is acknowledged that integrated impact assessment requires incorporating sustainability principles and criteria in the assessment process.	- Building sustainability assessment should be driven by sustainability-based principles and criteria, promoting equity and the conservation of capital. - Building sustainability assessment can offer the framework for incorporating principles of sustainable development in the building project in an integrated manner.

Most of the impact assessment methods that address sustainability seek to minimise the 'unsustainability' of certain actions and to maximise benefits of development. As has been observed with EA, this approach when applied to building sustainability assessment may not result in the delivery of sustainable building practice. A key challenge for sustainability assessment is to provide measures to determine whether or not an initiative is sustainable, and this should be the ultimate long-term goal for building sustainability assessment methods. Moreover, it emerges that integration (of issues, different ways of knowing, different perspectives, values and objectives in decision-making) should become the most significant aspect of building sustainability assessment.

In common with EA, building assessment methods should focus on the collection, analysis and presentation of adequate information on the basis of which decision-makers may improve their judgement (Kørnøv and Thissen, 2000). Arguably, the effectiveness of building sustainability assessment is determined by the extent to which it influences decision-making in the building process to incorporate the principles of sustainable development. In general, the effectiveness of many existing building assessment methods in influencing decision-making is decreased by the fact that these are often *ad hoc* assessments. Furthermore, it is crucial that the information obtained from building assessment be collected and fed into the project cycle. Hence, it is important to have insights into the nature and timing of decision-making process in the building process. Consequently, in order to address and attain its numerous objectives, building sustainability assessment should be viewed as a process rather than an activity, dynamically integrated with the project cycle.

Building assessment methods aspire to be robust, simple and yet comprehensive. However, it is not easy to capture all possible assessment scenarios and contexts of application in a fixed set of assessment criteria. Since building sustainability assessment may be applied at different stages of the building process, the assessment would serve different purposes – ranging from proposal formulation and project appraisal to a simple audit of an existing building's performance. This is why it is crucial to provide mechanisms that allow for flexibility and adaptability of the assessment methodology. This problem can be partially solved by developing a generic assessment process and providing an opportunity to customise the method to assessing needs during scoping. *Objectives-led* or *decision-orientated* scoping is required to set appropriate terms of reference and to assist the participants in focusing on key issues and responsibilities. A scoping stage in building assessment would comprise the following activities:

- Establishment and refinement of project vision and objectives based on the principles of sustainable development and stakeholders' needs;
- Establishment of common project values;
- Determination of all contextual issues, factors and values that cannot be agreed upon, which influence problem-definition (to incorporate environmental and social objectives and constraints into proposal formulation);
- Identification of significant assessment issues based on social values and best professional judgement;
- Development of terms of reference for subsequent stages of the assessment process, i.e. the methodology or assessment procedure; and

- Scheduling of all critical decision-points in the project life cycle and the identification of the nature of information needed.

Following the example of EA, building sustainability assessment should facilitate social and collaborative learning. Stakeholder participation in building assessment is invaluable in that participation leads to positive changes in environmental attitudes and behaviours. Most importantly, participation in building assessment can help building professionals to develop an understanding of the environmental and social implications of their work. For instance, scoping and other *inter-active* stages of the assessment process can provide a critical platform where information is exchanged and knowledge generated based on dialogue and mediation. This, however, requires that certain negotiation and conflict-resolution measures be built into the assessment procedure.

To achieve a meaningful stakeholder participation and specialist involvement in building sustainability assessment, it is necessary to ensure high levels of communication competence. Communication competence does not only require overcoming language barriers (especially in the transfer of technical information), but also establishing information needs, including information content, timing and form.

Thus a number of practical issues arise that need to be addressed in the building sustainability assessment model:

- It needs to be able to collect, analyse and present information in a way that is accessible to both building professionals and lay stakeholders;
- It must allow for feeding back knowledge into the building process and to carry it forward onto subsequent projects;
- It must be integrated with the project cycle;
- It should identify and align with the critical decision-points in the project cycle; and
- It needs to facilitate effective communication between project stakeholders, overcoming technical language barriers.

In response to these issues, lessons can be drawn from the Process Protocol (Cooper *et al.*, 1998). The Process Protocol helps revise stakeholder participation in the building process in terms of its timing and responsibilities allocated among various stakeholder groups. It also places an emphasis on improved stakeholder communication and transfer of knowledge. The Process Protocol, which is presented in the following chapter, provides the second principal resource used in this research.

Chapter 5

ADOPTING A PROCESS VIEW IN BUILDING DELIVERY – LESSONS FROM THE GENERIC DESIGN AND CONSTRUCTION PROCESS PROTOCOL

5.1 INTRODUCTION – PROCESS PROTOCOL AS A FRAMEWORK FOR OPTIMISING DESIGN AND CONSTRUCTION PROCESSES

The previous chapter concluded with the observation that the effectiveness of building sustainability assessment is determined by the extent to which it influences decision-making in the building process. Consequently, there is a need for a close and dynamic integration of the building sustainability assessment process with the building project cycle. A clear understanding of the project cycle is imperative, so that the points of *contact* with building assessment can be clearly identified and managed. To attain the goal of influencing the decision-making process, the model for building sustainability assessment should incorporate mechanisms for an effective sourcing of information from building stakeholders as well as for the timely dissemination of appropriate information among interested and affected parties at all critical decision-points. It is thus necessary to further address the issues of information needs (e.g. timing, content and form) and communication competence throughout the building process.

This chapter begins with the exploration of current barriers and difficulties experienced in the construction industry in tackling the sustainability agenda. It is shown that the phenomena of knowledge transfer and stakeholder empowerment are indispensable for a successful incorporation of sustainability in construction, especially at a project level. Subsequently, the Generic Design and Construction Process Protocol (Process Protocol) is introduced as a practical illustration of the industry's response to the problem of its fragmentation and overall inefficiency.

The Process Protocol was developed in 1998 at Salford University (Cooper *et al.*, 1998). It provides a framework to help improve and optimise the design and construction processes. One of the fundamental features of the Process Protocol is the re-construction of the design and construction teams into *Activity Zones* to create cross-functional teams (Wu *et al.*, 2001). With the use of process maps, the Process Protocol provides a means of describing the construction project in an accessible and transparent form to all stakeholders. In addition, the

Process Protocol identifies key decision-points and associated information needs throughout the design and construction processes (*ibid.*) that any building sustainability assessment model will need to interface with.

The chapter continues with the discussion of efforts to introduce sustainability considerations into the building process through the Process Protocol. This provides valuable insights towards the development of the specification for the building sustainability assessment model that enhances building design, construction, operation and decomissioning from a sustainability point of view. The Process Protocol, and associated process mapping, can be used in the conceptualisation of the design and construction processes for the purposes of developing the specification. It can also be of assistance in streamlining the building assessment process. In this way, the model can be better related to the building process, and thus more effective in application.

The chapter concludes with a brief discussion of issues that are of relevance to building assessment stemming from the philosophy and approach of the Process Protocol. They provide lessons that can be used to develop the model for building sustainability assessment and to present this assessment in a language that is understandable to construction practitioners.

5.2 TOWARDS SUSTAINABLE CONSTRUCTION – THE CHANGING EMPHASES

The construction industry has already responded to the challenge of embracing the principles of sustainable construction focusing particularly on meeting its environmental responsibility (Uher, 1999). Despite a common awareness that solutions to environmental problems require "*major changes in human values and actions*" (Cole, 2003:57), the efforts of promoting environmentally-friendly buildings are characterised by their technical focus. In fact, the sustainability agenda for the construction sector should be driven by a paradigm shift from viewing the construction sector as negatively *transforming nature* to that of positively *transforming society* (Birkeland, 2002). It seems, however, that the social, cultural and economic dimensions of sustainable construction are more difficult to tackle and operationalise in construction. Yet they are indispensable in reinforcing the efforts and commitment of the construction sector towards environmental sustainability.

Arguably, social sustainability in construction can be enhanced through capacity-building and empowerment of stakeholders allowing for a more meaningful participation in the building process, while contributing to the development of human capital. The implementation of a participatory approach in the building process is not only validated in terms of satisfying the aspects of equity and fairness by involving the client and other interested and affected parties, often referred to as "*people outside the project*" (Newcombe, 2003:843), in project planning and decision-making; it is also validated by developing a critical awareness within the society about responsible lifestyles and choices. Participation, which promotes the practice of integrated design and collaboration between building professionals, can enhance the quality of communication in terms of information exchange and knowledge transfer throughout the project. It can also reconcile the potentially conflicting views of the building process held by various participants.

5.2.1 Factors Contributing to the Current Lack of Sustainability within the Construction Sector

The construction industry constantly requires the forming of new relationships, mostly on an *ad hoc* basis (Turin, 2003), and is also characterised by delivering unique and complicated products. This situation has prompted a progressing fragmentation of the industry, both organisationally and technically. The observed fragmentation and distinct separation of the building professions are seen as key factors preventing a tangible transition of construction practices towards a closer alignment with the ideals of sustainable construction (Lee *et al.*, 2000a; Sheath *et al.*, 1996).

The allocation of responsibilities between the different building professions and their sequential intervention in different stages of the building process have led to a further specialisation and inefficiency in the coordination and communication between their project roles (Turin, 2003; Lee *et al.*, 2000a). Moreover, the prevailing informal and unstructured nature of the learning process, resulting from the constant reforming and dissolution of project teams, acts as a barrier for improving performance within the sector.

The contemporary building process is inherently a multi-disciplinary undertaking. The major parties traditionally involved in the building process include the client, the user, the professionals, the building or contracting organisations, and the manufacturer of building materials and components (Turin, 2003). However, the traditional distribution of roles in the building process and the already mentioned sequential interventions of different parties in the process pose serious barriers to any collaborative effort and integrated problem-solving, which can enhance the quality of the building process and product(s). This *status quo* has negative implications on an effective information exchange and knowledge transfer as well as on the understading of contextual issues and stakeholder needs; so critical to any project's success.

Under the existing industry structures, participants have different perceptions of the building process objectives and purpose; "*different justifications in the complex of activities with which building is concerned*" (Turin, 2003:180), which leads to conflicting conceptual frameworks within the building process (Groák, 1992). The resultant complexity of the process has meant that the ownership and control of the process have resided with the construction professionals. These professionals typically pursue their own agendas during the building process at the expense of other stakeholders, such as building end-users and construction workers.

Consequently, what historically was a *social process* has become primarily a *technical process* with an emphasis placed on production, such that the building project is now synonymous with the actual construction works (Cooper *et al.*, 1998).

5.2.2 Adopting a Process View of Building Project Delivery

The dominant technical focus of the building project diverts attention from the overall building process taking place to the physical aspects of a building product. As a result the pre-construction and post-construction activities have been sidelined and often accelerated to reach the production stage, or to move onto the next project. Thus, many procurement systems are driven by a *product view* to optimise cost, time and quality (Cooper *et al.*, 1998). Yet the product view holds only a limited capacity for any performance improvement in the building process necessary to deliver products of desired quality or fitness for purpose.

The constraints of existing building practices have been recognised by the construction industry through a number of initiatives over the past 50 years (e.g., Egan, 1998) that actively focus on a project delivery process rather than on a physical product. The industry's need and desire to become innovative, modern, competitive, efficient, and responsive (Gilham, 1998) provides an important driver to develop a new *modus operandi* in the construction sector – one that is actively promoting process thinking (Turin, 2003; Cooper *et al.*, 1998).

Adopting a *process viewpoint* in construction requires a new way of thinking, a change of culture and working practices. By focusing more on information exchange and transfer of knowledge, the new approach may improve the efficiency and effectiveness of the building process. Since project success relies upon the right people having the right information at the right time, a proactive resourcing through the adoption of a stakeholder view should ensure that appropriate participants are consulted early in the process (Cooper *et al.*, 1998). This is crucial for the purposes of identification, definition and evaluation of client requirements, which inform the development of suitable solutions (*ibid.*). The process view of building production also popularises a more integrated mode of construction, which requires effective communication between building participants and their early involvement in the building process to help mitigate the effects of fragmentation.

Most importantly, pursuing a process view in construction inevitably entails the redistribution of responsibilities and power throughout the building process among all interested and affected parties. This may consequently lead to a shift in construction from the ownership of the product, traditionally tied to the client, towards the ownership of the process shared by shareholders who make up the building process.

Groăk (1992:121) argues that "*buildings are the result of industrial and social processes*". Yet the building and construction professions are still struggling to discover and appreciate the social context of their work (Dooley and Fridley, 1998). Broader and more effective stakeholder participation provides opportunities to integrate social complexity and diverse viewpoints of interested parties into the building process, reconciling the social and technical dimensions of the project. This is an important component of the sustainability agenda, which is steadily becoming a mainstream concern.

5.2.3 Promoting Stakeholder Participation in the Building Process

As the traditional approach to the building process does not provide any opportunity for the construction team to be involved in the design process at the early development stages, there is almost no room for knowledge sharing, more open relationship building and the development of trust between the parties (Walker and Hampson, 2003). Yet the involvement of all stakeholders in the early stages of the process is imperative for the development of shared values. Innovative procurement paths provide ways to overcome this problem, although Walker and Hampson (*ibid.*) note that selecting an appropriate management style and approach is more important than the choice of a procurement method.

Stakeholder participation in the building process improves the quality of decision-making as the process is optimised by an extensive technical and non-technical knowledge base provided by various stakeholders. In this way, a reductionist separation of design and production problems can be avoided through an enhanced understanding of the complex interdependency between decision factors and related contextual issues (Bell and Morse, 2003). Participation also assures a broad-based consensus and support for decisions made, collective ownership of problems and solutions, as well as contributing to building local implementing capacity (Hamam, 1999). According to Bell and Morse (2003:19), "*the issue is perhaps no longer about desirability of such public involvement but its practicality*".

Participation does pose a number of challenges. Toth (2001) argues that a participatory approach can contribute to more effective decision-making if the intention to reach an agreement among the participants is serious and honest. However, if there is no such intention, the lessons learned during training exercises (a component of participatory techniques) can be abused and serve as an excellent knowledge base for *strategic behaviour*, for instance to push the process *away* from possible areas of consensus (*ibid.*).

Power is also an issue in a participatory process (Morris, 1994), which is used as the mechanism through which stakeholders influence the direction and decisions for the project. It would seem logical that the main project objectives are determined by the client or proponent who provides financial resources. As the construction industry is undergoing a transformation through the infusion of principles of sustainable development, the client is likely to have to trade-off control over certain aspects of the project in order to gain broad-based support. Indeed, the traditional definition of the client has already been extended to include the users of the facility, the community at large and many others (Newcombe, 2003); the traditional client being perceived as one stakeholder out of many.

For a vision of sustainable construction to be of value and to be realisable, it has to be shared and supported by professional and lay stakeholders (Fowles, 2000). Fowles (*ibid.*) argues that a conscious and informed participation in the processes of creating and using the built environment creates a transformative environment for all involved. More importantly, inclusive stakeholder participation needs to be transparent, so that a sense of ownership of the process can be developed (*ibid.*).

Indisputably, there is an urgent need for effective mechanisms to integrate internal and external stakeholders to share and own the building process. Such stakeholder management measures should provide a platform for dialogue, mediation and reconciliation of potentially conflicting stakeholders' views of the building process. Building assessment methods have a central role to play in this endeavour.

5.2.4 Enhancing Performance in Construction by Integrating Social and Technical Variables

Designing, constructing and maintaining buildings are arguably social processes influenced by the constraints of local climate, resources and regional traditions (Kohler, 2003). The incorporation of the sustainability agenda in construction necessitates the revision of the concept and practice of participation in the building process. The construction project needs to be redefined so that it focuses on the social processes and their benefits to the construction industry and wider society. In addition, the transition to sustainable construction requires developing shared values among internal and external stakeholders to ensure their long term commitment and collective responsibility for taking a sustainable course of action.

Adopting the process view in construction can considerably enhance the quality of project delivery and the performance of project stakeholders. The process view addresses not only technical but also social variables in the building project. As it provides an enabling environment for improved communication among project stakeholders, it helps establish the desired continuum for collaborative learning and knowledge sharing on a project-by-project basis.

The Generic Design and Construction Process Protocol is an example of an effort to conceptualise the building project using the process view. The following sections give an overview of this framework (i.e. Process Protocol), which aims to integrate social and technical processes during building design, construction, operation and demolition.

5.3 THE GENERIC DESIGN AND CONSTRUCTION PROCESS PROTOCOL

The Generic Design and Construction Process Protocol (Process Protocol) provides a framework with a common set of definitions, documentation and procedures to facilitate more effective co-operation between organisations involved in the building process (Kagioglou *et al.*, 1998). The Process Protocol is the product of a research project undertaken at the University of Salford (Cooper *et al.*, 1998) which involved a wide range of collaborating companies from the construction industry, including clients, contractors, sub-contractors, architects and suppliers (Aouad *et al.*, 1999). The primary aim of the research was to develop a means of streamlining design and construction activities by applying the process view. Lessons were drawn from best practices implemented in the manufacturing industry. In particular, the area of New Product Development (NPD) provided significant input, as it most closely resembles the nature of the building process (Kagioglou *et al.*, 2000). Moreover, the NPD and the construction sector share a number of characteristics, namely (Cooper *et al.*, 1998):

- The start of the project may be initiated internally, or by direct and/or indirect contact with the customers and/or other users;
- The development of the product requires the participation of a number of specialists and functions, such as designers, surveyors, marketing, or production managers;
- The successful construction or manufacture of a building or product will only be achieved if all external (suppliers and consultants) and internal resources are utilised and coordinated effectively; and

- The building or product is handed over to the customer/client with provision made for future support.

The research revealed that NPD, which entails the development of an idea, need or client's requirement into the final commercialisation of the product (Cooper *et al.*, 1998), provides a framework for an effective and efficient delivery of desired outcomes. The construction industry relies mainly on *ad hoc* methods to control, coordinate and manage activities during the building process. Evidently, there is a need for a similar framework in construction that can offer a structured approach to the building process, increasing its consistency and helping to avoid common mistakes (*ibid.*).

However, to establish a consistent process for the construction industry, it is necessary to re-examine its prevailing culture and working practices (Cooper *et al.*, 1998). One of the fundamental problem areas in construction that was identified through the research is the linear relation of the design and construction phases in the project (Aouad *et al.*, 1999). Therefore, the research focused primarily on the problem of integrating design and construction activities using a common managerial approach. An important aspect of that was the development of an effective communication strategy for the building process (*ibid.*).

Consequently, the Process Protocol can be defined as a way in which the design and construction processes are re-arranged to produce a more efficient, effective and economical delivery of construction projects (Aouad *et al.*, 1999). Tangible benefits of implementing the Process Protocol include wastage reduction, the shortening of project duration and improved communication methods and channels, among others (*ibid.*).

5.3.1 Principles of the Process Protocol

The Process Protocol is based on six principles that are fundamental to an improved building process (Cooper *et al.*, 1998). According to Kagioglou *et al.* (2000:143), these principles can best describe a "*new process paradigm*" underlying the Process Protocol. These principles are briefly discussed in the following sections.

5.3.1.1 Whole Project View

Addressing a whole project view in construction is a necessary precondition, as the definition of the project has traditionally been synonymous with the actual construction works (Cooper *et al.*, 1998). As a result, the pre-construction activities have been sidelined and often accelerated to reach the construction stage, or to move on to a *new job* (*ibid.*). This has resulted in a poor identification of client requirements and an ineffective project brief with limited involvement of internal and external specialists. Conceptualising the building process, from the recognition of a project need through to the operational stage (preferably including the demolition/deconstruction works), ensures informed decision-making at the front-end of the design and construction development process (Kagioglou *et al.*, 1998). This has consequent benefits for on-site activities. Most importantly, taking a whole project view provides opportunity to identify potential interdependencies of tasks within the process (Kagioglou *et al.*, 2000).

5.3.1.2 Consistent Process

Ensuring process consistency is also a critical aspect of the Process Protocol. This entails the adoption of a standardised approach to performance measurement, evaluation and control (Cooper *et al.*, 1998). Consistent processes facilitate continual improvement in design and construction (*ibid.*).

5.3.1.3 Progressive Design Fixity

The principle of progressive design fixity is operationalised using a *stage-gate* approach drawn from the manufacturing industry. It requires that a consistent planning and review procedure be applied at each stage of the process (Cooper *et al.*, 1998). In the Process Protocol, phase reviews provide an opportunity to examine the work executed in a particular phase (refer to Section 5.4.3). The progress needs to be approved before the planning, resourcing and execution of a new phase are possible. This allows for a progressive fixing and/or approval of design information throughout the process, resulting in increased predictability of construction works (Kagioglou *et al.*, 1998).

5.3.1.4 Coordination

For all stakeholders involved in the building process to work seamlessly together it is necessary to provide a mechanism for coordinating their participation and project activities throughout the process. In the Process Protocol the coordination of the process falls under the responsibility of the Process and Change Management Activity Zones (Cooper *et al.*, 1998). The actions of the Process Manager are supported by the Change Management Zone through which all information related to the project is passed (*ibid.*).

5.3.1.5 Stakeholder Involvement and Teamwork

Following the practice of establishing multi-functional project teams in the manufacturing industry, the Process Protocol introduces the concept of the *Activity Zone*. This means that process participants are described in terms of the activities that need to be undertaken in order to achieve a successful project and process execution (Kagioglou *et al.*, 2000). This is a major change in the identification of roles in the building process from the historically labelled roles of architects, engineers, contractors, whose scope of works constantly vary at the margins from project to project. Proactive resourcing of information from key stakeholders during phase reviews ensures that crucial design and production information is gathered early in the process (Cooper *et al.*, 1998). Working in multi-functional teams can also foster a team environment and encourage appropriate and timely communication and decision-making (*ibid.*). The Activity Zones of the Process Protocol are presented in Section 5.3.4.

5.3.1.6 Feedback

Learning from experience is imperative to a continual improvement of construction practice. The introduction of phase reviews in the Process Protocol provides an opportunity to record project experience throughout the process. This information can be utilised in later phases of the construction process or on future projects (Cooper *et al.*, 1998). Through these phase reviews, the Project Protocol establishes the *Legacy Archive*. This is a mechanism for recording, storing and retrieving project/process information (Kagioglou *et al.*, 1998). The Legacy Archive is meant to be used by project participants in the current and future projects.

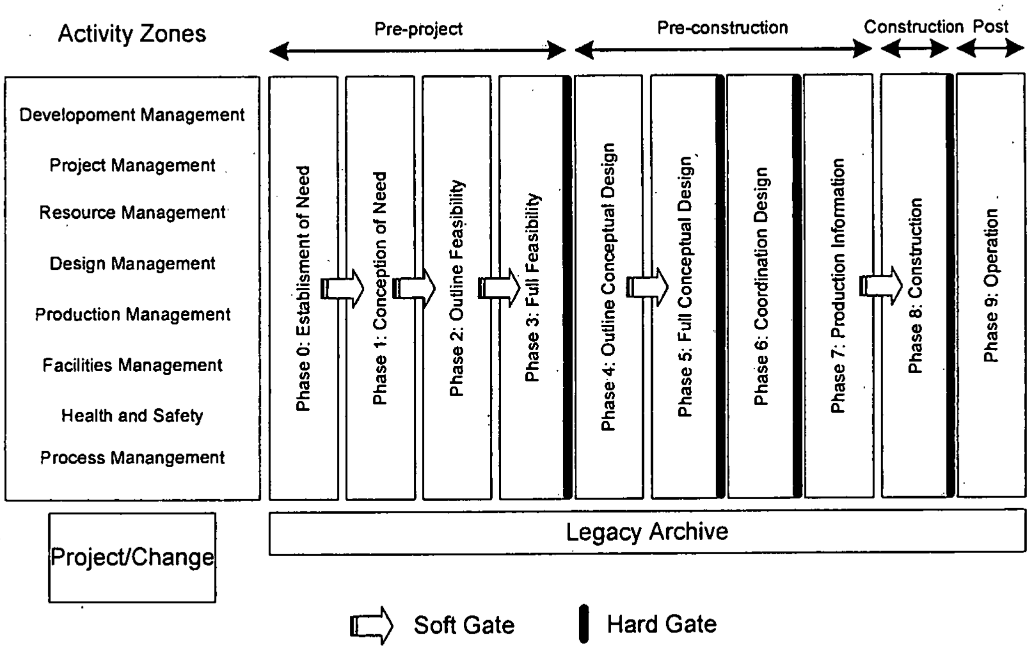
5.3.2 Organising the Building Process in the Process Protocol

The Process Protocol uses process maps to build up a framework for delivering any construction project (Kagioglou *et al.*, 1998). The building process is divided into 10 phases, which are incorporated into *Pre-project*, *Pre-construction*, *Construction* and *Post-construction* stages of the project life cycle. The process sequence in time and relevant process functions represented by Activity Zones are depicted in Figure 6.

The building process begins with the pre-project stage, which entails strategic business considerations of any potential project (Cooper *et al.*, 1998). During this stage the client's need is progressively defined and assessed. The statement of need is developed into the structural brief and all key stakeholders identified. Subsequently, core teams that will form the Activity Zones are appointed (Kagioglou *et al.*, 1998). In addition, the early feasibility study allows for the screening of potential design solutions and the selection of those solutions which will be considered further. It is also necessary to secure the outline financial authority before proceeding to the pre-construction stage (Aouad *et al.*, 1999).

During the pre-construction phases the client's need is developed into appropriate design solutions according to the project brief (Cooper *et al.*, 1998). This activity might involve many members of the construction supply chain, such as suppliers, specialist contractors as well as traditional design consultants (e.g. an architect and engineer). The design details are determined and reviewed to enable the planning of construction (including the assembly and enabling works) (Kagioglou *et al.*, 1998). The phase review process adds the potential for the progressive fixing of design information, together with its concurrent development. The major advantage of the progressive fixity is improved communication and coordination between the project's participants as they pass through each phase (Cooper *et al.*, 1998). The pre-construction phase ends with the securing of the full financial authority necessary to proceed with actual construction works. This key decision-point requires a full understanding of the extent of the construction works and associated risks (*ibid.*).

Figure 6: Project Stages in the Process Protocol (adapted from Aouad *et al.*, 1999)



The construction stage entails the production of the project solution (Cooper *et al.*, 1998). During this stage, the construction process is managed and information and resource flows controlled (Kagioglou *et al.*, 1998). The benefits of enhanced communication and coordination of activities during the design development are predominantly evident during this stage (Kagioglou *et al.*, 2000).

The post-construction stage consists of managing the monitoring and maintenance of the constructed facility (Cooper *et al.*, 1998). As the facility management specialists would have been involved in the earlier stages of the building process, these activities are delivered more efficiently. In addition, all records of the development of the facility are stored in the project's

Legacy Archive (*ibid.*). A post-project review can help identify any areas that need to be given more attention in future projects (Kagioglou *et al.*, 1998).

5.3.3 Phase Reviews and the Concept of Soft and Hard Gates

The stage/gate approach is a vital feature of the Process Protocol (see Figure 5) (Aouad *et al.*, 1999). During the phase review meetings, the feasibility of the project is examined against certain project and process critical success factors (Kagioglou *et al.*, 1998). The aim of the phase review is to ensure high quality performance. It is perceived as a *mistake avoidance mechanism* (*ibid.*).

The use of *soft* and *hard* gates at the phase review points helps reduce development times and facilitates a natural progression of the project life cycle (Aouad *et al.*, 1999) by imposing discipline on the project. Soft gates allow for concurrency in the process, while respecting key decision-points in the process (Cooper *et al.*, 1998). This means that the activities of a subsequent phase can be started before the current phase is finalised (e.g. between the pre-project stages). Hard gates require the completion of all activities and satisfying all criteria before a decision to proceed is made (Kagioglou *et al.*, 1998). An example of that would be the decision to build at the end of the pre-project phase, also the commencement of on-site activities, and the hand-over of the facility. In fact, current practices of the industry reflect the existence of *hard gates* to some extent, e.g. standard forms and conditions of contract. The stage/gate approach makes decision-points explicit and transparent to all stakeholders, other than those who are a party to the construction contract.

During a phase review meeting a report is presented with all relevant deliverables for the particular phase (i.e. documented project and process information). The main outcomes of phase reviews include the following (Kagioglou *et al.*, 1998):

- A potential decision to pass/fail or postpone the phase review for a later stage;
- Critical decisions on (mainly) financial authority to proceed;
- Planning for next phase and setting a date for next phase review; and
- Phase review minutes distributed to all attendees.

All phase review reports and minutes are entered into the Legacy Archive (Kagioglou *et al.*, 1998).

5.3.4 Stakeholder Involvement in the Process Protocol

Stakeholders in the Process Protocol are defined as individuals or organisations whose views, interests and needs can influence or are influenced by the proposed project (its initiation, formulation and/or implementation) (Kagioglou *et al.*, 1998). The timely identification, prioritisation of stakeholders and their needs, and their involvement in the process can arguably lead to more effective decision-making throughout the project life cycle (*ibid.*).

The Process Protocol groups project stakeholders into 9 Activity Zones: Development Management; Project Management; Resource Management; Design Management; Production Management; Facilities Management; Health and Safety Statutory and Legal Management; Process Management; and Change Management (Kagioglou *et al.*, 1998). These multi-functional and multi-disciplinary teams are responsible for specific sets of tasks and processes within the design and construction processes (Cooper *et al.*, 1998). An Activity Zone may be carried out by a single person or a complex network of people depending on the project's scale (*ibid.*). The multi-functional nature of Activity Zones implies that their membership is determined by specific project task and/or process (e.g. design detailing, production, supply, or continuous client input).

Activity Zones may overlap and are interdependent (Kagioglou *et al.*, 1998). For instance, Design Management often provides input for the Production Management and Facilities Management Activity Zones. These Zones may also provide input for Design Management (Cooper *et al.*, 1998). However, each Activity Zone has a primary responsibility for certain deliverables in the project:

- *Development Management*: Development Management is responsible for maintaining business focus throughout the project, and satisfying stakeholders' needs and constraints (Kagioglou *et* al., 1998). Therefore, the Development Management Zone can be conceptualised as the client/customer for the potential project (Cooper *et al.*, 1998). It is the only Activity Zone which has activities at every stage of the project cycle. Client's needs are presented and interpreted via the project brief developed by this Activity Zone.
- *Resources Management*: This Activity Zone is responsible for the planning, coordination, procurement and monitoring of all financial, human and material resources throughout the building process (Kagioglou *et al.*, 1998).
- *Design Management*: Design Management translates the business case and project brief into an appropriate design solution. This Zone also facilitates the integration of design inputs from other Activity Zones (Kagioglou *et al.*, 1998).

- *Facilities Management*: The Facilities Management Zone aims to secure a cost efficient management of the new asset, and the creation of an environment that strongly supports the primary objectives of the building owner and/or user (Kagioglou *et al.*, 1998).
- *Health & Safety, Statutory and Legal Management*: This Zone identifies and manages all regulatory, statutory and environmental aspects of the project (Kagioglou *et al.*, 1998).
- *Project Management*: The core responsibility of Project Management is an efficient and effective implementation of the project (Kagioglou *et* al., 1998). A crucial deliverable of this Zone is the project execution plan, which guides the integration of all relevant inputs from other Activity Zones (Cooper *et al.*, 1998). It collaborates closely with Process Management to ensure that agreed performance criteria are met. These criteria are based on requirements specified in the business case and project brief. Moreover, it is an active agent of the Development Management Activity Zone (*ibid.*).
- *Process Management*: This Zone develops and operationalises the Process Protocol (Kagioglou *et al.*, 1998). It is responsible for planning and monitoring of activities of each phase and for reviewing phase reports. Consequently, this Zone determines and examines process inputs and outputs at each phase. Process Management also provides recommendations to the Development Management Zone regarding a satisfactory delivery of the final product (Cooper *et al.*, 1998).
- *Production Management*: Production Management ensures that the optimal solution for the buildability of the design is implemented. It is also responsible for construction logistics (Kagioglou *et al.*, 1998).
- *Change Management*: This Zone communicates any project changes to relevant Activity Zones in the process. Change Management also develops and manages the Legacy Archive (Kagioglou *et al.*, 1998). Hence, Change Management acts as the interface between all Activity Zones and the Legacy Archive (Cooper *et al.*, 1998).

The use of Activity Zones helps harvest optimal benefits from teamwork. The communication process is enhanced as the participants work towards common objectives. In addition, this approach prevents any domination of a particular category of building professionals over any project phase or decision. This is a significant improvement over traditional conceptualisations of the building process, when typically the distinction between project phases is determined by the entry of different parties (e.g. an architect or contractors) (Kagioglou *et* al., 2000), and where the model reflects the viewpoint of a particular industry stakeholder, e.g. the RIBA Plan of Work.

5.3.5 Using Process Maps to Represent the Design and Construction Processes

Process mapping is a valuable management tool used to illustrate flows of information and/or materials within an organisation (Winch and Carr, 2001). Process maps are usually two-dimensional. The actors or functions responsible for each task are plotted on the vertical axis, and the horizontal axis shows project/process progression in time (*ibid.*).

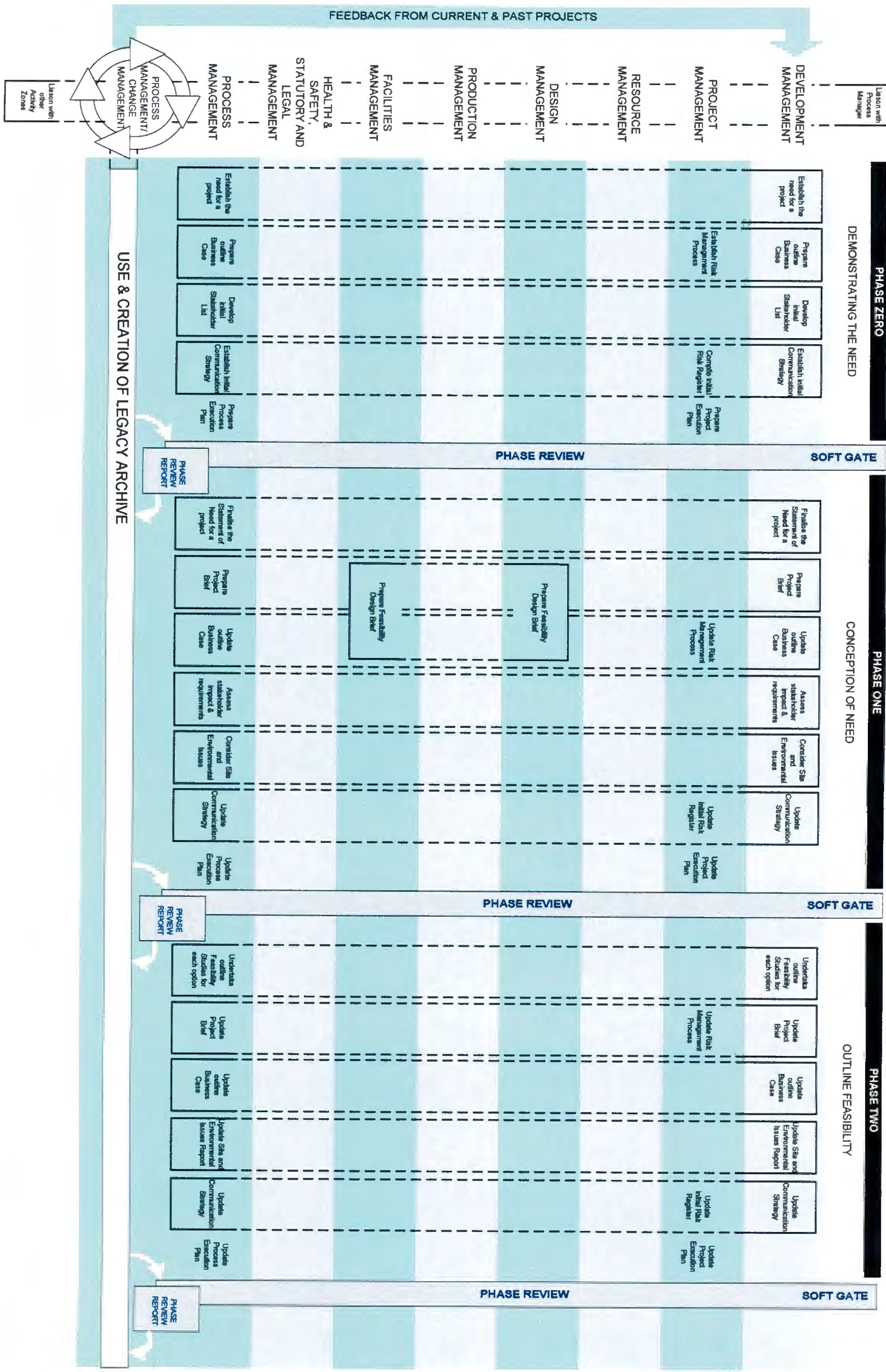
In the Process Protocol, participants are represented on the Y axis of the process model. They are referred to in terms of their primary responsibilities, i.e. as Activity Zones (Cooper *et al.*, 1998). The sequence of individual process activities or gates is represented on the X axis (see Figure 7). The generic model of the Process Protocol provides a visual representation of the building project in terms of prime responsibilities/functions and activities that may be undertaken during each phase. The process map enhances the transparency of stakeholder participation in the project by clarifying their roles and involvement throughout the project cycle. It indicates the potential interrelation of activities, processes and sub-processes. The map also assists in the identification of critical decision-points. Most importantly, the visual representation of the process allows all organisations involved in the project to communicate using a *lingua franca* - the language of the Process Protocol. Each organisation can map their own internal processes against the generic process model allowing them to clearly understand their relationship to the project.

The second stage of research on the Process Protocol (Process Protocol Level II) focused on the development of sub-process maps and produced the Process Protocol Toolkit. The toolkit provides an IT support for the creation of process maps based on the Process Protocol framework (Lee *et al.*, 2000b). In this way, users can create and customise their specific process as well as manage the process and project information.

5.4 INTRODUCING SUSTAINABILITY CONSIDERATIONS INTO THE PROCESS PROTOCOL

The enhanced communication and coordination of activities offered by the Process Protocol provides an environment that is conducive to the introduction of sustainability agenda at a project level. The Process Protocol has served as a template for the introduction of sustainability throughout the building process in research undertaken at the University of Loughborough (Zainul-Abidin *et al.*, 2003). For the purposes of that research, an understanding of sustainability was gained using the Dooyeweerd's *Theory of Modal Spheres* (*ibid.*). Dooyeweerd's theory formed the basis on which Lombardi (2001) developed a framework to address sustainability in the built environment.

Figure 7: The Process Map of the Process Protocol (1/3) (adapted from Kagioglou *et al.*, 2000:149)



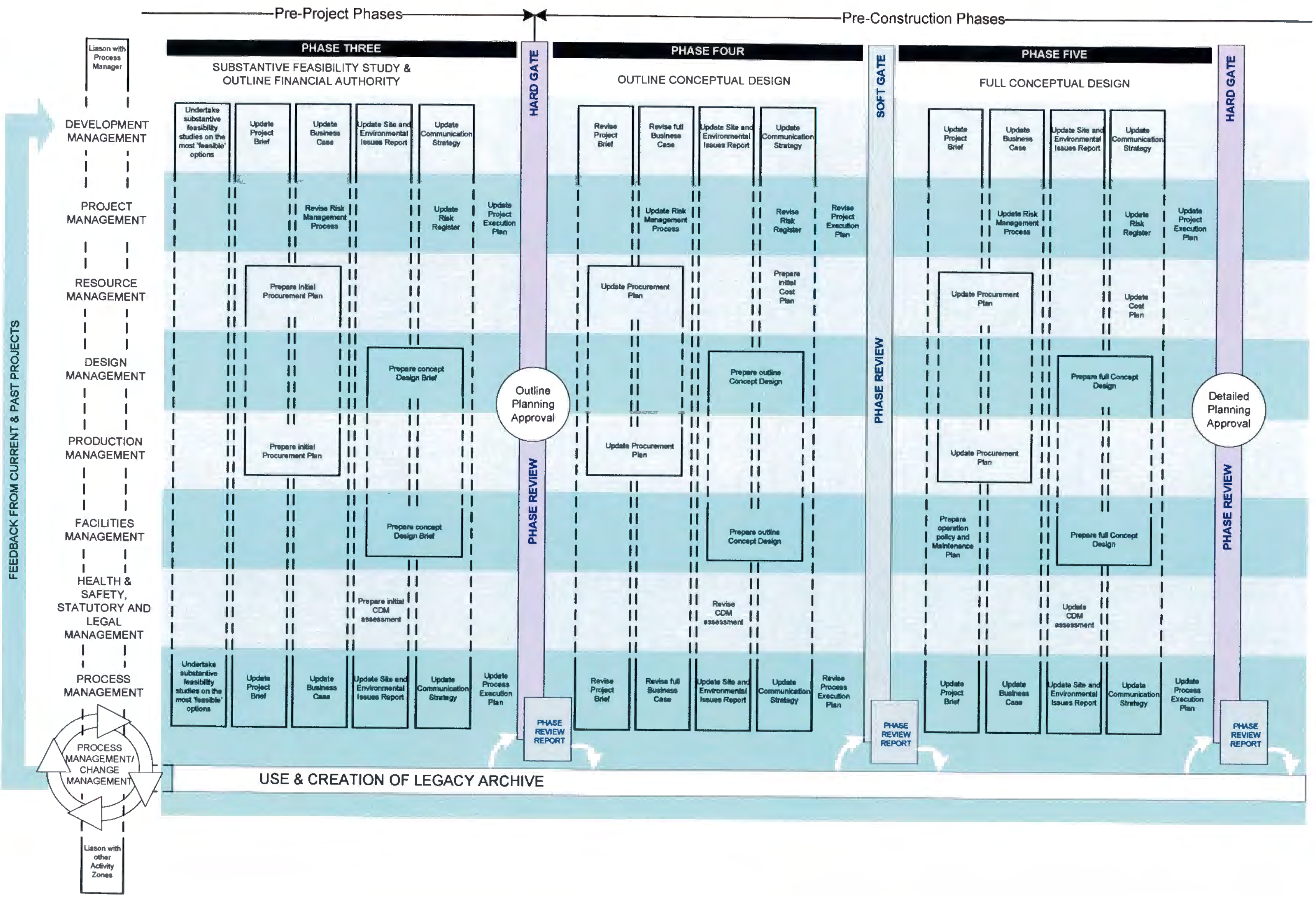


Figure 7: The Process Map of the Process Protocol (2/3) (adapted from Kagioglou *et al.*, 2000:149)

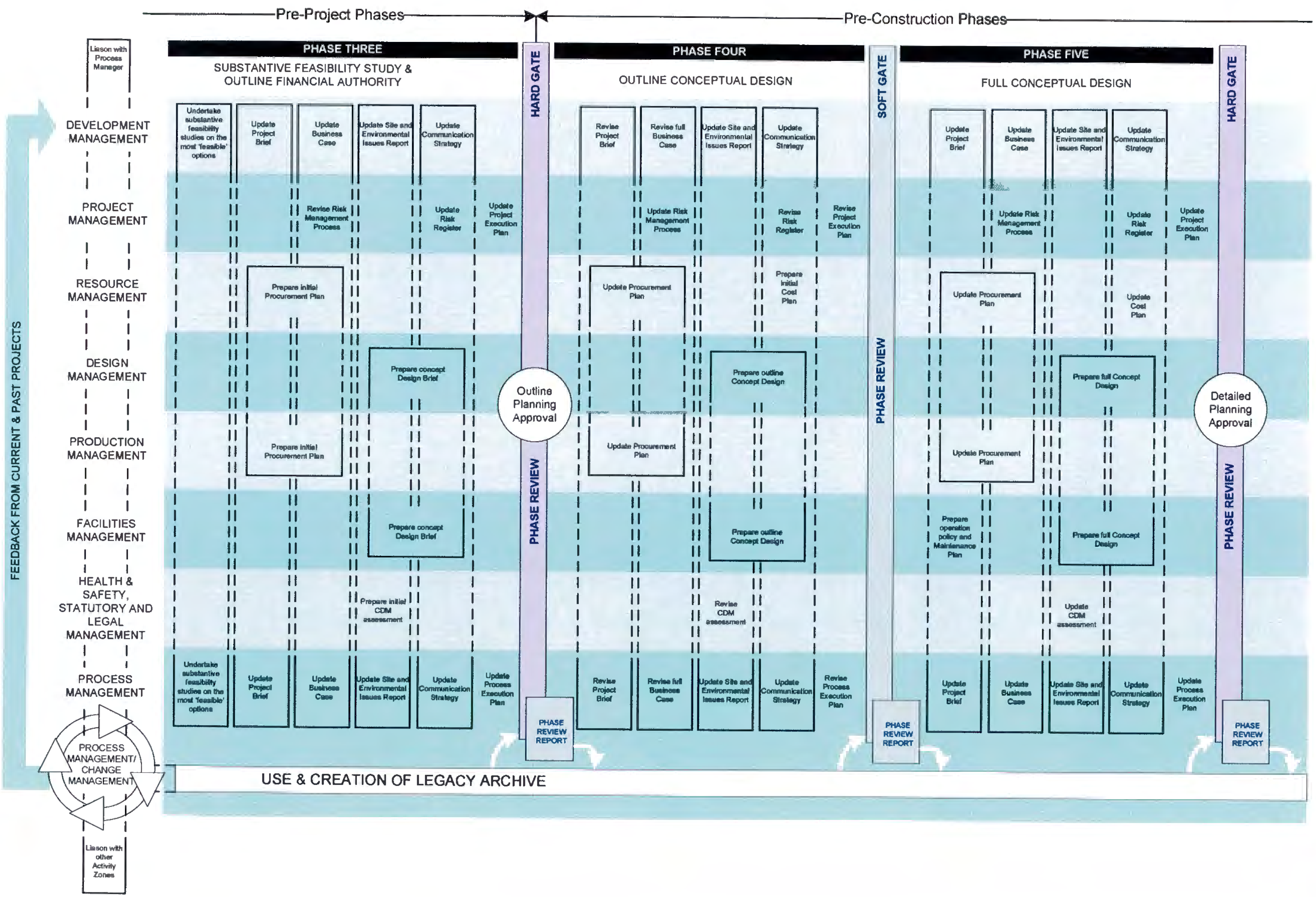


Figure 7: The Process Map of the Process Protocol (3/3) (adapted from Kagioglou *et al.*, 2000:149)

This framework was subsequently refined in Zainul-Abidin *et al.* (2003) to suit the context of the construction process, using the Process Protocol as a guiding resource. Other research at Loughborough University (in collaboration with Salford University) focused on the practical aspects of integrating social, environmental and economic considerations into the construction project. As a result, a separate Activity Zone has been introduced into the Process Protocol, namely the Sustainability Management Zone. Sustainability Management is responsible for the facilitation of sustainable practices throughout the design and construction processes.

5.4.1 Tackling Sustainability with the Dooyeweerd's Theory of Modal Spheres

According to the Dutch philosopher Herman Dooyeweerd, reality consists of entities (things and events) and laws (modalities/aspects), in which the entities operate (Basden, 2002). In his *Theory of Modal Spheres* Dooyeweerd identified 15 modalities (aspects), which are listed in Table 3.

Table 3: Dooyeweerd's Framework of Modalities (source: Basden, n.d.)

Modalities	Meaning
Numeric	Discrete quantity (amount)
Spatial	Continuous extension (continuity and shape)
Kinematic	Motion (movement and change)
Physical	Energy and matter (persistent, reliable being)
Biotic	Life and vitality (integrity of the organism and reproduction)
Sensitive	Sensing, feeling (sensation and responsiveness)
Analytical	Distinction (abstraction and free interpretation)
Formative	Formative power (creativity and deliberate creation and structuring)
Lingual	Symbolic representation (to enable meaning to be represented)
Social	Social interactions and institutions (to enable people to relate as people, to live together)
Economic	Frugality (to enable carefulness, self-control, management)
Aesthetic	Harmony (non-essential coherence, rest and play)
Judicial	What is due (law, responsibility to the other)
Ethical	Self-giving love, generosity (love that goes beyond what is due)
Pistic	Faith, vision, values, commitment (commitment that is more than response)

Although some of the modalities are self-explanatory, the meaning of social, economic and formative modalities, as proposed by Dooyeweerd, is worth elaborating. The social modality deals with social interaction (preferably in the spirit of collaboration), human relationships and social institutions (Basden, n.d.). For Dooyeweerd, the economic aspect is about frugality, conservation of resources and working within limits. It is not about finance or production and consumption rates. The formative modality represents formative power expressed by culture, history and technology. More specifically, it is about transformation (creativity, design and development, manufacture), progress (history and culture), achievement (goal-orientated approach, methods and techniques), and control and power (influence/affluence) (*ibid.*).

The application of Dooyeweerd's theory to conceptualise sustainability is useful as each modality provides a set of concepts necessary to describe and discuss sustainability in a more complete manner. A key feature of the Dooyeweerd's theory is the fact that all modalities depend on each other for their full meaning (Basden, n.d.). Consequently, all modalities are related and entwined. This also illustrates the interdisciplinary and cross-cutting nature of sustainability issues. Moreover, none of the modalities can be ignored or perceived as superior when the framework is applied (*ibid.*). This favours the idea of integrating rather than balancing sustainability issues, as the latter often suggests a need for trade-offs.

5.4.2 The Development of a Checklist to Promote Sustainable Design and Construction

Lombardi (2001) refined the meaning of the 15 modalities to better reflect the reality of the built environment in support of the planning process (see Table 4). In turn, Lombardi's work assisted Zainul-Abidin *et al.* (2003) in developing a checklist of activities that support sustainable design and construction (see Appendix C). Activities listed in this checklist should be considered or addressed during the design and construction phases with respect to each modality (*ibid.*).

Arguably, in order to suit different building contexts (e.g. new or existing buildings, different bio-regions), the proposed checklist could be further refined and made more comprehensive. In addition, the support of principles embedded in the Process Protocol, which are also fundamental from a sustainability point of view, could be made more explicit. For instance, more emphasis could be placed on stakeholder involvement and co-operation, integrated design, communication competency and knowledge transfer. Nevertheless, the checklist represents a valuable source of information on a range of activities and initiatives that help translate the theoretical sustainability deliberations into a practical realm of the construction process.

Having indicated the range of sustainability issues that need to be addressed in construction, it is critical to devise a way of tackling these issues throughout the project life cycle. The following section presents how this challenge has been addressed within the Process Protocol.

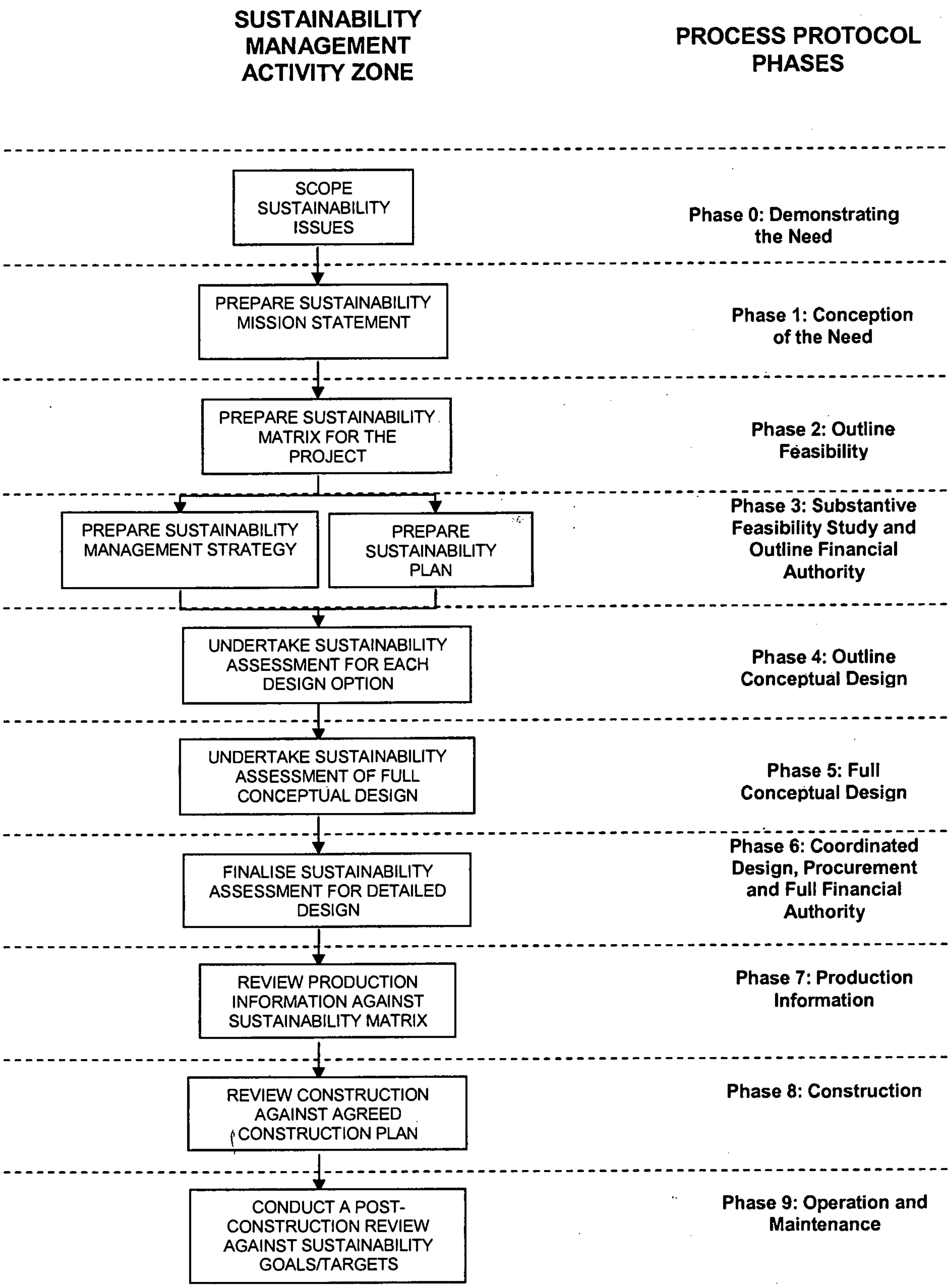
Table 4: Modalities of Sustainability and Their Relevance to Construction (source: Lombardi, 2001:91)

Modalities	Meaning	Redefined for Construction
Numerical	'How much' of things	Numerical accounting
Spatial	Continuous extension	Spaces, shape and extension
Kinematics	Movement	Transport and mobility
Physical	Energy, mass	Physical environment, mass and energy
Biological	Life function	Health, biodiversity, eco-protection
Sensitive	Senses, feeling	People's perceptions towards environment
Analytic	Discerning of entities	Analysis and formal knowledge
Historical	Formative power	Creativity and cultural development
Communicative	Informatory	Communications and the media
Social	Social intercourse	Social climate and social cohesion
Economic	Frugality	Efficiency and economic appraisal
Aesthetic	Harmony, beauty	Visual appeal and architectonic style
Juridical	Retribution, fairness	Rights and responsibilities
Ethical	Love, moral	Ethical issues
Credal	Faith, trustworthiness	Commitment, interest and vision

5.4.3 Operationalising Sustainability within the Process Protocol

The task of facilitating the incorporation of sustainability considerations throughout the design and construction processes falls into the management domain of the Process Protocol. The Sustainability Management Activity Zone is responsible for the development and management of the design and construction programme, which would allow the attainment of sustainability objectives agreed upon by stakeholders (Khalfan *et al.*, 2003). It is proposed that Sustainability Management would comprise the client, material supplier, consultant, construction professionals (e.g. designer and engineer), building services and maintenance professionals, and main constructor and sub-constructors (*ibid.*). While co-operating with other Activity Zones, Sustainable Management has a prime responsibility for facilitating a number of activities and the production of required deliverables (see Figure 8).

Figure 8: The Responsibilities of Sustainability Management in the Process Protocol (source: Khalfan *et al.*, 2003)



At the outset of the project (Phase 0), generic sustainability issues are identified and prioritised during a scoping exercise. The environmental, social and economic aspects of the project are screened using a *taxonomy* checklist (Salford University, 2002).

As the client's need is conceptualised, a sustainability mission statement is developed for the project. A consultant would be appointed at this stage where the project team lacks the necessary expertise (Phase 1). Subsequently, the previously identified sustainability issues are listed according to their priority in line with the sustainability mission statement with the client's participation. During the pre-feasibility study (Phase 2), a matrix is prepared with a refined list of sustainability issues that need to be addressed in the project. The matrix also includes performance goals/targets and a set of relevant indicators. Khalfan *et al.* (2003) argue that the project team needs to be practical in identifying sustainability issues, indicators and targets. Moreover, the established targets and indicators should be specific, measurable, achievable, realistic and time-bound (SMART) (*ibid.*).

A sustainability plan and a sustainability management strategy are established during the feasibility study (Phase 3). At this stage, it is determined what sustainability issues are addressed at what point in time during the project's progression. The decision-points are also determined and monitoring methods defined. In addition, the responsibilities are assigned to various Activity Zones. The sustainability plan is based on the previously defined mission and targets included in the matrix. Optimal design options that meet the sustainability requirements are selected for further development (Phase 4).

Full conceptual design is also assessed against the sustainability matrix, followed by the production of a sustainability report (Phase 5). It is suggested that an appropriate building assessment method is used at this stage (e.g. BREEAM or LEED). This is an important stage during the process, as recommendations are made for subsequent phases of the building process to ensure that the design and construction are aligned with the sustainability goals and targets (Salford University, 2002).

As the design is finalised (Phase 6), the sustainability assessment must be completed and a final check against recommendations made in the previous phase undertaken. Subsequently, the production information is reviewed against the pre-set goals and targets, so that the production information developed is coordinated with the sustainability plan (Phase 7). In addition, the construction monitoring parameters are established. During the actual construction works (Phase 8), any changes from the construction plans need to be assessed against the sustainability matrix by Production Management, while Sustainability Management monitors the compliance of construction with the sustainability plan. Finally, a post-construction review is conducted (Phase 9) to assess if the sustainability targets and goals have been met.

The introduction of sustainability considerations into the domain of building project management deserves special consideration. It offers a more meaningful alternative to conducting a building assessment alongside but separate from the actual building process. However, certain improvements in the procedure outlined above could make the introduction of sustainability considerations into the Process Protocol even more successful.

For instance, the proposed scheduling of activities conducted and/or facilitated by Sustainability Management in the Process Protocol is quite confusing. This problem might arise from the lack of additional information regarding the outcomes of this research within the public domain. There is a problem of task repetition, especially regarding the scoping and prioritising of sustainability issues. For example, the sustainability mission statement is developed after the issues have been scoped and prioritised, just to list and prioritise them again in line with the statement. The suggestion of using external building assessment methods during Phase 4 is also problematic; there is a possibility that the priority issues and targets set early during the project will not match those specified by a particular building assessment method. Such a method could rather be used during the early stages of the process to guide the development of the sustainability matrix.

In addition, it is difficult to understand the fundamental difference between the sustainability plan and management strategy. It is proposed that the sustainability plan should discuss which sustainability issues need to be addressed, using what methods, when and by whom. In addition, the plan should also specify monitoring methods and project milestones. Most likely, these issues would also constitute a part of the management strategy. In addition, the *site and environmental issues*, which define the project's context, are assessed and handled by Design Management Zone (refer to Figure 7). However, the involvement of Sustainability Management in this regard would be valuable to the project, even indispensable.

The concept of a separate Activity Zone responsible for the introduction of sustainability consideration in the Process Protocol may not be the most efficient and effective solution. To avoid the evident proliferation of tasks, the sustainability-related activities could be embedded in existing processes and be tackled by appropriate Activity Zones. This would better fit with the idea that sustainability should ultimately become embedded in mainstream management activities. Certain unique activities including scoping, the prioritisation of issues and development of the sustainability matrix could be facilitated by Development Management.

It is likely that the proposed Sustainability Management Zone will initially help stress the importance of introducing sustainability into the building process. In time its responsibilities could be successfully divided between existing Zones. However, the research presented in this thesis validates the urgency of integrating sustainability into the building process. It provides a practical example of how to conduct a sustainability appraisal during the building process. What becomes apparent is the fact that stronger emphasis should be placed on the development of a communication strategy among process participants due to the interdisciplinary nature of all sustainability considerations.

This section has outlined efforts made at introducing sustainability considerations into the Process Protocol, and consequently into the building process. The following sections synthesise lessons that can be learnt from the Process Protocol to enhance the quality of, and foster sustainability within, building projects via building assessment.

5.5 REVIEW OF INSIGHTS GAINED FROM THE PROCESS PROTOCOL

The current inefficiency of building delivery and related construction developments, as reported in literature, hinders efforts to promote and implement sustainable construction practices (e.g. Lee *et al.*, 2000b; Egan, 1998). The effectiveness of building sustainability assessment methods in fostering quality in buildings depends, to a large extent, on the quality of internal processes taking place during the project cycle. The social processes that occur in the building process (e.g. stakeholder communication and decision-making) are particularly significant to the successful outcomes of building sustainability assessment. However, the social dimension of the building process, which is perceived mainly as a technical endeavour, is undermined by existing organisational arrangements in the construction industry. Indeed, there is little room to validate the importance of social processes in the building process if the industry continues to judge its success and productivity using the three determinants of quality, time, and cost.

The Process Protocol encourages a re-examination of current construction practices to find a more optimal way of delivering buildings. By implementing the process view in building delivery, the social dimension can be more readily addressed. The Process Protocol shows that the building process can be greatly enhanced through a cautious development of a communication strategy and the re-examination of traditional responsibilities of building professionals.

Clearly, any building sustainability assessment needs to be well integrated with the building process. As each building project is unique, the building sustainability assessment model should be flexible enough to accommodate this diversity. However, adopting the proposition that the building process is generic reduces this problem to more manageable proportions. Overlaying the building process at key project decision-points becomes a less problematic issue for a building assessment method that focuses on the process rather than the product. Study of the Process Protocol reveals that the two critical qualities of the model proposed in this thesis are transparency and accessibility in terms of the communication strategy (i.e. exchange of information among participants) and the process itself (i.e. methodology). These two qualities significantly impact on the primary role of the model – the one of an educational medium. It is necessary to ensure that building sustainability assessment creates an environment that is conducive to the transfer of knowledge and capacity-building among professional and lay participants. Furthermore, by providing stakeholders with a forum to deliberate and exchange views, they are able to learn about ethical and practical sustainability issues. This also helps them to develop shared values, necessary to build commitment to sustainability. Only such an approach may enable building professionals, empowered through their involvement in building sustainability assessment, to make positive changes in subsequent building projects.

Consequently, the model is likely to act more as a building enhancement method, which improves the quality of the building process, rather than merely as an assessment method. Some may argue that the "*process is merely a means to an end: the built product that the client needs to house*" (Winch and Carr, 2001:528). Yet it is the very building process that provides greatest opportunities to limit wasteful and inefficient practices as well as to implement the necessary change of culture and behaviour among building professionals. By managing the building process in the optimal way, the final product should be of better quality (Bakens, 1997).

The following sections discuss the implications of applying the process view and incorporating insights gained from the review of the Process Protocol in building assessment.

5.5.1 Stakeholder Involvement

The issue of stakeholder participation in construction is relatively complex. It concerns the need for a broader involvement of lay stakeholders (people from outside the traditional boundaries of a building endeavour) as well as the nature of stakeholder interaction throughout the building process. The implications of incorporating stakeholder participation in the building process extend beyond changes in the structure of the design and construction processes (Fowles, 2000). Emphasis needs to be placed on forming a relationship between stakeholders "*in the form of partnership, equity and balance*" (*ibid.*:105).

However, achieving a productive and balanced interaction among building professionals involved in a particular project is a challenging task in itself. As the building project is initiated, a new multi-organisational project team is formed (Seaden, 2003). Due to its temporary nature, the participants are hardly committed to each other and, thus, they may pursue potentially competing agendas. Moreover, the internal communication is seldom properly designed and managed (*ibid.*).

While designing stakeholder participation (and team-building) in the building process, it is necessary to address the following variables (Davidson, 1998):

- Consensus about the domains of intervention of individual participants (i.e. clarity on the scope of participation and specialisation);
- The ease of access and adequacy of information (i.e. sufficiency, availability and rapidity of access); and
- The degree of interdependence of tasks involved in carrying out the project (i.e. interdependence of tasks and coordination).

These issues are extensively addressed by the Process Protocol. The Process Protocol has been developed to provide a common set of understandings and to identify generic activities performed in the construction process without reflecting (or emphasising) the interests of particular industry groups (Cooper *et al.*, 1998). In essence, the Process Protocol provides a means of representing the diverse interests of all parties involved in the building process (Kagioglou *et al.*, 2000).

The Process Protocol offers useful insights into the requirements of a building sustainability assessment method that should correspond to different patterns of the building process, i.e. where procurement paths may vary and where the roles and responsibilities of particular stakeholders may differ. It demonstrates that the 'fogginess' of stakeholder participation in the building process can be reduced by introducing clear definitions of roles and task-division. Adopting this approach in building sustainability assessment would make the process more efficient and productive by defining precisely what kind of input is expected from the participants.

5.5.2 Process Management

The quality of stakeholder involvement in any building project unequivocally depends on how well the process is managed. This includes managing tasks and roles of various process participants, and the ways in which they co-operate (Bakens, 1997). The current segregation between design and construction responsibilities and the lack of overall coordination contribute to inefficiency in building delivery. The need to re-conceptualise the building process is well acknowledged (*ibid.*).

The traditional approach to the organisation of the building process uses hierarchy (i.e. the structure of authority and responsibility) as a basic organisation form (Bakens, 1997). The new trend, evidenced in the Process Protocol, is to use material and information flow processes as a basic element of organisational design. As the flow processes are managed by multidisciplinary teams, this approach also fosters collaborative learning (*ibid.*).

The above lessons can be translated into the context of building sustainability assessment. For instance, it is necessary to emphasise the coordination between parties involved in building assessment, by integrating disciplines and new expertise. The assessment process needs to be closely integrated with all phases of the building process, especially with the up-front phases. This involves distinguishing a set of tasks (inputs into the building process) and identifying how these tasks are interrelated. Similarly to the building process, the building sustainability assessment process needs to be considered as an integral whole to optimise its potential benefits (Bakens, 1997).

5.5.3 Improved Process Transparency

The Process Protocol emphasises the value of clear communication of information and values throughout the building process and process transparency. This entails the coordination of activities and tasks, allocation of responsibilities, and definition of the formats of input and output information packages. Furthermore, due to the multidisciplinary nature of the building team, it is necessary to ensure that the assessment methodology is presented in a language that is understandable to all. Providing a common set of definitions and procedures for the model can help achieve a higher degree of consistency between assessments (Cooper *et al.*, 1998).

5.5.3.1 Enhanced Communication – The Attainment of Shared Meaning

Adequate communication is necessary to eliminate the major cultural, behavioural, organisational and institutional barriers that currently exist between project participants (Lee *et al.*, 2000b). The ethical implications of communication between the project team that need to be addressed include the channels of communication and information ownership (Davidson, 1998). Information can be easily used as a source of power in the building process, and difficulty in accessing information leads to conflict (Dimitrijevic and Davidson, 2004).

The adequacy and ease of access to information is often indicated as a prime source of difficulties and resultant loss of performance in construction projects (Davidson, 1998). Clearly, it is critical to plan information management at the outset of the building project. This means that the dissemination of information needs to be based on a number of modes, which are tailored to the habits and language of expected information recipients (*ibid.*). The Process Protocol recognises the requirement to integrate different modes of communication and information dissemination between various members of the project team (Aouad *et al.*, 1999). Hence, it postulates the need for defining the terms and content of information exchange throughout the building process.

The use of gateway decisions, i.e. decisions that enable the project to move forward to a subsequent stage (Dimitrijevic and Davidson, 2004), in building assessment will require the recognition of what type of information is required to support decision-making at any particular point in time. This approach, used in the Process Protocol, is similar to that of decision-scoping in Environmental Assessment. Consequently, while developing the specification for the model, it is necessary to understand the movement of information between participants, the nature of information required, as well as its content and most likely sources (*ibid.*).

"*Delivering quality means fulfilling the requirements of internal and external clients; indeed this corresponds to the mission of the building process*" (Bakens, 1997:129). Effective communication with the client and end-users is of prime importance to a successful building project. This entails capturing the client's needs and inviting the client's input in the development of appropriate solutions. Yet client's requirements are rarely fully captured (Lee *et al.*, 2000b). The briefing process offers immense opportunities for a meaningful interaction between project stakeholders. The best buildings tend to be those where targets are made clear in a brief that is understandable to all the players, users and occupants included (Leaman, 2003).

As the aim of briefing is mainly to identify and define the scope of the project, and more specifically that of the proposed solutions (Kagioglou *et al.*, 1998), briefing should ideally extend throughout the project duration. The Process Protocol treats a project brief as a *living document* that changes as new information is presented. The briefing process can assist in the motivation and effective control of interventions aimed to improve the overall sustainability of the building project. Therefore, it is crucial to integrate building sustainability assessment with project briefing. It will not only facilitate the client's involvement in the building process, but also in assessment, as the separation of these two processes disappears.

5.5.3.2 Designing Building Assessment Methodology

Arguably, a close alignment of building sustainability assessment with the building process would make the information received from the assessment more relevant and suitable for project decision-making. Moreover, an adequate quality of information provided in time could significantly improve the decision-making process (i.e. allow for an effective incorporation of sustainability considerations), driving the development of construction sector onto a sustainable path.

The Process Protocol provides a framework for carrying out any construction project. Hence, it can provide terms of reference for the development of the model's specification. By using the Process Protocol the following benefits, inherent to the Process Protocol, are gained (Lee *et al.*, 2000a):

- Taking a whole project view;
- Recognising the interdependency of activities;
- Focusing on the front-end activities;
- Improving process transparency and consistency;
- Using the stage/phase review approach to facilitate concurrency and progressive fixity and/or approval of information throughout the process;
- Coordinating participants and activities in the process (i.e. clear assignment of responsibilities);
- Establishing multi-functional teams including *outside* stakeholders;
- Fostering a team environment;
- Committing to shared project values;
- Facilitating the effective transfer of *know-how*; and
- Establishing feedback mechanisms.

It is therefore proposed that the model is mapped against the Process Protocol to identify points of interface with the building process. The process mapping will not only facilitate the presentation of the assessment methodology, but it will also assist stakeholders in understanding where they fit into the process and what is required of them. Moreover, the communication process is improved by mapping information flows between process participants. The development of the model's methodology will entail the identification of potential assessment deliverables, determination of required inputs and coordination of assessment activities with the building process decision-points (i.e. allocation of responsibilities and timing of activities).

5.5.4 Forming Commitment to Sustainability through Project Values

Morris (1994) argues that in order to deliver a successful project, the project and stakeholders' objectives should be integrated. As the project evolves its objectives should continue to fit stakeholders' interests. Arguably, professional and lay stakeholders would effectively co-operate in the building process and building sustainability assessment if they have a common interest and purpose (Bakens, 1997), and most importantly if they share values.

Values can be defined as "*singular states of mind for guiding actions and judgments* (...) *beyond immediate goals to more ultimate end-states*" (Enk and Hornick, 1983:59). This definition suggests that by establishing common project values during building sustainability assessment, the participating parties are likely to give up their individual perspectives, as they realise that their interests are addressed by a consolidated vision of project development (Meppem and Gill, 1998). This helps reinforce stakeholders' commitment to project objectives. Stronger commitment to attain the project vision (which is based on the premises and principles of sustainability) would result in informed and joint decision-making and implementation, thus enhancing the sustainability of a given building project in terms of its delivery and product performance.

Often the vision of sustainability, and the ways in which it is determined in a sustainability assessment situation, is shared by relatively few dominant stakeholders (Bell and Morse, 2003). Such assessments may also become over-focused on dominant local issues at the expense of other concerns important in sustainable development (*ibid.*). Therefore, it is essential to address the issues of power imbalance and the lack of a consolidated vision aligned with the principles of sustainability, if a participatory approach is to be effectively implemented in the assessment of the building project's sustainability.

Culture, next to power, constitutes a potent agent in shaping participation (Newcombe, 2003). It is expressed through the ideology or shared values of project participants. According to Newcombe (*ibid.*), culture is seen as a force for co-operation between stakeholders. This indicates how important it is to incorporate the needs of stakeholders into the projects objectives and to establish project values early in the building process. The practice of establishing a common project vision, so important in terms of the project's sustainability, can help avoid certain conflict between stakeholders especially around long term versus short term objectives, quality versus quantity and control versus independence (*ibid.*).

Porter and Rossini (1983) maintain that meanings, values, and attitudes are of fundamental importance. Value judgments are therefore at least as important as technical considerations in any assessment situation (Susskind, 1983). According to Enk and Hornick (1983), understanding human values is central as they determine what data and analysis should be included in the assessment. Similarly, Susskind (1983) argues that the treatment of value judgments throughout the process determines the quality of decisions reached. Hence, values play an integral role in building sustainability assessment, for instance, during problem-definition, setting of assessment boundaries, prioritisation of assessment issues, gathering of information and the choice of targets and indicators – as these are all judgment-based decisions.

For any assessment to yield a good decision, the judgments ought to be made with the full participation of all relevant stakeholders (Susskind, 1983). However, stakeholders should not be asked to take positions until they are adequately empowered. Participation should therefore be viewed as an action-orientated social learning (Simanowitz *et al.*, 2000; Meppem and Gill, 1998).

The Process Protocol widens stakeholder participation to include the client and end-users. In addition, it gives an opportunity for building professionals, such as a contactor or facility manager, who traditionally join the project after production information has been compiled, to actively participate in the decision-making in the early stages of the building project. This means that their values are represented throughout the project. By working in multi-disciplinary groups, participants are encouraged to engage in dialogue and mediation. This leads to better understanding of problems and shared problem-solving.

Through their prolonged involvement in the building process these participants can meaningfully contribute, and subscribe to, shared project values. In this way, the framework for building design and construction, which forms the Process Protocol, provides a functional context for the infusion of sustainability values among project stakeholders. The model could therefore build on the participation practices included in the Process Protocol.

5.5.5 Knowledge Transfer and Capacity-Building

The effectiveness of knowledge transfer and the associated capacity-building among construction stakeholders are both critical factors for the development of the construction industry, especially in terms of continuous improvement. The difficulty in addressing these factors lies in a temporary nature of networks building organisations involved in the building process, which are formed on project-by-project basis. Gann (2003) lists two main issues that affect the process of knowledge exchange in construction projects. The first issue involves the nature of knowledge used and created in project-based activities. The second issue relates to the flow of knowledge between project teams and project-based firms.

As the building process requires integrating knowledge from many different disciplines, the designers, engineers and project managers usually acquire relevant information on the job through project processes (Gann, 2003). However, due to the discontinuities between projects and project teams, any new knowledge developed within a particular project may be easily lost. Hence, the challenge is to provide mechanisms for the *storage* of knowledge and for its necessary *transfer* within the industry (*ibid.*).

Knowledge is created through the processing of information for particular purposes (Cole, 2003). It involves "*categorisation, synthesis and evaluation in order to make decisions about actions*" (Gann, 2003:40). Cole (2003) argues that knowledge is attached to an individual or group and is not transferred easily.

Furthermore, it is possible to distinguished between *explicit* (which can be communicated and written down) and *tacit* (which is experience-based) knowledge (Cole, 2003). Tacit knowledge, which entails the *know-how*, is acquired through practice and requires personal interaction, as well as individual learning and experience. According to Cole (*ibid.*), tacit knowledge plays a major role in building design and construction. It provides unique advantages to its holders and contributes the most to a positive change in construction practice.

An understanding of the importance of tacit knowledge, and the mechanisms for its transfer, is fundamental for the introduction and implementation of sustainability in construction. This is primarily due to the value-laden and context-dependent nature of the concept of sustainability. In addition, sustainability is addressed through holistic and integrated approaches, and is best tackled using the experience of the diverse members of the design and construction teams.

The Process Protocol emphasises the value of knowledge development and sharing in a project environment. It also addresses the issue of knowledge transfer between construction projects. For instance, the multi-disciplinary Activity Zones promote teamwork and active involvement of process participants in activities that they may traditionally not be involved in. This is an invaluable aid in the creation of tacit knowledge. The participants learn through experience and feedback, which is facilitated through phase reviews. The Legacy Archive provides a means of storing knowledge on best practice across projects and across disciplines. In addition, continuous learning is facilitated in the Process Protocol by providing the basis to develop a company and industrial knowledge databases (Aouad *et al.*, 1999).

The building sustainability assessment model should incorporate some of the approaches of knowledge management used in the Process Protocol. These would include the creation of multidisciplinary teams to enhance experience-based learning and capacity-building, and the creation of the Legacy Archive. It is also important that the model provides a forum for a wider participation in decision-making including the users of the built environment. This can help to ensure that "*more knowledge exchange will occur at a number of different levels and scales*" (Gann, 2003:52). The transition towards sustainable lifestyles, which involves changes in behaviour and building culture, requires that all building stakeholders individually assimilate the values of sustainability. Therefore, the building assessment model should play the role of an education medium, and it should allow stakeholders to develop the knowledge needed for such transition.

5.6 CONCLUDING REMARKS – ENHANCING THE QUALITY OF THE BUILDING PROCESS THROUGH BUILDING ASSESSMENT

The traditional model of building process organisation promotes a strong segregation between the design and the construction responsibilities in the project (Bakens, 1997). It also lacks any effective mechanism for the overall coordination of building activities. It seems that in order to improve the performance of the construction industry as a whole, the organisation of the building process needs to be changed (*ibid.*).

However, it is essential that any improvement in the organisation of the building process should be based on the premise that "*quality of the building process that is embodied in the building as an end-product, depends on the quality of all the sub-processes*" (Bakens, 1997:130). This approach perceives the building process as an integral whole and makes possible the harvesting of benefits of any improvement efforts. This approach is implemented in the Process Protocol framework.

The Process Protocol illustrates possible ways to address important issues that need to be resolved by the building sustainability assessment model (see Table 5). It stresses the importance of inter-personal relations between project participants, which depend on attitudes, communication and team-building. Transparency and clear communication of information throughout the assessment process is key to a successful and meaningful outcome. Alignment with the Process Protocol can make the information received from building sustainability assessment more relevant and suitable to all decision-makers in the construction sector by presenting it in a language familiar to them. Similarly, it can make the construction process accessible to those outside the construction sector by presenting the process in a language that is independent of the technical terminology of the industry. Adequate quality of information provided in time can significantly improve the decision-making process (i.e. allow for the incorporation of sustainability considerations), directing the development of the construction industry onto a sustainable path. Moreover, providing a common set of definitions and procedures for the model can help achieve a higher degree of consistency between assessments.

Table 5: A Summary Table with Key Features of the Process Protocol that are Relevant to Building Assessment

KEY CONCEPTS IN THE PROCESS PROTOCOL	DEFINITION AND CHARACTERISTIC FEATURES	REASONS FOR INCORPORATING INTO THE MODEL'S SPECIFICATION
Process Viewpoint	- A process viewpoint requires considering the entire project life-cycle from the project's outset. It focuses on information exchange and knowledge transfer among project stakeholders to improve the efficiency and effectiveness of the building process. - Incorporating process view offers a more integrated mode of construction through early involvement and effective communication of building stakeholders. - A key issue in the process view is the redistribution of responsibilities and power among building stakeholders throughout the building process.	- There is a need for a close and dynamic integration of the building sustainability assessment process with the building project cycle to enhance the relevance and effectiveness of the assessment process. - Adoption of the process view is necessary for the effective customisation of any building assessment to the context of its application. - The process view allows for conceptualising building assessment as a set of tasks which are often interrelated. It also requires addressing all stages of the building project cycle from the assessment outset. - The process viewpoint makes explicit reference to the quality of technical and social processes that comprise a building project. Building sustainability assessment needs to explicitly acknowledge the importance of social processes to the project's sustainability. - Emphasis is placed on stakeholder participation in designing a building sustainability assessment process and their direct involvement in the assessment activities. - Attention needs to be paid to effective sourcing of information from building stakeholders as well as to the timely dissemination of appropriate information among interested and affected parties at all critical decision-points. - Greater transparency and accessibility in terms of the communication strategy (i.e. exchange of information among participants) and the process itself (i.e. methodology) is required in building assessment.
Process Consistency	- The Process Protocol recognises the requirement to integrate different modes	- Providing a common set of definitions and procedures for the building sustainability assessment model can help achieve a

	of communication and information dissemination between various members of the project team. There is a need to define the terms and content of information exchange throughout the building process. - Process consistency requires adopting a standardised approach to performance measurement, evaluation and control.	higher degree of consistency between assessments.
Progressive Design Fixity	- *Stage-gate* reviews provide an opportunity to examine the work executed in any particular phase of the building project. Progress needs to be approved before the planning, resourcing and execution of a new phase are possible. - Phase reviews allow for the examination of the project's feasibility against certain project and process critical success factors.	- One of the advantages of the progressive fixity is the improved communication and coordination between the project's participants as they pass through each phase. - Project phase reviews provide an opportunity to check what information and resources are needed for effective decision-making in subsequent stages of the building process/building sustainability assessment. - "Mini" project appraisals/ assessments could be conducted at each hard gate to monitor distance to pre-establish targets and facilitate effective measures to enhance the project's sustainability. - Progress review and feedback at each gate facilitate knowledge generation throughout the assessment process.
Establishment of Activity Zones	- The establishment of Activity Zones re-constructs the design and construction teams to create cross-functional teams. - Process participants are described in terms of activities that need to be undertaken in order to achieve a successful project and process execution. - Project quality is optimised by more extensive technical and non-technical knowledge base provided by various stakeholders.	- Involvement of key stakeholders in early stages of the assessment process will facilitate the development of shared values and common project vision - Groping building stakeholders in terms of crucial activities/responsibilities should ensure a more effective transfer of *know-how* and collaborative learning among them. Consensus can be developed over the domains of intervention of particular participants. - Building sustainability assessment should provide direct experience in sustainability orientated decision-making to all building stakeholders.
Feedback	- The Process Protocol introduces the concept of the Legacy Archive, which is a mechanism for recording, storing and retrieving project/process information. - Legacy Archive facilitates phase reviews and information exchange among project participants and	- Any building assessment method needs to be equipped with mechanisms for recording project experience throughout the process. This is necessary for subsequent project/process appraisals. - Information management system should provide an easy access to information, and in this way facilitate knowledge sharing. - Introduction of the Legacy Archive will provide for greater transparency of the

	documents project's history.	building process.
Process Mapping	- Process mapping offers a visual representation of the building project in terms of prime responsibilities/ functions and activities that may be undertaken during each phase. - The use of process maps provides a means of describing the construction project in an accessible and transparent form to all stakeholders. Process maps help to illustrate what the building project involves, i.e. what resources it draws upon, what activities need to be performed, what independencies exist between those activities. - Visual representation of the process allows all organisations involved in the project to communicate using a *lingua franca*.	- Mapping building sustainability assessment against any building projects helps identify key decision-points and associated information needs. Process mapping allows for easy identification of assessment deliverables, determination of required inputs and coordination of assessment activities with the building process decision-points. - Process mapping can help ensure that sustainability considerations introduced into the building project via building sustainability assessment inform and shape the building proposal, and the design, construction, operation and decommissioning of a building. Since building assessment outputs are viewed as inputs into the building process, their specific timing, content and form become important. - Using process maps helps present the building sustainability assessment process in a language that is understandable to construction practitioners and lay stakeholders. Emphasis is placed on the issues of overcoming technical language barriers and on the establishment of information needs (i.e. timing, form and content) during the assessment. - Communication during building sustainability assessment is improved by mapping information flows between process participants. Process mapping assists stakeholders in understanding where they fit into the process and what is required of them.

The examination of efforts made in introducing sustainability into the building process (on the example of the Process Protocol) raises two important questions namely:

1. How should the proposed model for building assessment influence or interact with the building process?
2. How should continuous improvement be built into the process?

Ideally, the model should provide relevant sustainability information to building stakeholders, and facilitate decision-making. This should be possible without having to impose an additional framework (that of the building assessment process) onto the actual building process. Therefore, the ability to integrate building sustainability assessment into the building process, thus avoiding or minimising its application as a stand-alone exercise, is one of major challenges in the development of the specification. In this way, building professionals and other participants can be empowered through a direct experience in sustainability orientated decision-making during the building process.

The outcomes from building sustainability assessment, which is conceptualised as an integral part of the building process, would not only take the form of a well-performing building (end-product), but also of important intangible benefits for building stakeholders, such as personal transformation. As personal experience is the most powerful tool for learning, the involvement of building stakeholders in sustainability-related decision-making is likely to result in the emergence of new consciousness. This new consciousness rather than any building assessment method would be the key driver of the construction sector into a sustainable future.

Incorporating these practices into the model provides a framework for transforming the industry's and society's concept of the building project in a way that addresses social, economic and environmental aspects of development in an integrated manner. In this respect, the model serves less as a method for assessing sustainability and more as a means for enhancing sustainability throughout the building process and the product's life cycle. It may therefore be necessary to move away from the terminology of building assessment and talk of *enhancement* models, reflecting a shift from measuring to one of proactive improvement.

The following chapter aims to develop the functional specification for the model for building sustainability assessment synthesising insights gained from the literature review on sustainable development, current building assessment practice, Environmental Assessment and the Process Protocol.

Chapter 6

DEVELOPING A SPECIFICATION FOR THE BUILDING SUSTAINABILITY ASSESSMENT MODEL

6.1 INTRODUCTION – MAIN FEATURES OF A FUNCTIONAL SPECIFICATION

The aim of this chapter is to incorporate lessons gained from the review of Environmental Assessment (EA), the Process Protocol (PP) and existing building assessment methods (i.e. BREEAM, LEED, GBTool, SPeAR and SBAT) into the specification of a model for building sustainability assessment. Conclusions presented in Chapters 4 and 5 indicate that EA and PP take a process view of a project cycle and, therefore, share a number of important features. For instance, EA and PP emphasise the value of social processes that take place alongside technical interventions in the project cycle. Consequently, attention is drawn to the problems that occur in the area of communication, such as language barriers and different perspectives of project participants. Moreover, both EA and PP aim to identify information needs throughout the project cycle with regard to information timing, content and form (i.e. decision-scoping in EA and gate/stage approach in PP).

The most relevant insights, in terms of enhancing the practice of building sustainability assessment, sourced from these two fields of expertise can be grouped into three key themes. These include:

- *Integration* (i.e. integration of sustainability principles, stakeholder values and perspectives);
- *Accessibility and transparency* (i.e. open participation and communication competence); and
- *Collaborative learning* (i.e. active involvement and transfer of knowledge).

These themes will form three core functionalities of the building sustainability assessment model. Arguably, focusing on these themes should help produce an assessment method that is more effective and context-relevant. This is achieved through the development of a specification for the model that addresses these key outcomes.

A specification is used to describe how a given service is to be delivered or an item produced (UK: Highways Agency, 2003). Traditionally, a service or product specification was produced in a prescriptive manner. Nowadays prescriptive methods are used less commonly in specification writing, being replaced by a functional (or performance-based) specification (*ibid.*). Such a specification focuses on the characteristics of the final service or product. Consequently, a given service or product is defined in terms of its delivery or benefits – outputs and outcomes (*ibid.*). The *functional* approach is applied in the specification presented in this chapter. More specifically, this approach helps to illustrate how the model would perform in the areas of its core functionalities. However, this specification may also include certain prescriptive elements.

The functional specification presented in the following sections details what the model is supposed to do, and how a user will interact with it (Smith, 2001). This requires listing the model's main objectives and identifying its audience, i.e. who is going to use the model and in what way. The specification outlined in this thesis does not present any design details. Its main role is to describe the underlying and fundamental concepts of the model, and not its implementation aspects (Berry *et al.*, 2001). The model's inputs and outputs will be identified, especially with regard to the information flow through the model, and presented using process maps. The development of the functional specification will entail creating *use cases* (scenarios) and *user personas* (Smith, 2001). In this aspect, the specification can be conceptualised as a *user's manual* (Berry *et al.*, 2001). The specification presented in this form can be more readily used for the purposes of model validation.

Having developed the functional specification for the model, it is possible to examine how the model would meet its main objectives, and whether it would allow for a meaningful incorporation of sustainable development principles. In this way, the model, which is based on a generic framework that can be customised to different patterns of the building process and different application scenarios (i.e. a proposal formulation, project appraisal and performance audit), can be made *fit-for-purpose* (i.e. focused and practical). In fact, this is considered to be its main criterion of success.

6.2 THREE CORE FUNCTIONALITIES OF THE MODEL – THE UNDERLYING PRINCIPLES AND OBJECTIVES

While designing any model, whether theoretical or physical, it is necessary to specify its underlying premises and objectives in terms of desired performance and deliverables. Such a design process should be guided by a vision, which is best postulated via a set of fundamental principles. In this context, principles act as basic laws or rules and form the core of the model. The vision provides a system of reference for decision-making during the design and subsequent operationalisation of a given model.

The knowledge of principles that determine the model's framework and functionality is essential for its validation purposes. It is especially important in theoretical validation that examines the logic of reasoning employed during the model's design. This kind of a validation process focuses on the relevance and applicability of selected principles. The effectiveness of the model in meeting its objectives can be later verified through its empirical validation.

The principles and objectives of the building sustainability assessment model form a key component of its specification. They are classified under three themes, i.e. integration, accessibility and transparency, and collaborative learning. This classification indicates the three core functionalities of the model.

The principles and objectives discussed in the following paragraphs have been primarily sourced from the literature review of the field of sustainable development. More specifically, the Bellagio Principles of sustainability assessment provide practical guidelines regarding the content and process of building sustainability assessment. In addition, the existing building assessment methods (in particular GBTool, SPeAR and SBAT) and insights gained from the review of Environmental Assessment and the Process Protocol are used as points of reference regarding the desired features and components of the model.

6.2.1 Promoting Sustainability through the Principle of Integration

The rule of integration is central to the conceptualisation and, consequently, assessment of sustainability or the progress towards sustainable development. In the context of building sustainability assessment this means that the principles of sustainable development should be explicitly integrated with the building project's objectives and goals. The problem definition during the assessment process can also advance properties that define the condition of sustainability, e.g. holism, context, quality, self-sufficiency, regeneration and adaptability. Therefore, the inclusion of problem definition in the assessment methodology is indispensable if a given project or initiative is to be considered sustainable.

In general terms, the building sustainability assessment model should be capable of promoting equity and preserving the carrying capacity of the natural environment. Hence, the project objectives, informed by the model, need to refer to inter- and intra-generational equity. This is achieved by providing development opportunities to future generations and by promoting the use of resources in ways that increase equity and social justice.

The principles of equity are best fostered through participation in project-level decision-making. Therefore, the principles of equity fall into the domain of process-orientated principles that enhance the practice of building assessment and the building process itself. By recognising the value of social processes (inputs) occurring throughout the building process, the principles of equity can be more easily infused in the building assessment framework and process.

The model will also assist in addressing the problem of carrying capacity of the natural environment. The contextual analysis that identifies the project's needs and objectives should focus on the environmental utilisation space. In other words, the sensitivity of the receiving environment needs to be examined during the initial stages of the model's application. Such analysis aims to estimate levels of activity that could be supported by local ecosystems without their irreversible damage. Thus the issues of sustainable resource use, protection of biodiversity and pollution control would be included in the problem definition. Arguably, a meaningful integration of socio-economic and environmental objectives during problem definition could be proactively achieved using the model.

It becomes apparent that in order to effectively address the issues of sustainability, the model needs to be characterised by problem-solving capacity. Problem-solving is necessary whenever any information is needed and used. It can be viewed as a powerful learning tool (McAllister, n.d.). When the model is applied, the participants in the building assessment will be presented with new concepts, e.g. the concept of sustainability or different types of capital, or more specific concepts related to building design, construction or operation. Therefore, it is crucial to ensure that the model provides the participants with an opportunity to develop a deeper understanding of problems, as well as to be actively involved in the production of required solutions. The emphasis should be placed on seeking value-adding opportunities to enhance the quality of the built and natural environment, and maximising socio-economic benefits from building projects. By implementing a problem-solving approach, it will be possible to develop the anticipatory potential of the model. This means that the building stakeholders should solve problems based on a previously established project vision. In this way potential costs and externalities of proposed solutions have to be addressed. In addition, the spatial and time scales for defining problems should form part of the context (or decision situation) for decision-making.

The integration of the model will be reinforced by its next two core functionalities. Enhanced transparency and accessibility are required for a meaningful implementation of the sustainability agenda at a project-level, as well as for the optimal performance of the model. Collaborative learning would build commitment amongst process stakeholders towards sustainability, and thus improve the quality of the assessment process and its outcomes.

6.2.2 Enhancement of the Building Process through Increased Transparency and Accessibility

The development of the model should give due consideration to the process-, service- and product-related aspects of building assessment while addressing the issues of sustainability. In this way the model can promote the improvement and transformation of building practices, placing the sustainability agenda at the centre of any decision-making process. As the model will take a process view of a building project, the issues of transparency and accessibility become essential to its effective application. Adequate transparency enables process verification, which reinforces its viability. It also allows for a meaningful participation of building stakeholders in building assessment, thus, optimising opportunities for collective learning.

Transparency will be crucial for the coordination of activities and the allocation of responsibilities and tasks throughout a participatory building assessment process. Transparency will be also imperative for effective communication among the participants, especially in terms of information provision and its integration. Transparency will require that all judgements, assumptions and uncertainties made during the assessment are explicitly communicated in decision-making, and all concepts are clearly defined. Most importantly, good process transparency will also assist participants in understanding their roles in the assessment process.

In developing this particular functionality of the model, lessons will be drawn from the Process Protocol and decision-scoping. In particular, the model should promote a prompt identification of decision-points and associated information needs, i.e. the timing, format, content and potential source of information. Transparency of the model can be significantly enhanced by visual aids employed in the communication of concepts and in the presentation of progress achieved throughout the assessment process to building stakeholders (e.g. the measurement of progress towards pre-established targets of performance). In addition, the transparency of the model will be improved by the use of process mapping. Process mapping will help to synchronise building assessment with the actual building process, which is necessary to increase the effectiveness of the model.

Process transparency is closely linked with the ability of stakeholders to gain access to information during an assessment. Accessibility promotes inclusion – a fundamental concept in participation. To foster accessibility, the model will aim to eliminate potential barriers to participation. These may include language barriers, knowledge gaps amongst lay participants, or sequential involvement of stakeholders in the process. All these barriers can limit co-operation and consensus-building during the assessment process. This problem should be addressed by proposing an effective communication strategy with mechanisms for information resourcing and dissemination. Both transparency and accessibility will help reduce conflicts and disagreements that surface when stakeholders hold different values and opinions. At the same time, a commitment to co-operation and mutual learning that will be advanced by the model will strengthen the process transparency and accessibility.

6.2.3 Practicing Collaborative Learning

The educational capacity of the model is considered as its key functionality. The model should act as an educational medium for all stakeholders involved in the building assessment process. This functionality emphasises the importance of the social dimension of building assessment and its contribution to the quality of the building process and the final product delivered.

During building assessment stakeholders will participate in the development of a project vision and the establishment of project needs, values and objectives. This will be a proactive learning process, as stakeholders will be exposed to new concepts (e.g. issues surrounding sustainability) and will discover different values and interests held by other participants. In building consensus, stakeholders will be faced with the challenge of identifying significant values and issues to be addressed in building assessment. Through their involvement in the evaluation and problem-solving stages of the assessment, stakeholders should also develop a sense of ownership over the building process.

By providing a platform for information exchange and dialogue, the model will encourage effective knowledge transfer (i.e. tacit and explicit knowledge) and, consequently, stakeholder capacity-building. As the participants of building assessment would interact while accomplishing specific tasks, they can learn from each other and about each other. This valuable process of social (or collective) learning is a fundamental premise of any interdisciplinary activity.

Interdisciplinarity is imperative to the integration of knowledge and experience of stakeholders. The model should therefore promote pre-established interrelations between lay and professional stakeholders in the building process, so that professional knowledge is complemented with a variety of socio-cultural realities of participants. To harvest optimal benefits of stakeholder participation in building assessment, the problem of communication competence has to be addressed in the development of the model.

The transfer of knowledge and *know-how* that takes place during building assessment will form the focal point of the model. Hence, the process of building sustainability assessment should be participatory and closely integrated with the actual building process (or project cycle). If building assessment remained a stand-alone exercise moderated by an assessment consultant, then the knowledge necessary to foster sustainability in construction would be retained by specialists often external to a given organisation. Yet the model will allow stakeholders to gain knowledge and experience, and to integrate *sustainability thinking* into their professional practice and even everyday life. This is the main rationale behind the concept of empowerment of individuals through their participation in the building assessment process.

The following sections indicate how these three core functionalities of the model will be executed in the model's use scenarios.

6.3 DEVELOPMENT OF SCENARIOS FOR THE MODEL'S USE

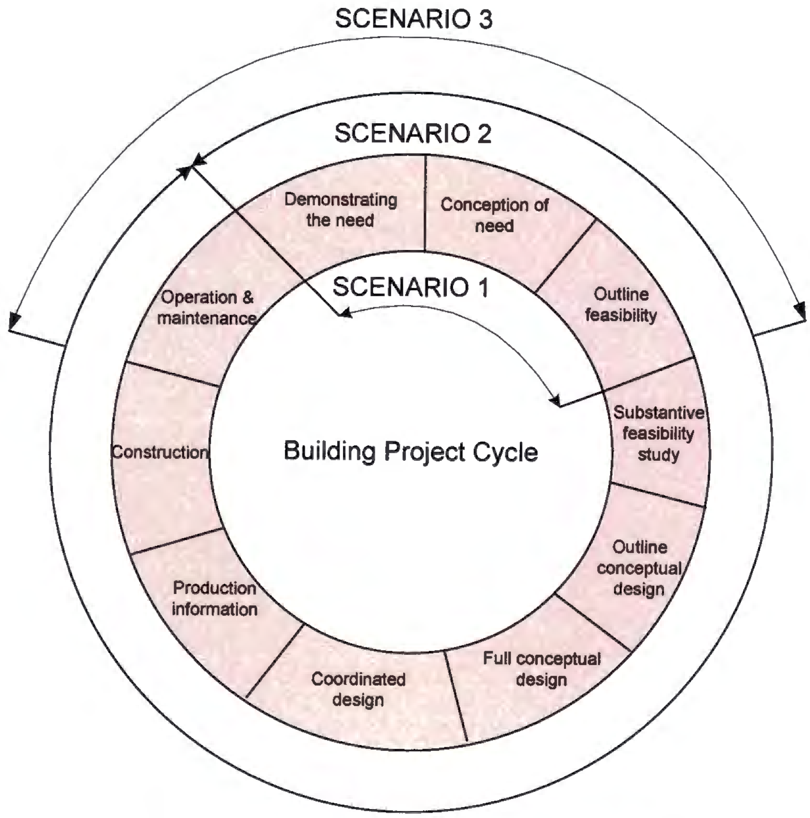
The discussion of potential application scenarios illustrates how the model for building sustainability assessment would work in practice. The model may be used in three types of instances characterised by specific objectives, namely:

- in the development of a project proposal;
- in project sustainability appraisal; and
- in the audit of building performance.

It is important to note that a building project may embody more than one of these *use scenarios* (see Figure 9). For instance, the model can be applied in the development of a proposal and subsequently be used for the purposes of project sustainability appraisal. Alternatively, the model can be used to assess performance of an existing building to determine the need and opportunities for its performance improvement, and then it may be applied in the subsequent proposal formulation and project implementation. As the model will provide a different contribution in each of the three cases, its generic framework has to be customised to suit the needs of each application. Consequently, certain assessment inputs and potential outputs will differ between application scenarios, although the desired outcomes of using the model should remain the same.

In each use scenario, the model should aim to establish a common project vision based on the principles of sustainability and stakeholders' needs. This is achieved through the emergence of common project values shared by all process participants. The model will also retain its fundamental premises and key elements. These include the scoping stage with learning workshops and consensus-building in the prioritisation of significant issues, or record keeping in the form of the Legacy Archive – an information management system to keep record and make information updates.

Figure 9: Relation of the Model's Use Scenarios and a Building Project Cycle



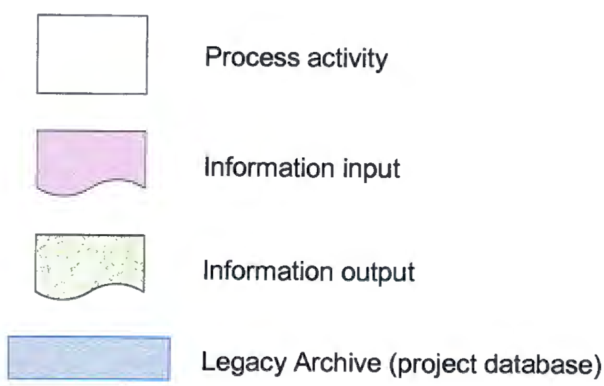
The scoping activities, in all three applications, will focus on the identification of key issues and project objectives, as well as on the establishment of terms of reference for a given building project (i.e. the building process and assessment). In this context, scoping is viewed as a preliminary situational analysis that shapes the design and content of all subsequent stages of the project cycle. Scoping includes a comprehensive consideration of the proposal (i.e. its substance and boundaries) and the selection of design and organisational solutions that satisfy the purpose of the proposal and its objectives. Therefore, in the scoping stage decisions will be taken that relate to the potential quality and focus of building sustainability assessment and the building process.

The model will combine elements of assessment and evaluation, as information on building related issues is collected, analysed and communicated to building stakeholders. At the same time, the assessment findings would be evaluated in relation to their implications for the project decision-making. This requires that emphasis is placed on a timely consideration of values, priorities, facts and issues, and on an effective communication strategy throughout the building process. Arguably, in all three scenarios discussed below, the model can play an important auxiliary role for managing the building project. This means that the model will be used not only to enhance the performance of a building in question, but also to enhance the quality of the social and technical processes that comprise the building project.

Furthermore, potential design and operationalisation of the model based on this functional specification can be informed by process maps that will be developed for each use scenario. Process maps will show information flows throughout the assessment process and the distribution of process activities and inputs during a building's project progression. Hence, the process maps for each use scenario will assist in the discussion of potential effectiveness of producing desired outcomes (e.g. integration of sustainability thinking, enhanced transparency and accessibility, as well as collaborative learning).

The maps will offer a graphical representation of the building sustainability assessment process integrated with the building project, as they include only process activities with information inputs and outputs. The shapes used in these process maps are listed in Figure 10.

Figure 10: Basic Shapes of the Process Maps for the Model's Use Scenarios



When reading the process maps it is useful to follow the progression of process activities in time. Process activities are represented on the maps as white boxes connected by arrows. These activities comprise those that are inherent to building assessment and those of the building process. Information inputs for process activities are presented as pink boxes, hence the arrows connecting them with appropriate activities point downwards. Information outputs from activities are presented as green boxes. The outputs are captured in the project database, i.e. the Legacy Archive, from where they are sourced as inputs into subsequent project activities (as indicated by blue arrows).

The process maps presented in the following sections complement the discussion and description of the three model's use scenarios.

6.3.1 Use Scenario 1: Development of a Building Project Proposal

Proposal formulation is presented as a separate use scenario of the model. This is due to the fact that this stage of the project cycle provides an opportunity for the most meaningful integration of socio-economic and biophysical objectives with project strategic goals. If a decision to proceed with a potential building development is taken, and a commitment to the project vision declared by all stakeholders, then sustainability considerations would influence the entire decision-making process in the subsequent stages of the project cycle.

Proposal formulation is the commencing stage of any building process. The project is initiated by a statement of need expressed by a private or public developer, commonly termed the client's brief. The project need (i.e. the reason for a potential project) is further developed and justified during proposal formulation (Kagioglou *et al.*, 1998). Subsequently, the concept of a proposed development is converted into the details of a potential project (Tasmanian State Government, 2002). The outcome of this stage of the building process results in a decision to proceed or not with the particular undertaking.

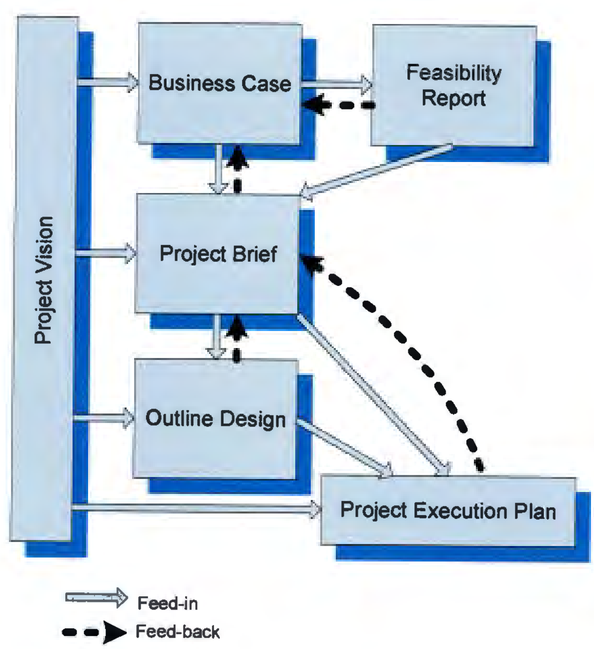
The development of the building project proposal entails intensive consultations with the client and other key stakeholders to adequately capture their needs and requirements. It employs strategic thinking about the problem (i.e. the project need) in the search for the most satisfactory solution. The problem is analysed in terms of required outputs, outcomes, existing opportunities, major risks, costs, and estimated time and resource requirements (Tasmanian State Government, 2002). This information is used to formulate key strategic objectives and goals of the proposed project. This is followed by a feasibility analysis, which aims to determine the viability of the project relating its objectives to the existing socio-economic context.

The outputs of this stage include a business case and project brief with an outline design and project execution plan. The business case provides the rationale for the project, and the project brief presents the scope of the project and specifications for proposed solutions (UK: Office of Government Commerce, 2003). The project execution plan complements information about the project conveyed in the business case and project brief by describing subsequent stages of the building process, pointing out control procedures and attributed cost estimates (*ibid.*).

More specifically, the business case is a *start-up* document that aims to assess the justification of the project (Tasmanian State Government, 2002). It considers such issues as risks, costs, benefits, product specifications, customer requirements, estimated time and budget requirements (Kagioglou *et al.*, 1998). It also lists clear objectives and success criteria for the project (UK: Office of Government Commerce, 2003). The business case helps to obtain commitment from key stakeholders to the project vision and objectives, as well as investment approval through a clearly presented rationale for the investment (*ibid.*). The business case is reviewed at each decision-point throughout the project cycle to ascertain that the project meets its key objectives and benefits (Kagioglou *et al.*, 1998).

The business case forms the basis of the project brief that helps to communicate a project rationale to the project team (see Figure 11). The project brief outlines what should occur in the initiation stage of the project, stating general requirements and a plan of action (Tasmanian State Government, 2002). It outlines the direction and scope of the project and includes a formal statement of objectives and functional and operational requirements of the finished product (UK: Office of Government Commerce, 2003; Kagioglou *et al.*, 1998). The importance of this document is that it informs the development of a detailed design and a specification of the work in the subsequent stages of the project cycle.

Figure 11: Relationship between the Outputs of Proposal Formulation



The project brief provides key inputs into the project execution plan, which forms a guideline for the project team to deliver the agreed project outputs (UK: Office of Government Commerce, 2003). The project execution plan outlines the responsibilities of the project team and other key stakeholders. It describes the purpose of works and decisions to be reached, distributes tasks and allocates responsibilities (Tasmanian State Government, 2002). Therefore, the project execution plan is a baseline against which progress achieved in the later stages of the project cycle can be monitored (UK: Office of Government Commerce, 2003).

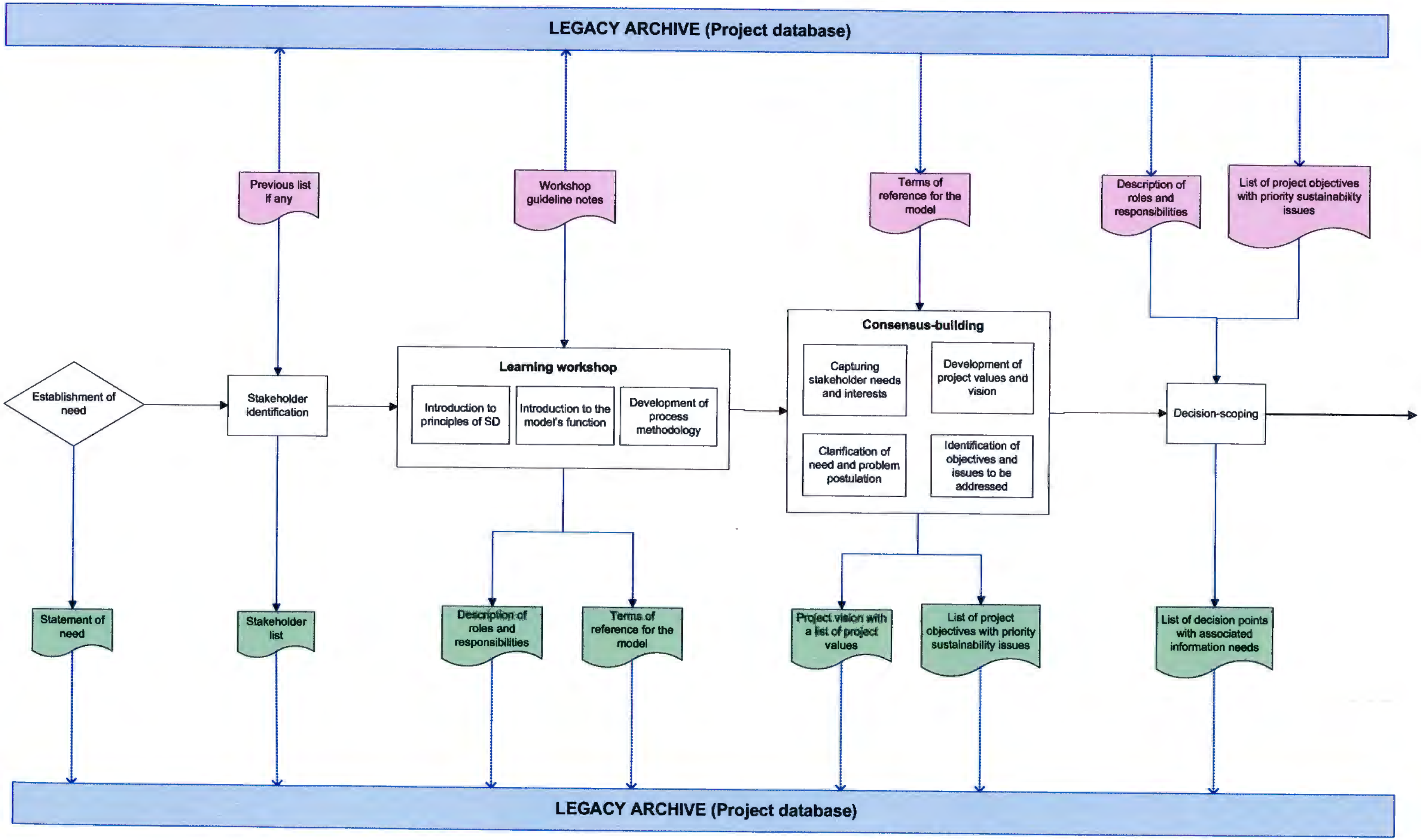
Arguably, project proposal formulation is the most crucial stage in the building process from a sustainability point of view. This is when sustainability can be effectively and proactively introduced into problem conceptualisation, so that the principles of sustainable development can provide foundations for the formulation of the project vision. The vision, which is subsequently reflected in the business case and the project brief, should determine the entire design of a potential building product and process.

The major role of the building sustainability assessment model, at this stage of the building process, will be to provide key stakeholders with a forum for learning and dialogue. The model should help stakeholders to promptly identify strategic opportunities and interrelations between all decision-factors in establishing project vision and later in the business case. Most importantly, the model should also facilitate the development of common project values to reduce potential conflicts and shape responsible attitudes and stakeholder commitment to sustainable development. This would take place during scoping, after the project need has been expressed and key stakeholders identified (see Process Map 1).

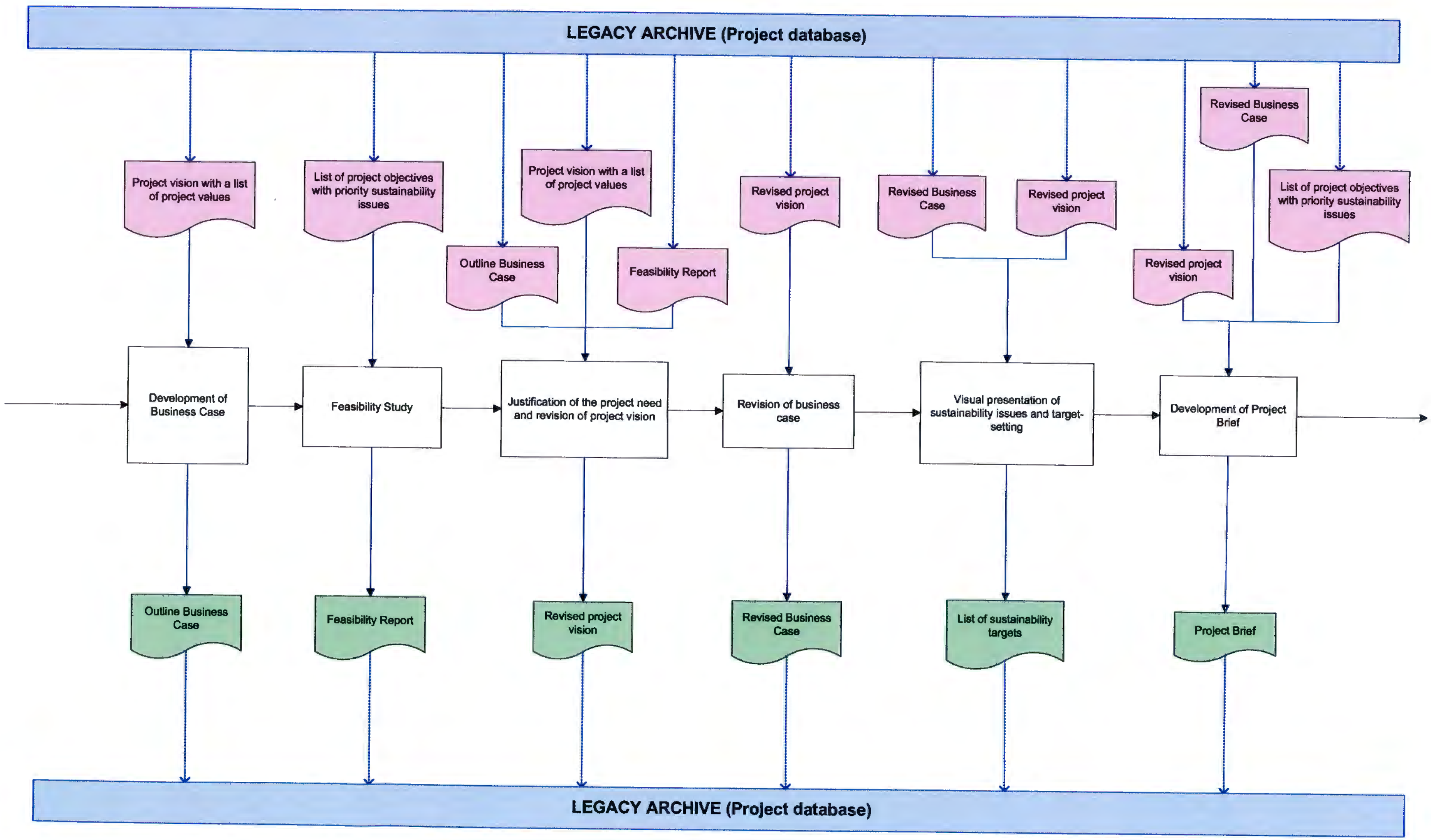
The scoping phase of the model will focus, firstly, on problem-definition and subsequently on problem-solving. Stakeholders would be invited to express their needs and interests in the preliminary attempts to conceptualise the project need. Afterwards they would be provided with information on sustainable development and sustainability, and they would be challenged to establish common project values and to prioritise project objectives accordingly through mutual-adjustment. This will be followed by a contextual analysis of the existing socio-economic and biophysical environment in order to validate the project need and to refine the project vision. The problem-solving would comprise the development of the project brief, project execution plan and the development of an outline design, where technical and other practical solutions are proposed and analysed.

By default, the model will initiate an integrated building process by addressing all stages of a building cycle during proposal formulation and, consequently, by broadening stakeholder participation at the outset. For instance, the key stakeholders involved at this stage could include a client/developer, potential end-user, designer, contractor, specialist supplier and a facility manager/operator. This necessitates the provision of an effective communication strategy and a transparent process. Hence, stakeholders should be informed about the purpose of applying the model, and participate in the development of terms of reference for the entire proposal formulation process.

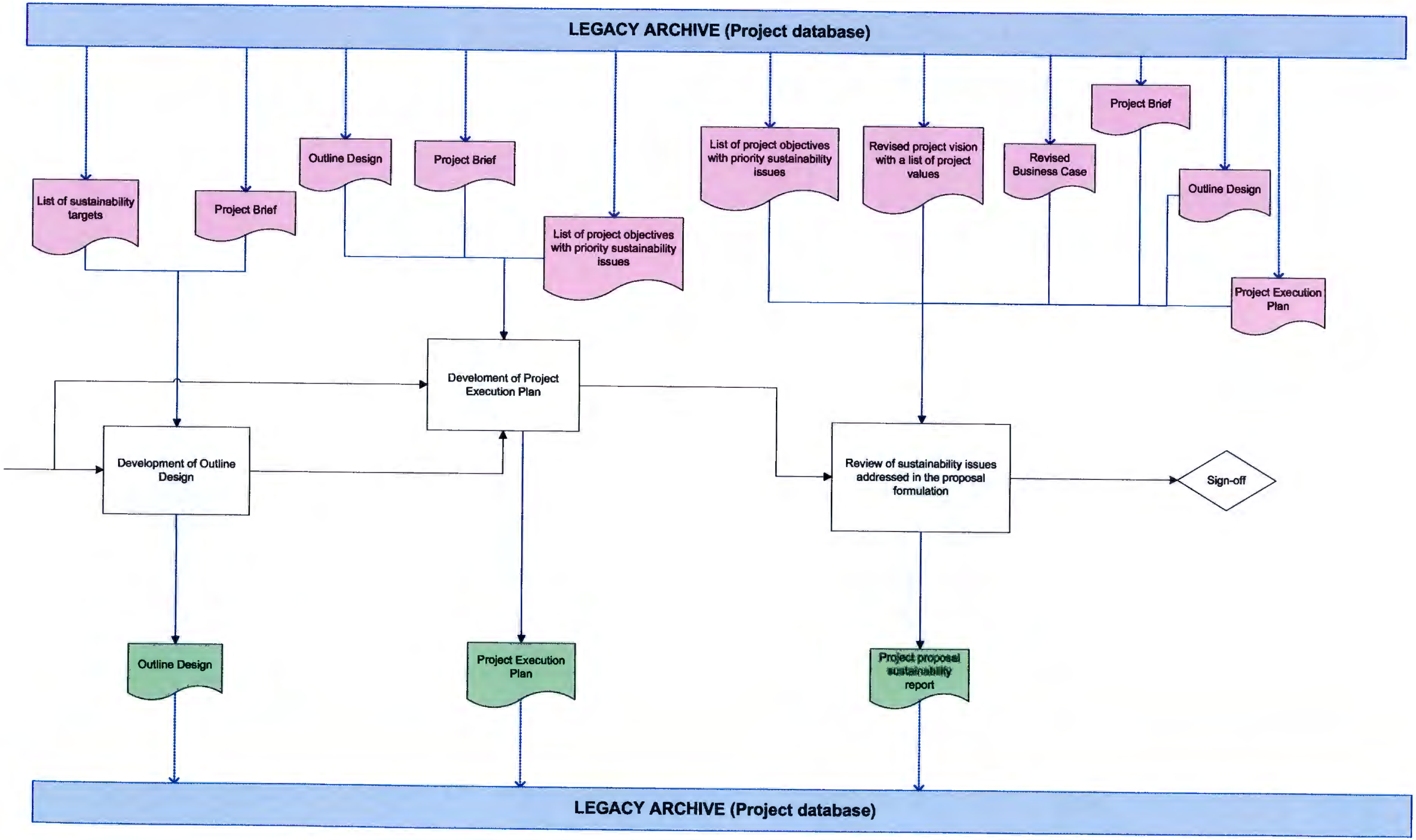
Process Map 1: Development of a Project Proposal Using the Model for Building Sustainability Assessment (1/3)



Process Map 1: Development of a Project Proposal Using the Model for Building Sustainability Assessment (2/3)



Process Map 1: Development of a Project Proposal Using the Model for Building Sustainability Assessment (3/3)



The model will impose discipline into the proposal development by requiring a clear description of roles and responsibilities, as well as inputs for each decision-point. In addition, a visual presentation of objectives with priority sustainability issues would assist in target setting.

In terms of the model's direct contribution to the outputs of this initial stage of the building process, scoping would allow for a more complete gathering of information necessary for the development of the business case, project brief, project execution plan as well as the outline design. As a result, the project proposal will not only capture client/user requirements, but it will be also grounded in the existing socio-cultural context and contributes to sustainable development within local settings.

When the model is used in the formulation of the proposal for a new development, scoping should determine, firstly, if the construction of a new building is the optimal solution to the problem stated (i.e. the expressed project need). Secondly, the contextual analysis should focus on the choice of the prime location for the project. This requires taking into account the sensitivity of the receiving natural environment and available socio-economic opportunities. In addition, the feasibility study needs to include an examination of existing regional development plans and relevant regulations. In this way, the problem can be adequately shaped by the affected environment, thus increasing the viability of the proposed development.

Proposal formulation can also refer to a building renovation or a change of use (e.g. from commercial to housing). In this case, scoping would focus on the opportunities to enhance building environmental performance and to increase user satisfaction, while ensuring economic viability of a proposed undertaking. Issues that need to be considered during scoping include self-sufficiency in resource use, sensitivity of the receiving environment, effective end-user participation, or the extent of necessary renovation works to extend a building's lifespan, among others (refer to Section 6.3.3).

The outcome of this use scenario should lead to a decision whether the project will be funded and executed. All outputs that have been produced during this strategic project planning should be deposited in the Legacy Archive - a project database. In this way, the vision and values established during proposal formulation can inform subsequent stages of the building process. The following section discusses how the model can assist in enhancing the project's sustainability throughout the entire building process.

6.3.2 Scenario 2: Building Project Sustainability Appraisal

Arguably, a key challenge faced by the construction industry worldwide is its ability to improve the quality of building processes in order to enhance the sustainability of building initiatives and the performance of delivered buildings. This situation necessitates the revision of traditional success factors by which building projects are evaluated in terms of efficiency and effectiveness, such as cost, quality and time (Baccarini, 1999). Attempts have been made to incorporate the aspects of potential biophysical impacts into the evaluation of building projects, including resource consumption, pollution and implications for biodiversity (Bourdeau, 1999). This approach is embedded in the early building environmental assessment methods (e.g. BREEAM and LEED).

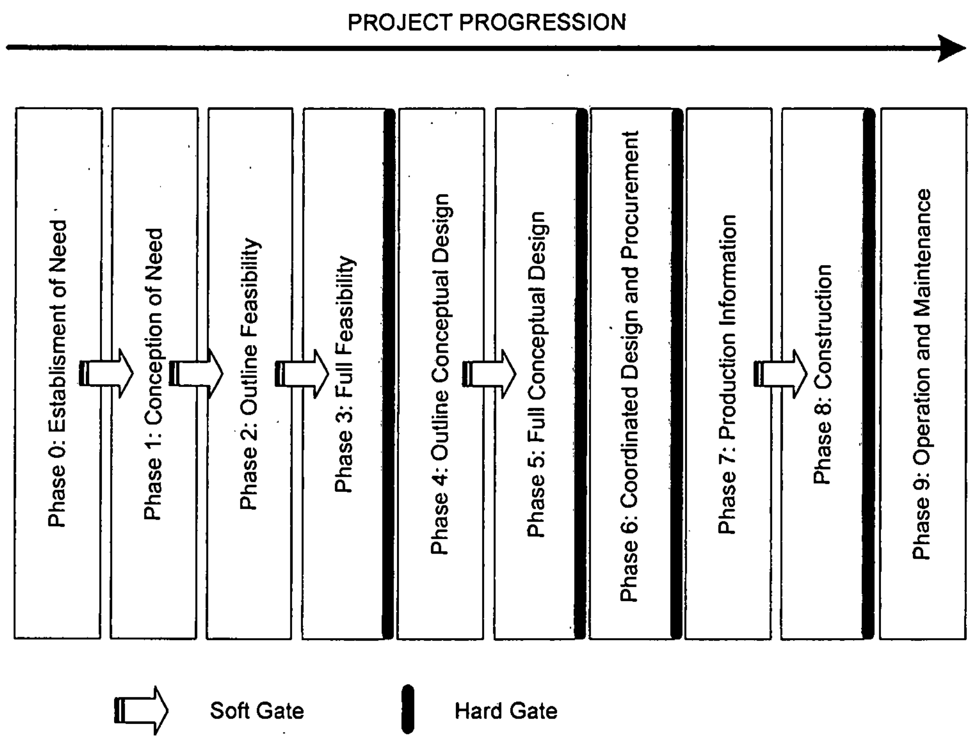
At the same time, it has been recognised that if building developments are to be assessed within the global context of sustainability, then the emphasis is shifted towards the issues of environmental quality, economic constraints, social equity and cultural concerns (Bourdeau, 1999). Hence, more recent *sustainable* building assessment methods (e.g. SPeAR and SBAT) provide an extended scope of assessment to address these issues. Nevertheless, most of current interventions aimed at the improvement of construction practice focus on the design and performance of buildings as the end-products of building processes. Hence, the very processes that shape and produce buildings are not addressed explicitly as advocated in this thesis. Arguably, the building sustainability assessment model needs to assist in appraising the sustainability of building *projects* rather than buildings, if the existing practice and professional culture of the industry are to be meaningfully challenged and transformed.

This means that the model could not effectively function in the form of a standard checklist that addresses building performance, and which lists principles that guide building design and construction in accordance with the agenda of sustainable construction. Such an approach would not appreciate, or take advantage of, the fact that each building project is unique by nature in terms of stakeholder needs, existing socio-economic context, environmental surroundings or access to resources, among others. It is proposed that the sustainability appraisal of the building project be viewed as an exercise of interactive evaluation and facilitation of activities that comprise the project. Hence, the appraisal needs to embrace both technical and social processes. The previously-defined core functionalities of the building sustainability assessment model (i.e. integration, transparency and accessibility, and collective learning) become especially relevant in this application.

A building project appraisal is concerned with two main issues – whether the established sustainability objectives are being met and whether the principles of sustainable development are being effectively incorporated into the building process. In discussing this particular use scenario of the model, the Process Protocol will be used as a generic representation of the building project. A building process template provided by the Process Protocol consists of 10 stages, as presented in Figure 12.

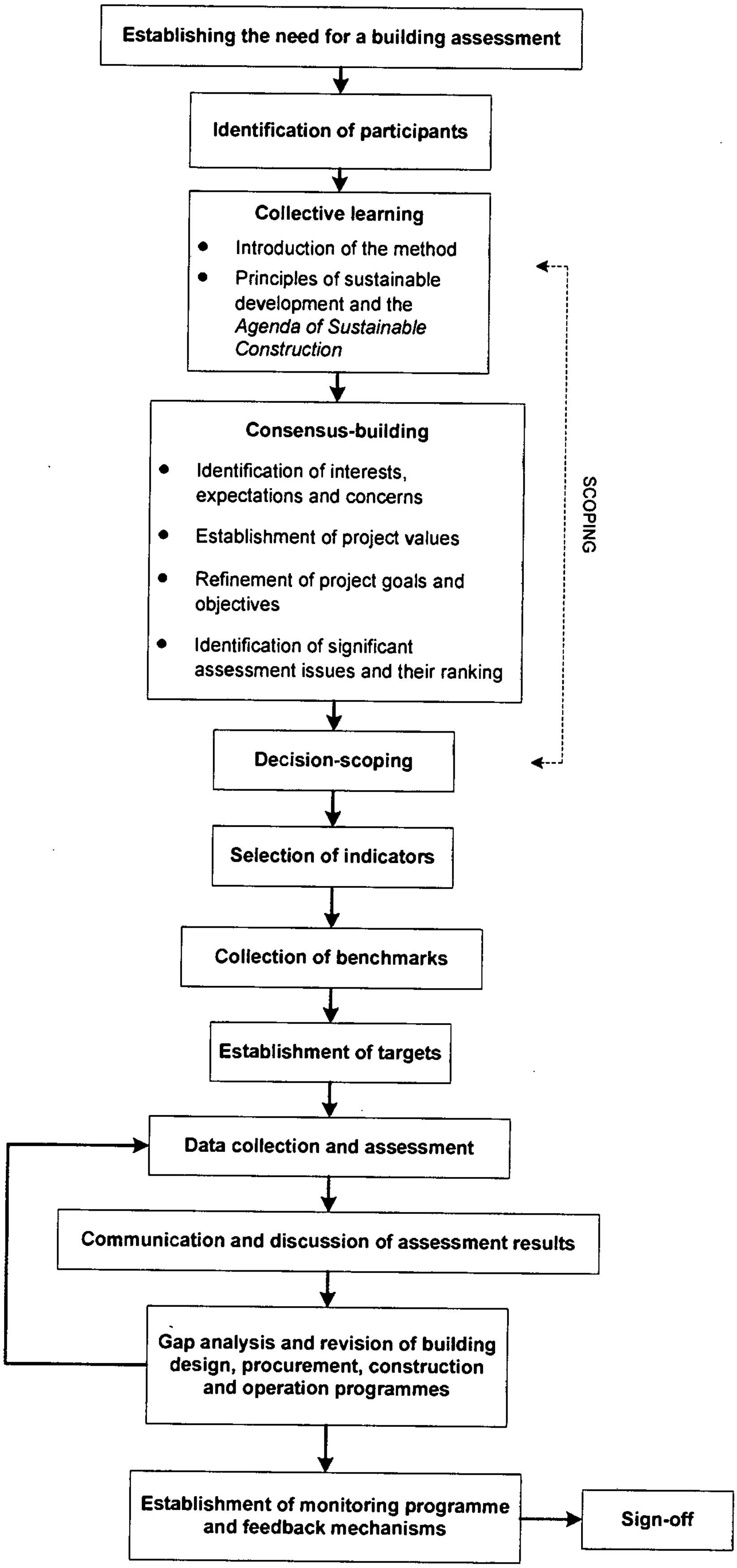
These stages are populated with activities which may be specific to a particular stage of the building process, or which may stretch over more than one stage. Such a representation of the building project and its progression, which incorporates a process view, is helpful in the identification of the type and timing of potential inputs from the model. In this way a *high level* decision-scoping exercise can be undertaken.

Figure 12: Graphical Representation of a Building Process (adapted from Aouad *et al.*, 1999)



Similarly, a building sustainability assessment process can be depicted as a progression of certain activities (see Figure 13). The assessment process begins with the establishment of a need for the application of an assessment method. This is followed by the identification of participants of the assessment and its relevant audience. Subsequently, process participants are presented with the assessment method to fully understand how it functions and interacts with the building process. This helps to better understand what assessment inputs are required, and what the assessment can deliver in terms of expected outputs and outcomes.

Figure 13: Generic Representation of a Building Sustainability Assessment Process



Moreover, participants are acquainted with the principles of sustainable development and the agenda of sustainable construction. This knowledge is fundamental if common project goals are to be established in support of the sustainability vision.

The next stage of the assessment process requires that the interests of all stakeholders are brought together. Only then does it become possible to develop shared project values through mutual adjustment. These "*negotiated guiding principles*" (Thomson *et al.*, 2003:337) inform the establishment of project goals and strategic objectives. Undoubtedly, project values would also shape decision-making throughout the building process, as any proposed solutions should explicitly relate to them (*ibid.*). Achieving a broad consensus regarding this value framework for the project is critical for the development of individual commitment – among all building stakeholders – to the accomplishment of agreed project outcomes. Hence, it is necessary to clearly state project *means* (i.e. a building's physical and operational requirements) and *ends* (i.e. broader socio-economic services and environmental benefits from a building development) at this stage of the building assessment process (Bordass *et al.*, 2001). This process would be one of the activities in scoping.

Scoping aims to identify significant issues to be addressed in building assessment using a set of indicators, which are subsequently measured and monitored. In addition, scoping is used by stakeholders to design subsequent stages of the assessment process. This is achieved during decision-scoping by identifying information needs for project decision-making.

The next stage of building assessment comprises the collection of benchmarks and data necessary for the actual assessment exercise. Targets are established against which progress made, in the achievement of project goals and objectives, can be evaluated. This is followed by the presentation of results to all stakeholders using visual aids. The communication of results of building assessment to process participants should aim to convey some sort of explanation, including a discourse on the implications of these results.

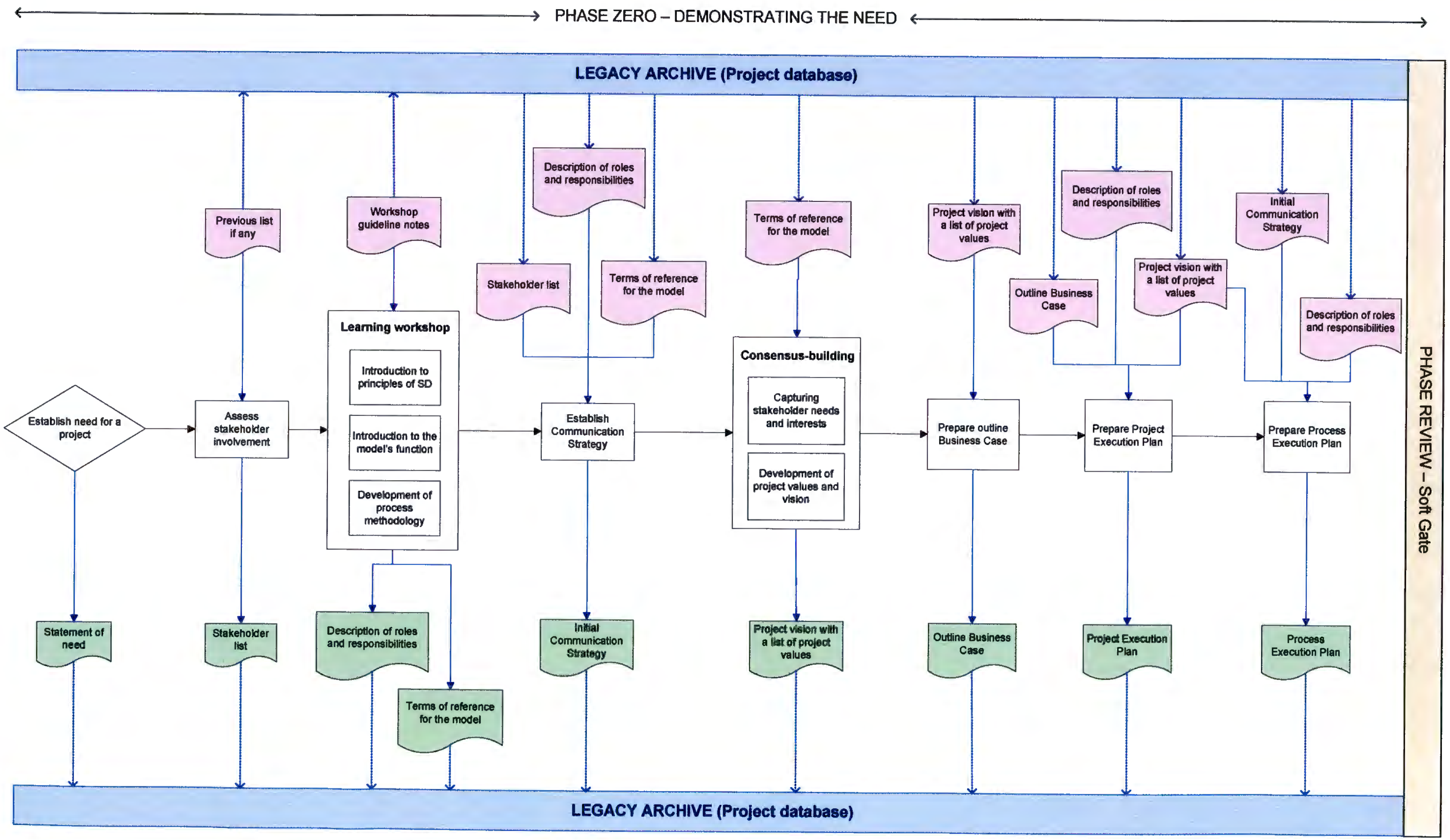
After results have been communicated, it is possible to proceed with a gap analysis and make the necessary adjustments in the building design, procurement, construction and operational programmes. This phase of the building assessment process would have a more cyclical than linear character, since assessment and presentation of results can be conducted at various stages of the building process. The assessment sign-off could take place during the building commissioning stage, although some form of monitoring and continued feedback on the actual building performance during its operation needs to be ensured. The entire building assessment process needs to be documented for transparency and verification purposes. All documents, assessment results and monitoring data could be captured, for instance, by a project database.

It may be implied from this description of the building assessment process that the model may not fulfil its intended problem-solving and stakeholder empowerment potential if it is applied alongside, but separate from the actual building process. Thus, a meaningful localisation of the model within the building process (i.e. its adaptation into the project context) is critical in the development of its specification. If building sustainability assessment corresponds with and facilitates decision-making in the building process, then it is possible to talk of project sustainability appraisal that constructs a problem definition and allows for the co-production of a problem solution. In the context of sustainability appraisal of the building project, two notions are brought to the fore, namely, the *co-production of understanding* (i.e. problem definition) (Robinson, 2004) and *co-design* of technical and practical solutions (Enserink and Monnikhof, 2003). Their viability is ensured through proactive stakeholder participation in the project sustainability appraisal. In this way the social and technical processes that produce buildings can be regarded and treated as complementary in the building process.

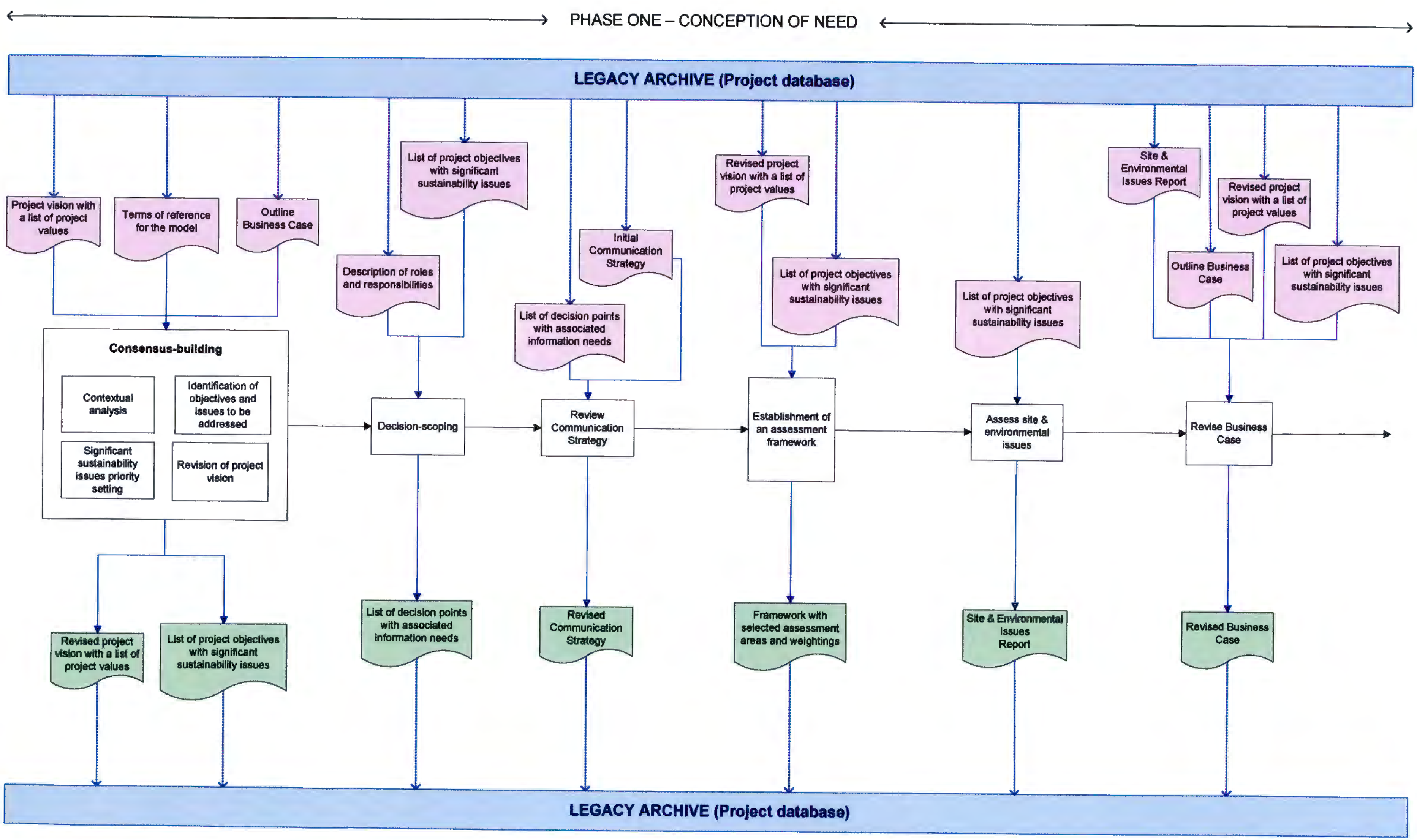
The model can best respond to the iterative nature of building design, engineering and construction when it is introduced into the domain of project management. Project management is concerned with a successful achievement of project goals with an efficient use of resources. It comprises a set of activities such as planning, scheduling and progress monitoring (Tasmanian State Government, 2002). The Process Protocol offers a unique approach to optimising building project management by providing an explicit view of project progression with the use of *hard* and *soft* gates, and by grouping project participants into Activity Zones. For the purposes of incorporating the model into a template of the Process Protocol, only core project activities are discussed (see Process Map 2). The first stages of the Process Protocol are concerned with the development and justification of the project need. Although potential contributions of the model into the proposal formulation have already been presented in the first use scenario (in Section 6.3.1), some repetition is made to provide a full understanding of how the model relates to the Process Protocol, thus allowing for a project sustainability appraisal.

As the sustainability appraisal should provide a platform for stakeholder dialogue, a team formulation will be undertaken at the first stage of the Process Protocol (i.e. Phase 0: Demonstration of Need). If possible, the team should comprise an architect, planner, engineer, cost consultant, supplier, contractor, sustainability consultant (if necessary), facility manager, client and end-user. This is necessary as all stakeholders need to participate in the development of the project vision, which is based on project values and expressed through a set of strategic objectives and project goals.

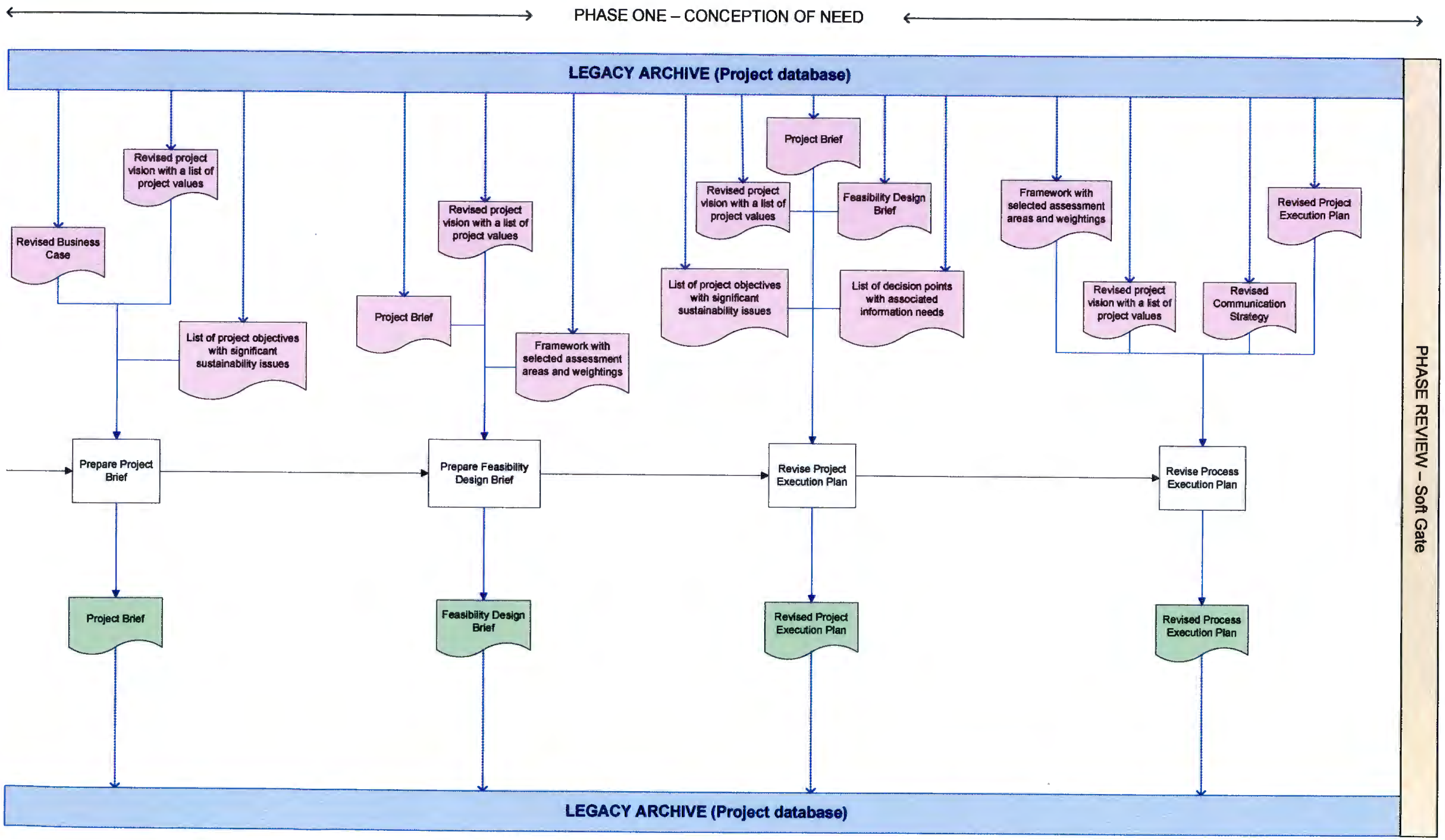
Process Map 2: Building Project Sustainability Appraisal Using the Proposed Model (1/12)



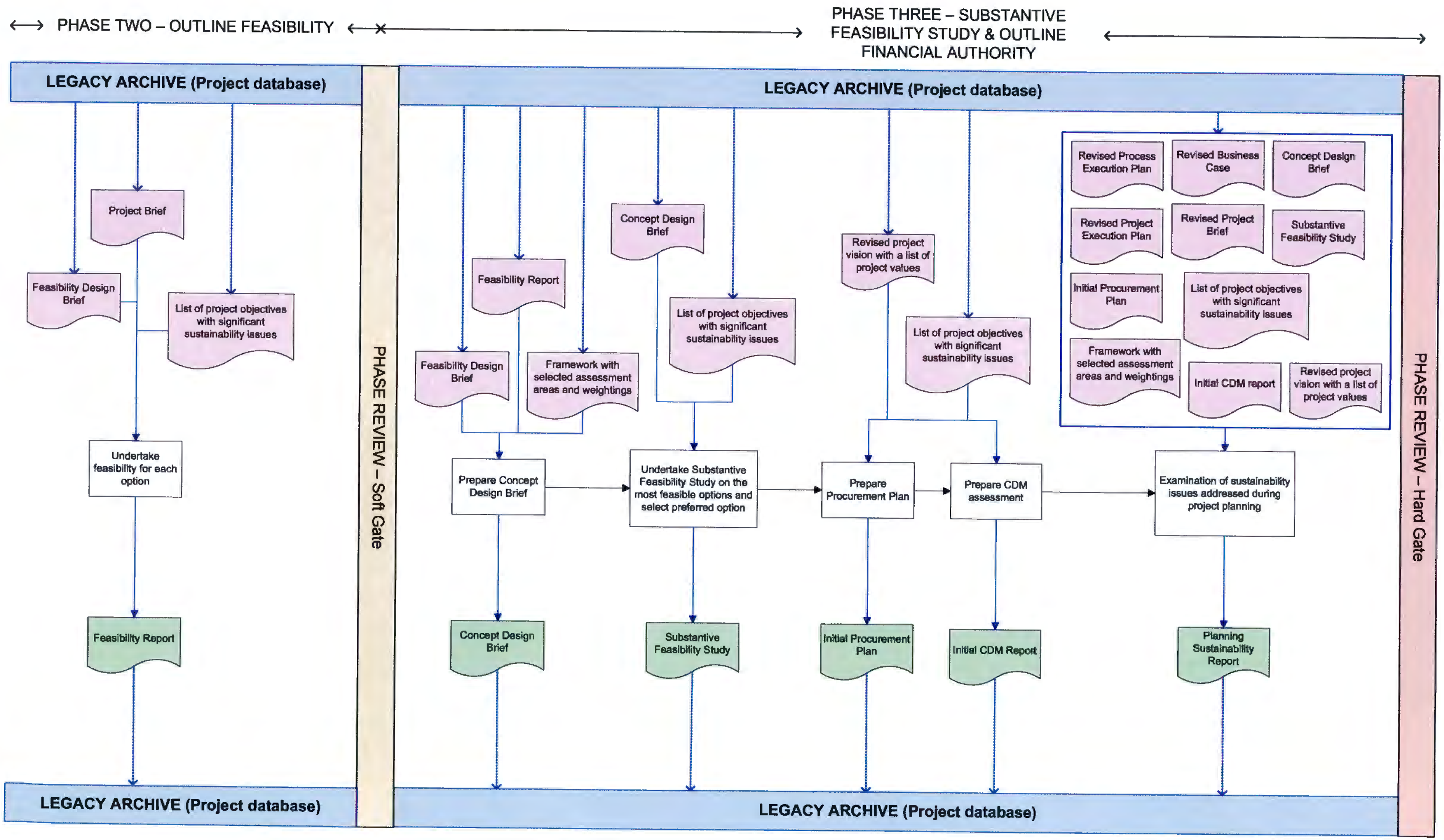
Process Map 2: Building Project Sustainability Appraisal Using the Proposed Model (2/12)



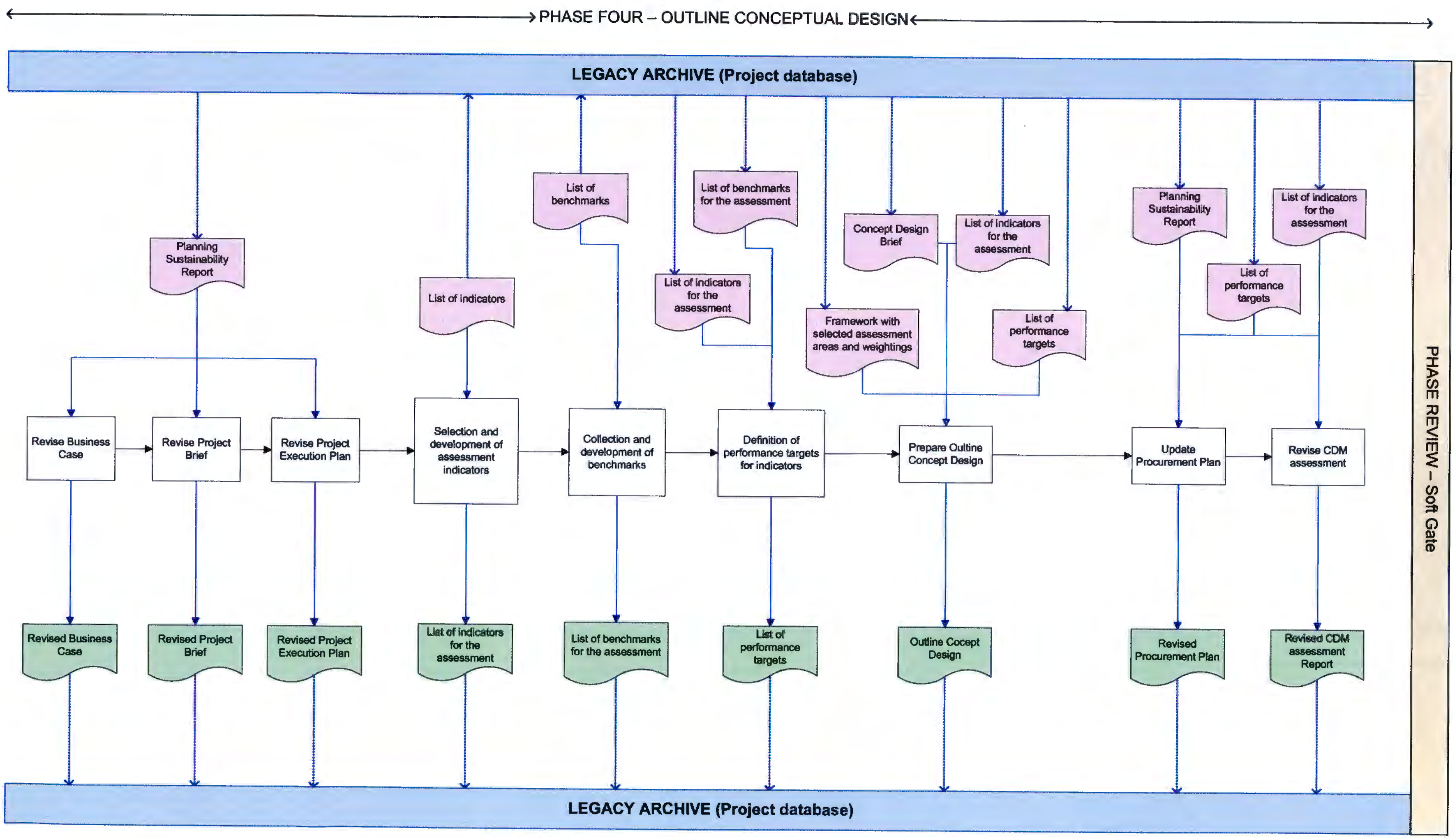
Process Map 2: Building Project Sustainability Appraisal Using the Proposed Model (3/12)



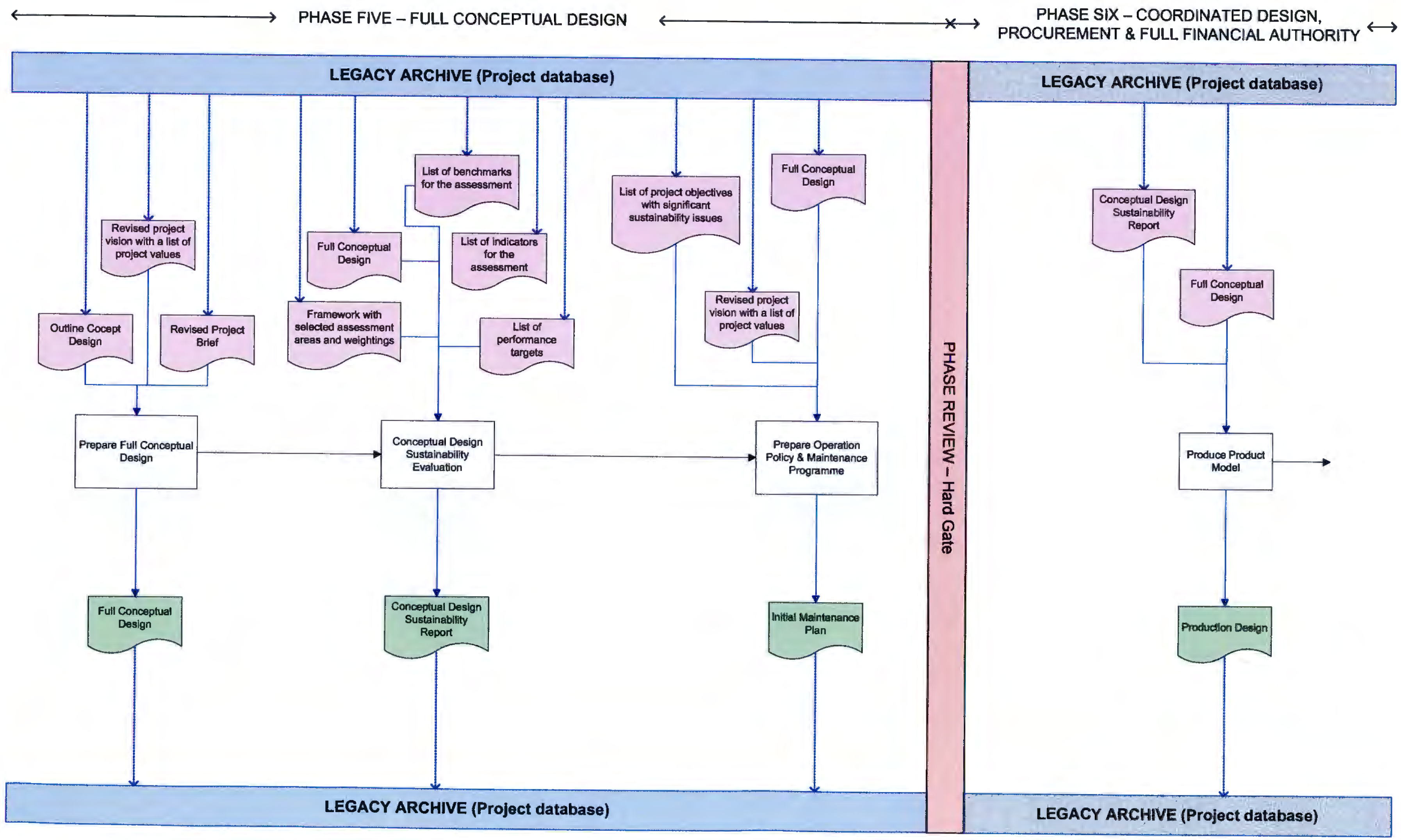
Process Map 2: Building Project Sustainability Appraisal Using the Proposed Model (4/12)



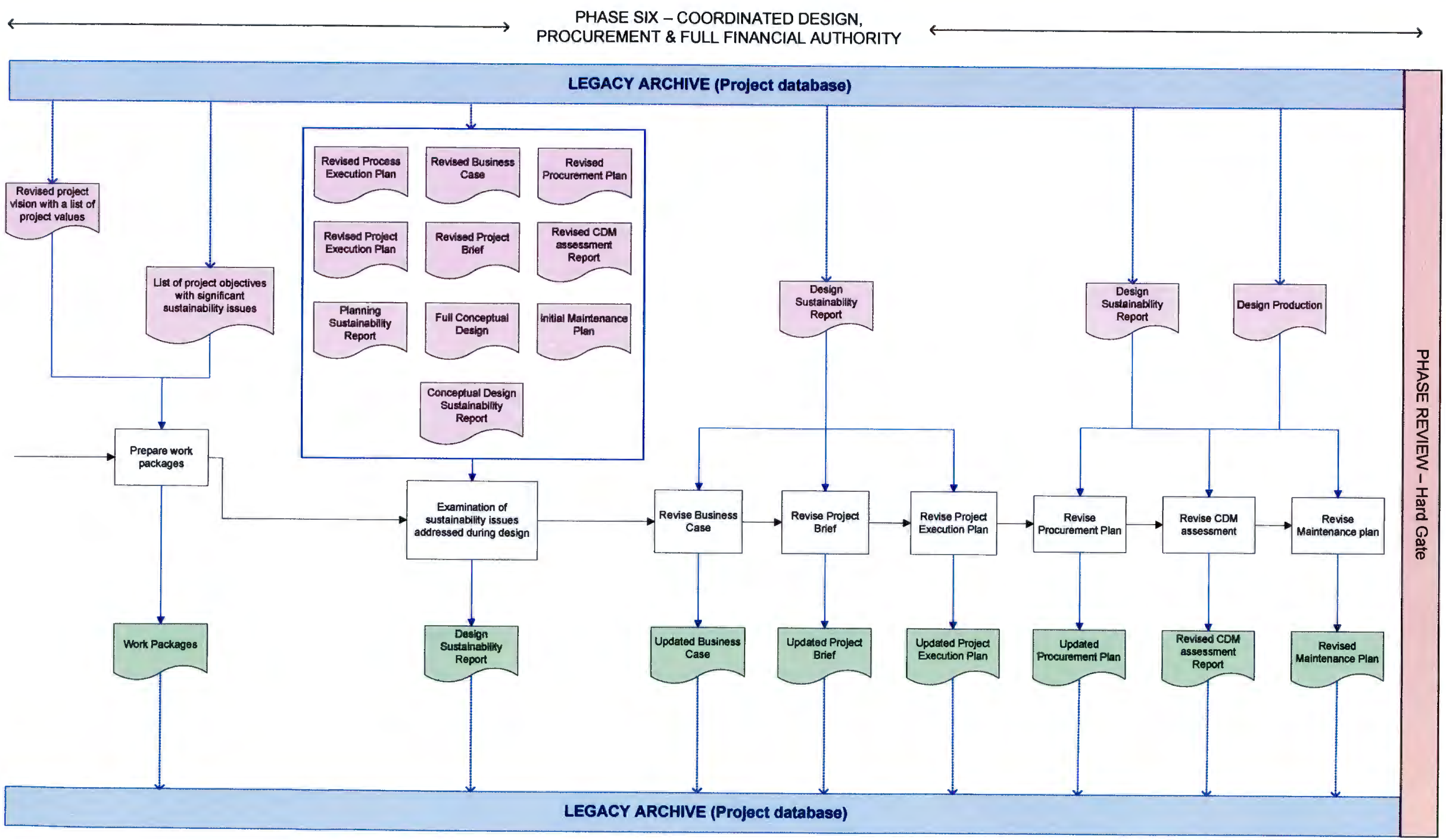
Process Map 2: Building Project Sustainability Appraisal Using the Proposed Model (5/12)



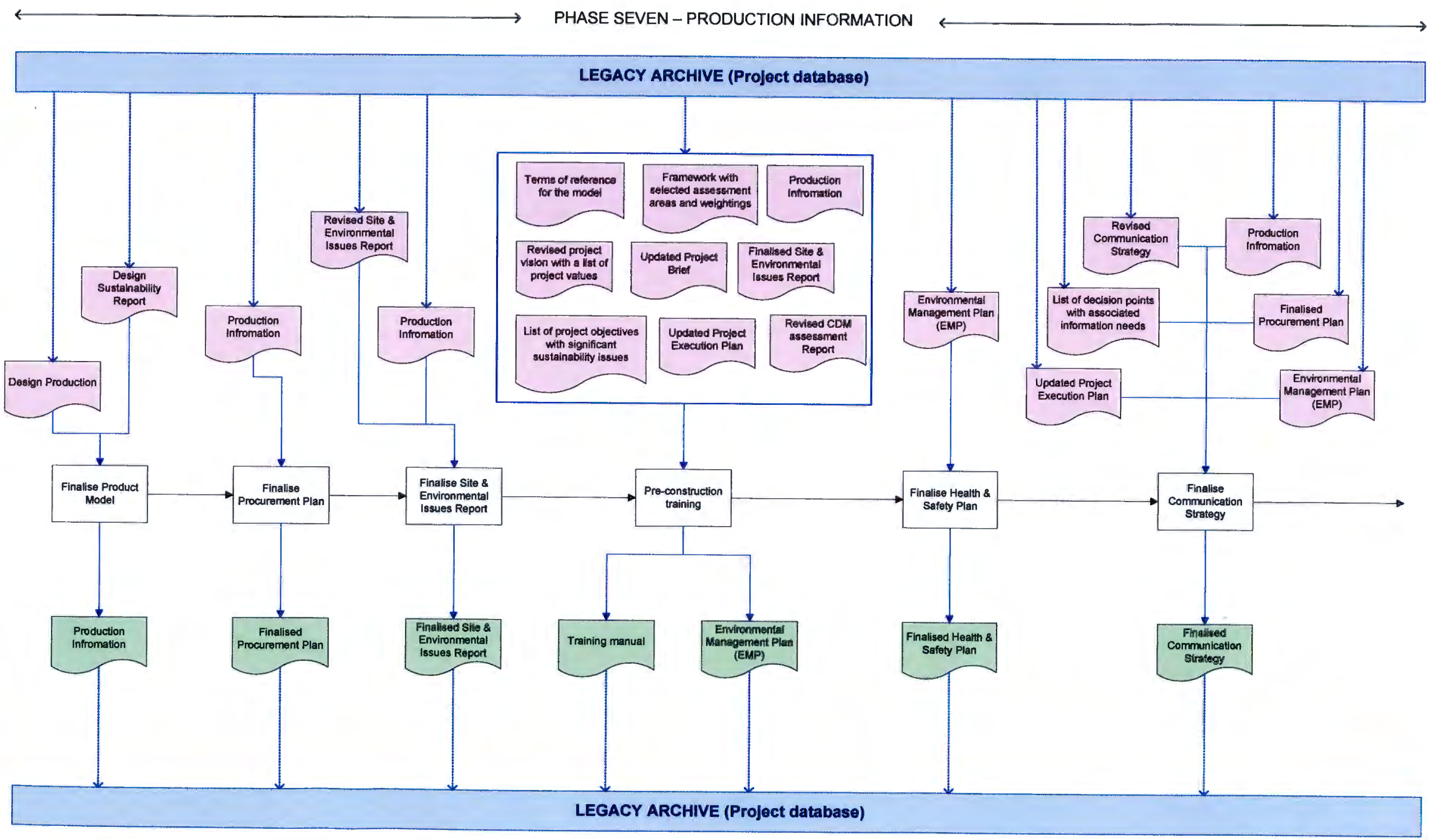
Process Map 2: Building Project Sustainability Appraisal Using the Proposed Model (6/12)



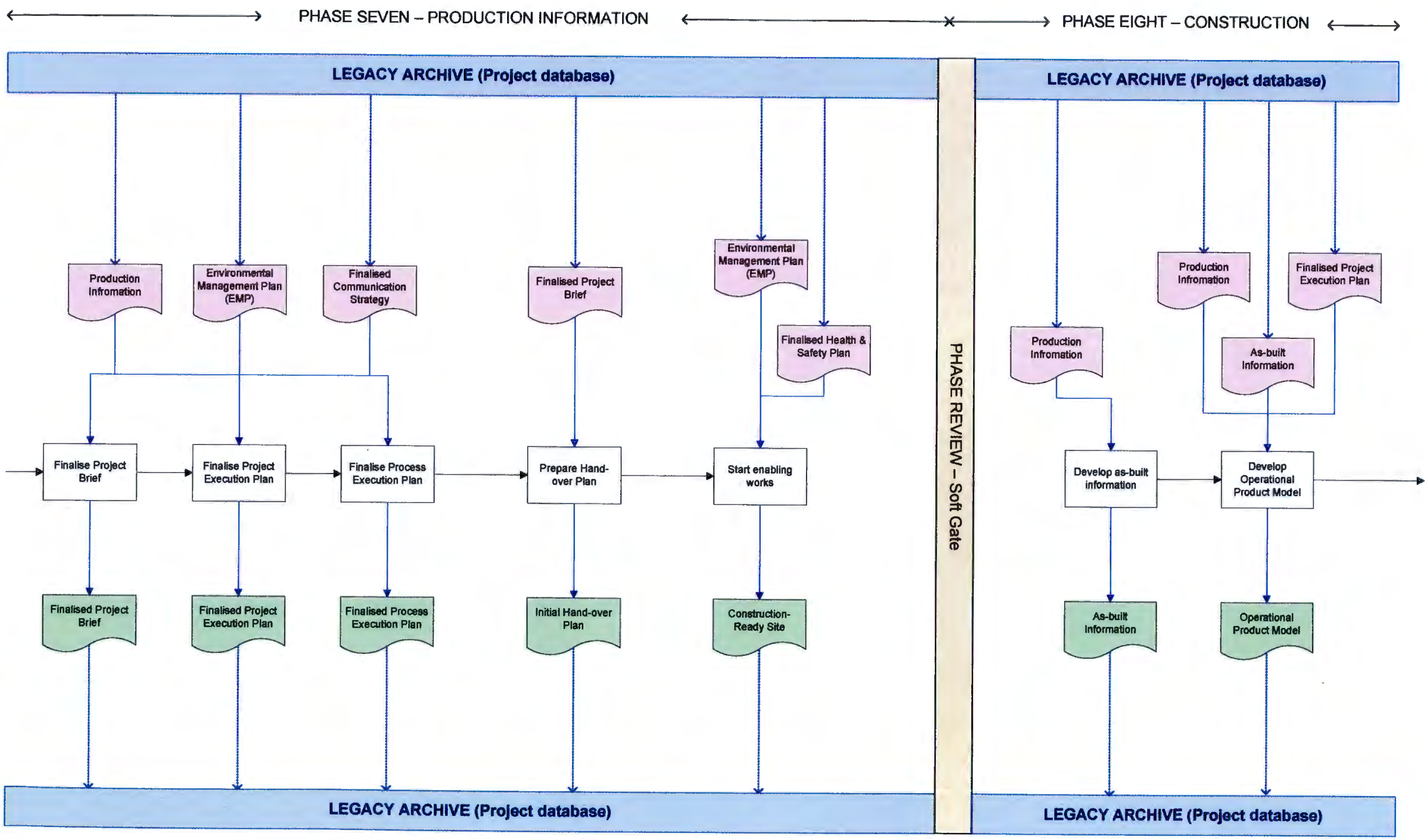
Process Map 2: Building Project Sustainability Appraisal Using the Proposed Model (7/12)



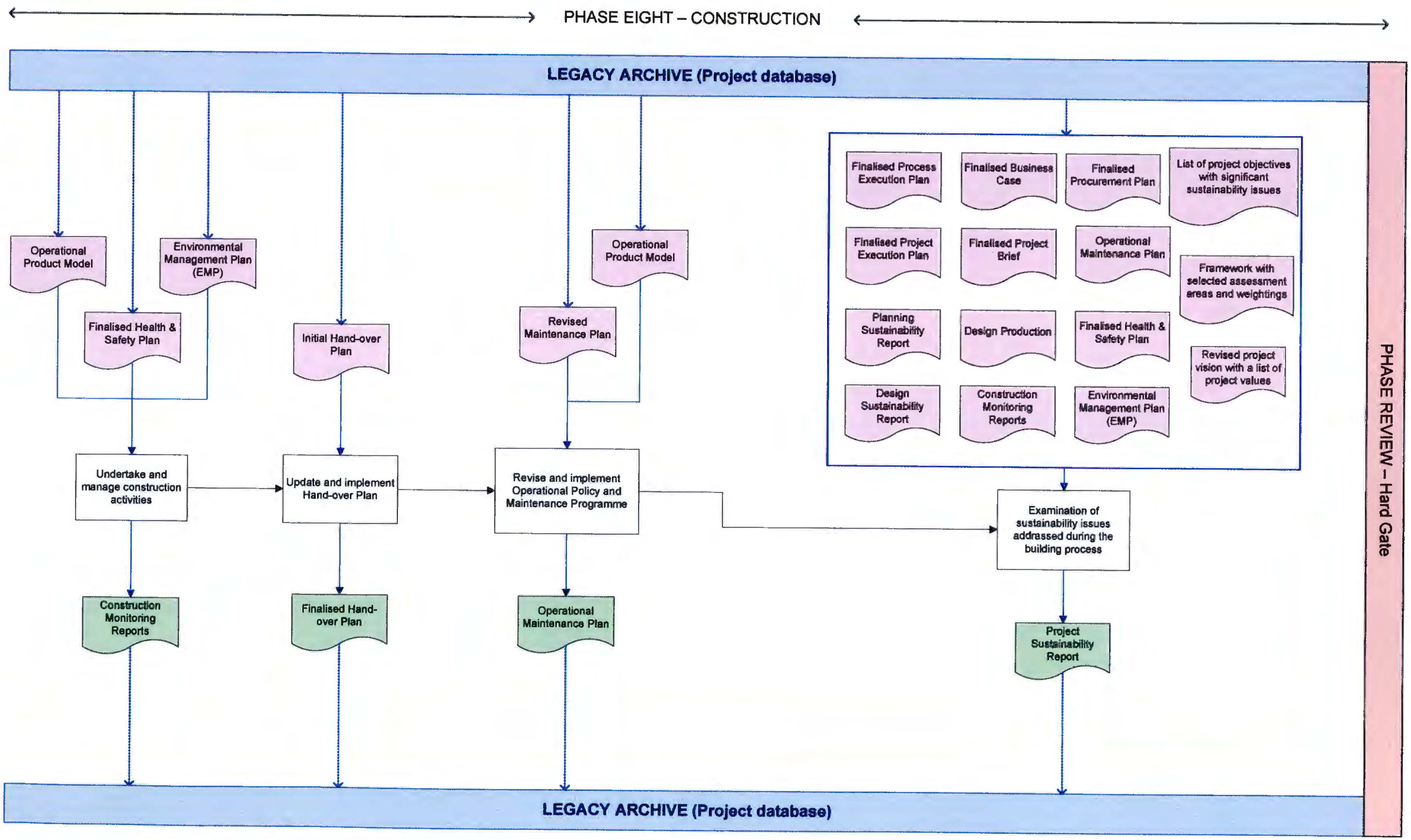
Process Map 2: Building Project Sustainability Appraisal Using the Proposed Model (8/12)



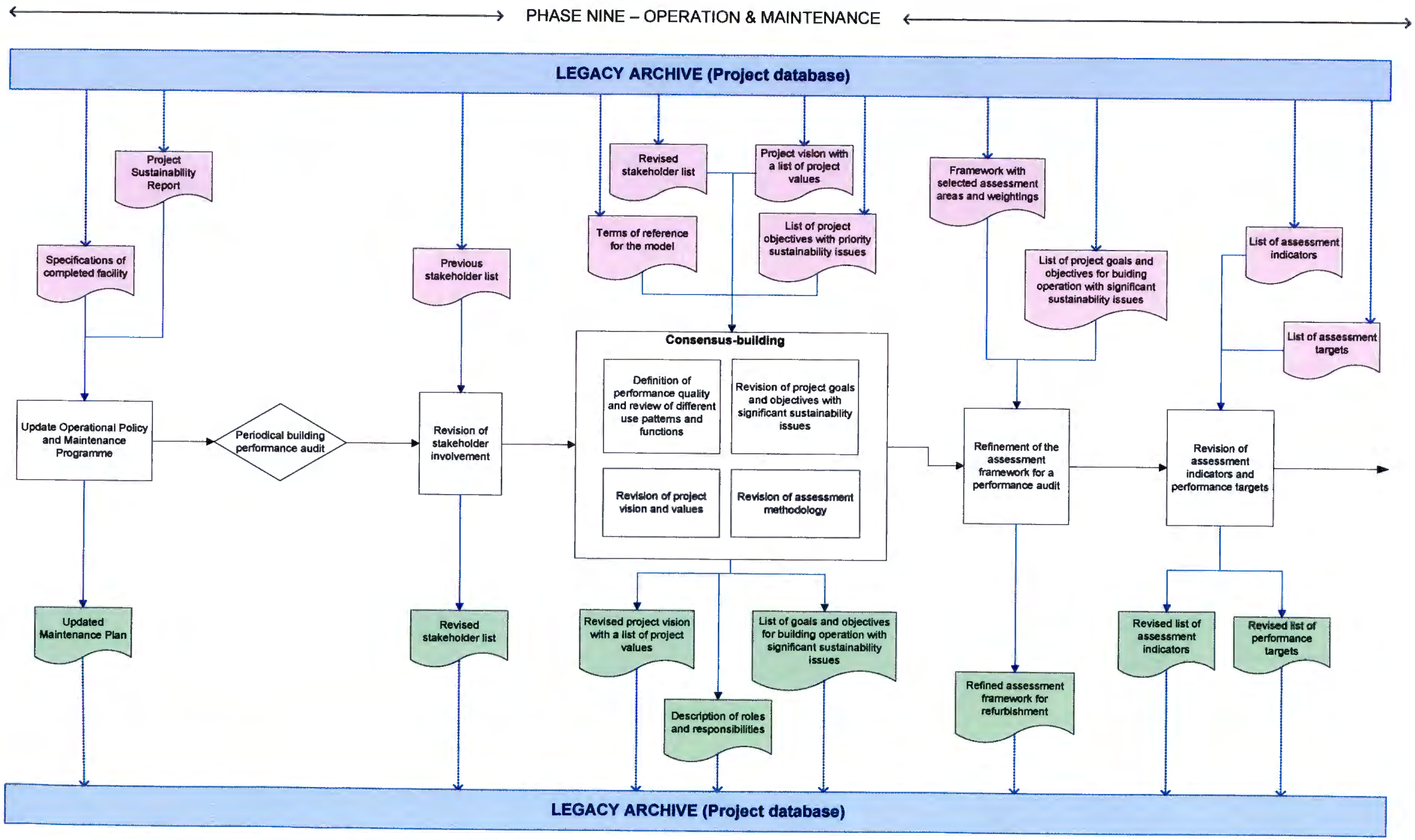
Process Map 2: Building Project Sustainability Appraisal Using the Proposed Model (9/12)



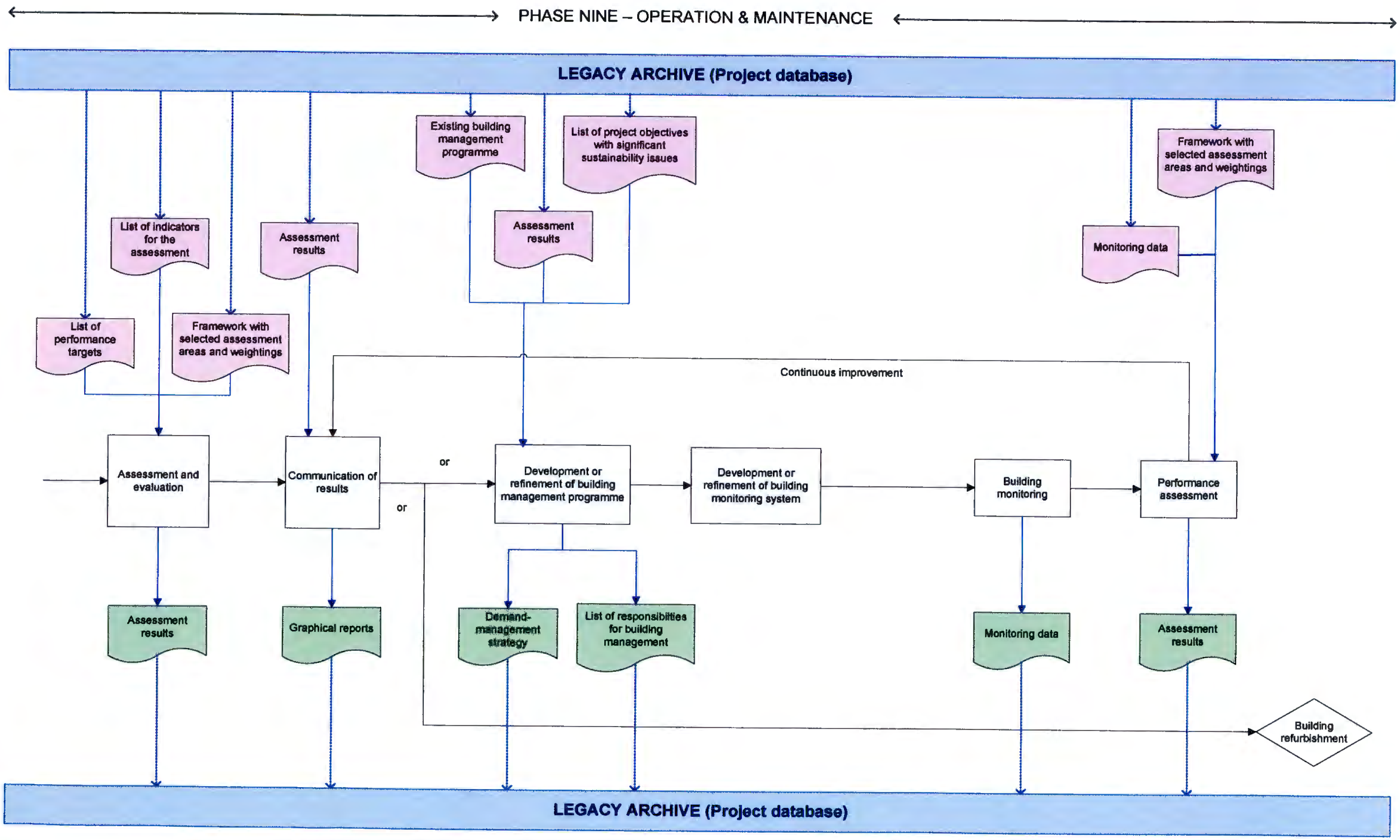
Process Map 2: Building Project Sustainability Appraisal Using the Proposed Model (10/12)



Process Map 2: Building Project Sustainability Appraisal Using the Proposed Model (11/12)



Process Map 2: Building Project Sustainability Appraisal Using the Proposed Model (12/12)



If the project vision is to meaningfully support the ideals of sustainable development and guide the team in enhancing the sustainability of the project, then collaborative learning needs to take place. Hence, a stakeholder learning workshop will be held that conveys information on sustainable development and its principles, and introduces the agenda of sustainable construction. At this stage stakeholders would be also acquainted with the model and the implications of using it for the purposes of the project sustainability appraisal. This will facilitate the development of terms of reference for the model.

The second workshop (or series of meetings) which will bring stakeholders together should also take place during the first stage of the Process Protocol. This workshop will form the initial phase of scoping aimed at strategic thinking about the project need, i.e. the clarification of the need and problem postulation. Supported by the mechanisms of negotiation and conflict resolution, stakeholders would present their needs, interests and perspectives. This would enable them to develop the project vision and shared values. Outcomes of this workshop should inform the development of an outline business case with a project rationale, which would be based on the premises of sustainability and project success factors.

The next phase of scoping will commence during the second stage of the Process Protocol (i.e. Phase 1: Conception of Need) and shall continue until the end of the third stage (i.e. Phase 2: Outline Feasibility). At this point scoping will be concerned with problem definition, which would begin with the validation and justification of the project need. In order to identify strategic objectives and project goals, project means and ends should be clearly stated and referred to (see Section 2.1.5). A contextual analysis that will be undertaken concurrently should examine the existing socio-economic context in which the project is situated, and which it will affect, as well as the sensitivity of the receiving natural environment. Based on this information, stakeholders will identify significant project issues that need to be addressed in the assessment and evaluation, and will rank them based on shared project values. Significance can be drawn from institutional references, social values and expert judgment. Information from the contextual analysis and priority setting is critical for the development of satisfactory solutions to the problem in the form of planning and design alternatives. The scoping sessions will provide all stakeholders with an opportunity for their active involvement in the co-production of these alternatives. The outcomes of scoping will be subsequently incorporated into the business case, project brief, project execution plan and a preliminary design brief. In this way, decisions made during scoping can effectively influence the scope of the project, specifications for proposed solutions and operational requirements.

Furthermore, during Phase 1 of the Process Protocol stakeholders should ensure that adequate information is provided from the appraisal to the project team at each decision-point.

Therefore, a decision-scoping procedure will be undertaken to indicate all decision-points and to specify decision-needs. This will be accompanied by the allocation of responsibilities and resources among project participants regarding their inputs to the appraisal process. Arguably, the involvement of stakeholders in the delineation of the appraisal process and the specification of its deliverables can deepen their personal commitment and support towards the appraisal outcomes. Ownership of the process will not only results in better understanding, but will also contribute to enhanced quality.

Subsequently stakeholders can revise a communication strategy and amend the information management of the Process Protocol. Normally, two of the Activity Zones (i.e. Process Management and Change Management) are responsible for such tasks as the determination of process deliverables, management of gate reviews, distribution of information to other Activity Zones, and the development of the Legacy Archive. However, since the project sustainability appraisal involves new processes (e.g. scoping, priority ranking, co-production of design alternatives, and sustainability assessments), new communication needs and new deliverables, all stakeholders should be engaged in the development of an information management system for the project. Information management comprises an active acquisition, distribution, processing and structuring of information on the process set-up, on the content of problems raised, and stakeholder perceptions and interests (Enserink and Monnikhof, 2003). The issues that can be addressed during decision-scoping that relate to information management include the following (*ibid.*):

- Access to resources in terms of information and knowledge;
- Clarity of roles and responsibilities of all participants;
- Identification of forums for collaboration in the process;
- Clear and comprehensible presentation of information and knowledge; and
- Knowledge transfer from specialists to other participants.

Decision-scoping will allow all stakeholders to participate in the specification of tasks that need to be undertaken in support of the sustainability appraisal. It is important to ensure that these tasks derive from a clear picture of desired outputs and outcomes of the appraisal (Enserink and Monnikhof, 2003).

Information management in the Process Protocol is supported by the Legacy Archive. It forms a project database that captures all process deliverables and outputs of gate reviews. When the project sustainability appraisal is undertaken, the Legacy Archive will also store minutes from stakeholder meetings, assessment results and project status reporting. Although information from the appraisal should be regularly fed into relevant project outputs (e.g. the business case, project brief, project execution plan, process execution plan, operation plan and maintenance programme), it may be also presented in the form of *a living document*. The living document structures the content of the process, presents substantial developments in the process and provides process information to all participants and outside parties (Enserink and Monnikhof, 2003). Hence, the value of the living document would be in showing the appraisal progression. In this way it can serve as a source of reference to all project stakeholders. More importantly, it would facilitate the introduction of other participants who join the project at a later stage (e.g. subcontractors) to the nature of the project and its requirements. The living document may also serve as a basis for later audits.

Moreover, during Phase 1 of the process stakeholders will also undertake the development of an assessment framework. This initial framework should present assessment areas that will be analysed during the building project with their relative importance from the sustainability point of view. The framework will subsequently inform the development of a feasibility design brief.

An examination of sustainability issues addressed during project planning will take place during Phase 3 (i.e. Substantive Feasibility Study and Outline Financial Authority). Stakeholders would review how sustainability considerations have influenced and shaped the development of the business case, project brief, project execution plan and process execution plan. Other outputs of the planning stage that will be also examined include the concept design brief, feasibility study and an initial procurement plan. In this way, before the project moves into the design phase, stakeholders will have yet another opportunity to ensure that it evolves in a direction that is consistent with the project vision and values.

The next stage of the process (i.e. Phase 4: Outline Conceptual Design) should begin with the revision of the business case, project brief and project execution plan to address comments from the review of the planning stage. Subsequently, appropriate performance and process indicators can be selected to populate the assessment framework. This would be followed by the collection of benchmarks (e.g. best- and worst-case scenarios) and definition of targets for each indicator. Target setting will involve negotiation and consensus-building among stakeholders in selecting ambitious, yet realistic, measures towards achieving the sustainability vision. This can be a problematic task especially when the international and local contexts need to be taken into account. The assessment framework that will be established in this way should guide the project team in the development of building design, its production and operation.

Conventionally, *sustainable* assessment frameworks are based on three or four components (i.e. assessment categories). SBAT groups building assessment issues under social, economic and environmental categories, whereas SPeAR introduces an additional category of natural resources to emphasise its importance in construction. However, the resulting artificial divide between social, economic and environmental categories generates some difficulties. Sometimes it is not possible to decide which indicators are strictly social, economic or environmental. Moreover, this approach may limit one's ability to pursue the main premises of sustainability thinking, such as integration and the search for interconnectivity and synergy between phenomena. Since structuring of information is as important as individual assessment indicators (Cole, 2002), it might be advantageous to redesign the conventional assessment framework of a *sustainable* assessment method in order to optimise the effectiveness of the model. For instance, the components of the assessment framework, which group indicators according to their affinity, would draw on the fundamental aspects that could make a construction undertaking a sustainable initiative in a proactive and effect-orientated manner. The new components could focus the assessment process on the major interests of all stakeholders, and thus promote performance excellence and product vitality, stakeholder empowerment and social equity, as well as environmental integrity.

Furthermore, the model should allow for the graphical illustration of the progress made towards achieving the sustainability objectives at particular stages of the project cycle. This means that a graphical interface of the model should provide stakeholders with information of required detail, i.e. during design, construction or operation. As the results of each assessment will be deposited in the project Legacy Archive, it will be possible to visualise the evolution of the project over time.

All operational aspects of the model should be developed and finalised during Phase 4. Development of an outline design will provide a more tangible expression of the problem-solving initiated in the last phase of scoping, as the concept is converted into the details of the project. At this point, the assessment framework should assist stakeholders in the evaluation of design alternatives. The decision-making that aims to identify an alternative to successfully address stakeholders' needs and fulfil the project vision will be supported by a visual presentation of assessment results.

While the outline design is developed, stakeholders should also deliberate upon the choice of a procurement route and its implication for the project's sustainability. For the South African construction industry this may include the implementation of preferential procurement policies and partnering with Small, Micro and Medium Enterprises (SMMEs) (Shakantu *et al.*, 2002). Furthermore, process-related issues of building construction and operation need to be translated into appropriate management strategies. This may include the development of an Environmental Management Plan (EMP), material quality control and waste minimisation strategies, Health and Safety policy (H&S) and training programmes for construction workers. The issues of building construction and operation cannot only concern the quality of the final product and its useful lifespan. For instance, the construction stage may stimulate local economy and lead to the empowerment of workers, e.g. through environmental training and *on-the-job* skill development.

Phase 5 of the Process Protocol will involve the development of a full conceptual design informed by the project vision and based on the project brief. This will be followed by the evaluation of the conceptual design conducted using appropriate indicators with established targets. The results will be presented to stakeholders using visual aids and inform a gap analysis. In addition, during this stage of the Process Protocol, a building operation plan and maintenance programme will be established with the participation of a facility manager and end-user(s). Their participation is vital as a building's useful lifespan is practically determined by user satisfaction and the flexibility of services it provides. As these issues offer great scope for collaborative learning, stakeholder dialogue should be also encouraged at this stage.

During Phase 6 of the Process Protocol (i.e. Coordinated Design, Procurement and Full Financial Authority), the project team will produce a project model through the coordination of design information. This stage of the process will involve the examination of sustainability issues addressed during design. This means that stakeholders will evaluate the proposed design and the potential building performance, as well as the planning and the preliminary programmes for building construction, operation and eventual decomissioning or change of use. This appraisal will also provide feedback on the process conducted until this stage. The main task of the examination would be to identify gaps between established performance targets and the actual progress made in achieving them. It will be conducted using the established assessment framework and communicated via visual aids. The gap analysis will allow for adequate adjustments in the proposed project solution and its planned execution (a feedback necessary for continuous improvement). More importantly, stakeholders will be provided with yet another forum for dialogue and learning. The results will be captured in the Legacy Archive to be subsequently used in the revision of the business plan, project brief and project execution plan. Afterwards, the procurement policy can be revised and work packages prepared. Similarly, building construction and operation programmes will be also modified to incorporate feedback from the design sustainability appraisal.

The following stage of the building process (i.e. Phase 7: Production Information) will involve the planning of construction works, including the assembly and enabling works. Procurement will be implemented and enabling works will begin. During this stage, construction workers would undergo training and capacity-building. All new process participants should be acquainted with the model, project vision and values. They would be also presented with construction-relevant sustainability issues that need to be attended to during construction works. A pre-construction training could also provide the basis for the development of an Environmental Management Plan (EMP) and inform the establishment of a Health & Safety plan.

Moreover, this stage will entail the finalisation of the communication strategy, business case, project brief and project execution plan. During a gate review production information will be checked against project goals, so that it supports the sustainability vision.

Subsequently, the project will move into the construction stage (i.e. Phase 8: Construction). This phase of the Process Protocol will comprise the monitoring of procurement, development of an operational product model and the implementation of a hand-over plan. Management and monitoring of construction works will be undertaken to ensure quality control and adherence with the EMP, including waste management and pollution control. This stage of the building process will end with a project sustainability evaluation. It will allow for a more complete examination of sustainability issues addressed during building delivery, i.e. planning, design and construction. The aim of this evaluation is to indicate how successfully sustainability and the principles of sustainable development have been integrated into the project. At this point stakeholders will be able to discuss the model's outputs as well as the quality of its outcomes. This evaluation should result in the development of a project sustainability report with the visual presentation of targets achieved. This report will document the sustainability appraisal of the building process.

During the last stage of the Process Protocol (i.e. Phase 9: Operation and Maintenance) a building's performance will be monitored in terms of resource consumption and indoor environmental quality. In this way, the project team can provided with information about the actual building performance that may be now compared with the design estimates deposited in the Legacy Archive. This information needs to be supplemented with user feedback on the levels of satisfaction with building services, as "*designers and occupants evaluate buildings differently*" (Zimmerman and Martin, 2001:170). Post-project reviews, facilitated by a revised assessment framework to suit the needs of a building performance audit, will assist the project team in the identification of areas which should be given more consideration in future projects. The project team can also learn from periodical audits about how the building responds to the changing user requirements over time. Furthermore, the implementation of the operational policy and maintenance programme, which would preferably include an Environmental Management System (EMS), will help the facility manager and building occupants identify and introduce measures aimed at continuous improvement of building performance. This may entail a demand management system for resource consumption or a better user interaction with the building, for instance in terms of obtaining optimal benefits from its passive design. Therefore, in using the model at this stage of the building cycle the emphasis will be placed on creating a learning environment for building users, the project team and other interested parties.

Continuous monitoring of building performance and user satisfaction plays an important role in planning any refurbishment works. Refurbishment can be also facilitated by the model. The assessment framework would need to be modified to suit the new context of its application. The stakeholders would review project values and identify a new set of significant issues to be addressed during refurbishment. This forms the third use scenario for the model, which is discussed in more detail in the following section.

6.3.3 Scenario 3: Auditing Building Performance

An environmental audit of building performance is probably the most common application of building assessment methods. The audit usually involves an evaluation of resource consumption and waste generation during building operation, indoor air quality and building management practices. According to Cole (2000), building environmental performance is a result of the interaction between the building base and its major systems with the interiors and subsystems introduced by end-users. Hence, building performance is also influenced by management practices (*ibid.*). The assessments of building environmental performance using assessment methods typically result in the overall score that provides a basis for building performance rating and/or labelling for marketing purposes.

Arguably, an evaluation of building performance using a building assessment method should be concerned with the quality of building services provided to the end-users and its impact on and interaction with its surroundings. Since quality is associated with value, its comprehension can be facilitated by the interpretation of value in construction. Value may be defined in simple terms as a ratio of benefits to sacrifices (Thomson *et al.*, 2003). This approach is found in the Japanese Comprehensive Assessment System for Building Environmental Efficiency (CASBEE) (Institute for Building Environment and Energy Conservation, 2004). In this system, building assessment is focused on resource use and ecological loadings (grouped under *Environmental Loading*), and on indoor environmental quality and amenities (grouped under *Environmental Quality and Performance*). The final scoring of building assessment in CASBEE is derived from the ratio of *Environmental Quality and Performance* (benefits) to *Environmental Loading* (sacrifices), which determines *Building Environmental Efficiency*:

Building Environmental Efficiency = (Environmental Quality and Performance)/Environmental Loading

Hence, in CASBEE assessment results are interpreted in terms of the environmental implications associated with services that are provided by the assessed building (Cole, 2005).

Dell'Isola (1997), cited in Thomson *et al.* (2003), gives a more specific definition of value in the building context. Here, value is derived from building function, quality and costs:

Value = (Function + Quality)/Cost

Function may encompass aspects of building use, access and space. Quality entails aspects of building performance, engineering systems and construction (Gann *et al.*, 2003). Cost may be expressed in terms of environmental loadings, resource consumption and financial burdens of building production/use. This definition, apart from quality and cost, brings into the scope considerations of building performance along with the issues of functionality and project values.

Building performance can be established through the relationship between building form and function in a particular context (Kalay, 1999). Performance is therefore determined through an interpretive judgmental evaluation which "*considers the form and other physical attributes of the proposed solution, the functional objectives and goals it attempts to achieve, and the circumstances under which the two come together*" (*ibid.*:396). This argument also links building performance with the issues of its functionality and project values that form the context in which the building has been created and/or operated.

In order to evaluate the quality of building performance, it is necessary to identify the most desirable function(s) that can be supported by a particular building within its specific context (e.g. physical settings and stakeholder needs). Subsequently, one could examine how effectively and efficiently the building is managed and operated to provide the required services. Building performance could be improved, using this information, simply by changing operational and management practices. However, sometimes it is necessary to alter a building's form in order to meet its existing or more desirable functions in the most satisfactory manner. In this case, the building's refurbishment or modification would require setting strategic goals referring to users' needs that define desired building function(s), and take into account the sensitivity of the receiving natural environment, environmental utilisation space and the interactions with an existing socio-economic context. This information would then guide the adaptation of the existing building form and the selection of building management strategies to support the established goals. It is proposed that these tasks would be facilitated through the application of the model in this particular use scenario.

Stakeholder involvement in the building process is "*necessary to ensure that perception of consumer expectations and the translation of those perceptions into service quality perceptions*" (Winch *et al.*, 1998:194). This argument is equally valid for the evaluation of building performance and the planning of refurbishment works. Since any consideration of the quality of a building's performance is context-based and its determination goal-orientated, the audit of building performance using the model will require a broad stakeholder involvement. It should be easier to identify relevant stakeholders and their needs in this use scenario, especially in terms of those stakeholders who are directly affected by a particular building (i.e. its owner, occupiers and neighbours).

During the performance audit the model would provide stakeholders with a clear strategy to establish their essential needs regarding a given building, with mechanisms to review the continuous improvement of building services. It is important that this process addresses the quality of a building (i.e. its form and structure). However, emphasis would inevitably be placed on the benefits that this building brings to its users, as well as on what it demands of them in terms of its operation (Bordass *et al.*, 2001). This brings to the fore important issues of building manageability, usability and responsiveness. Through their direct involvement in the audit, building users and the facility management staff can develop and implement *demand management* strategies to reduce resource consumption. They can also learn how to interact with the building to improve the effectiveness and efficiency of its services. Furthermore, if a building is considered as a means to the users' ends, then more attention can be paid to the time dimension (short- and long-term goals) and performance attributes, such as comfort, health and safety (*ibid.*).

The model is not only meant to help in the audit of an actual building performance, but also to facilitate any refurbishment process that may result from, or follow, the audit. Therefore, the model could be used for the purpose of formulating a refurbishment proposal as presented in the first use scenario (Section 6.3.1). However, since major refurbishments can involve significant construction works, the application of the model may become similar to that presented in the second use scenario (Section 6.3.2). Hence, during the building performance audit the model cannot be limited to the use of a standard checklist, but rather would need to be dynamic and responsive to the application needs.

The building performance audit would require that relevant stakeholders are identified, after a decision to undertake the performance audit has been reached (see Process Map 3). If the purpose of the audit is to evaluate and benchmark current performance of the building with a potential need to change existing management practices to improve its performance, then the participants might include the building owner, occupiers, a facility manager, as well as relevant service providers, specialists in certain assessment areas (e.g. an energy auditor), and neighbours who are affected by the building. If the audit is aimed to identify areas of building performance to be addressed during refurbishment works, then the process might also involve relevant building professionals.

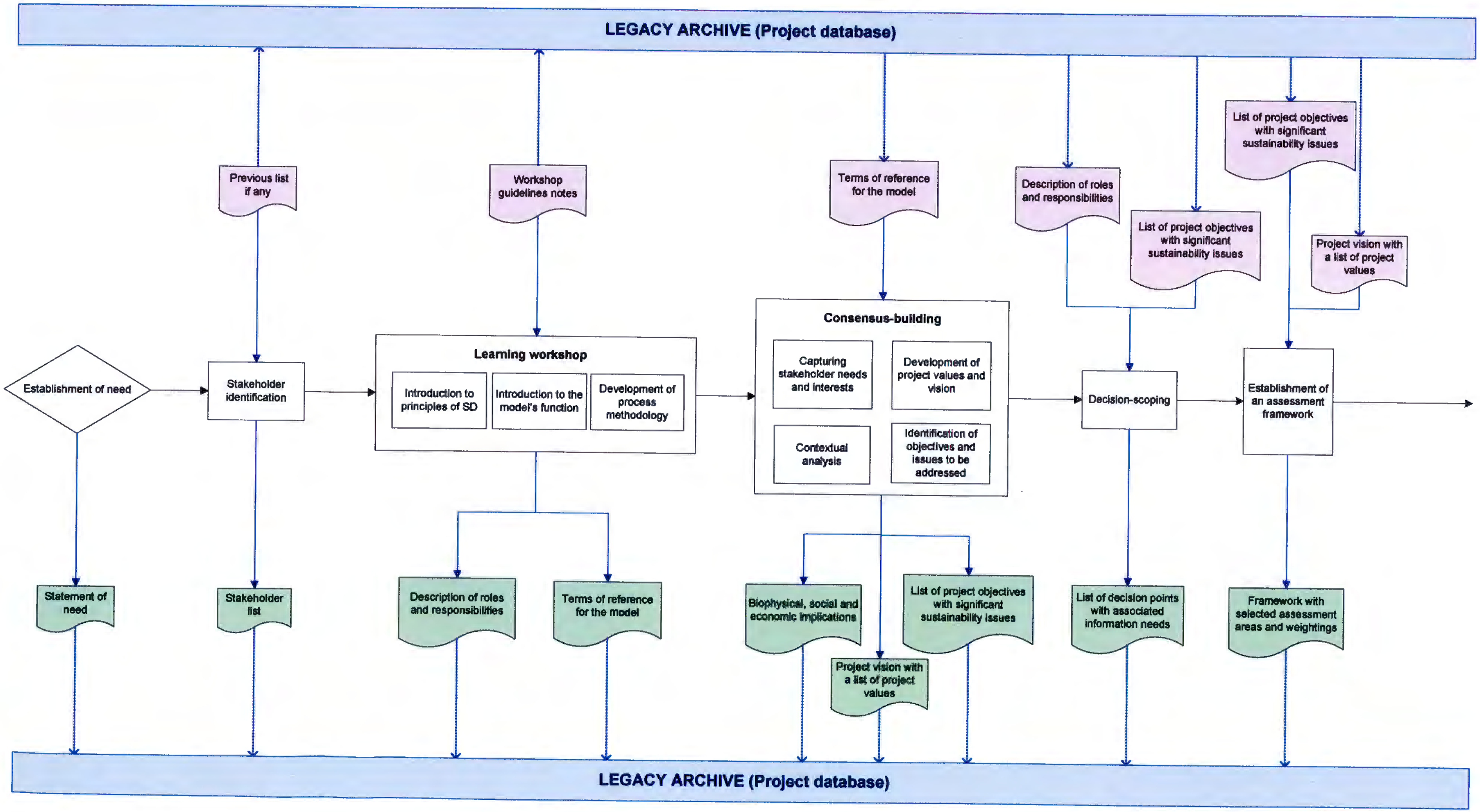
The audit conducted using the model will entail the introduction of sustainability thinking and principles to inform the establishment of project values. Consequently, the context in which the building operates should be deliberated by all stakeholders. This is important so that there is a common understanding of the biophysical, social and economic implications of current building performance, and of the opportunities for potential improvement.

After the context has been established, process participants can define desired performance quality, preferably stated as performance targets for the audit and/or project goals and objectives for refurbishment. The project vision developed in this way should address the quality of building services expected by end-users and other affected stakeholders in relation to the required building functions, form and project values.

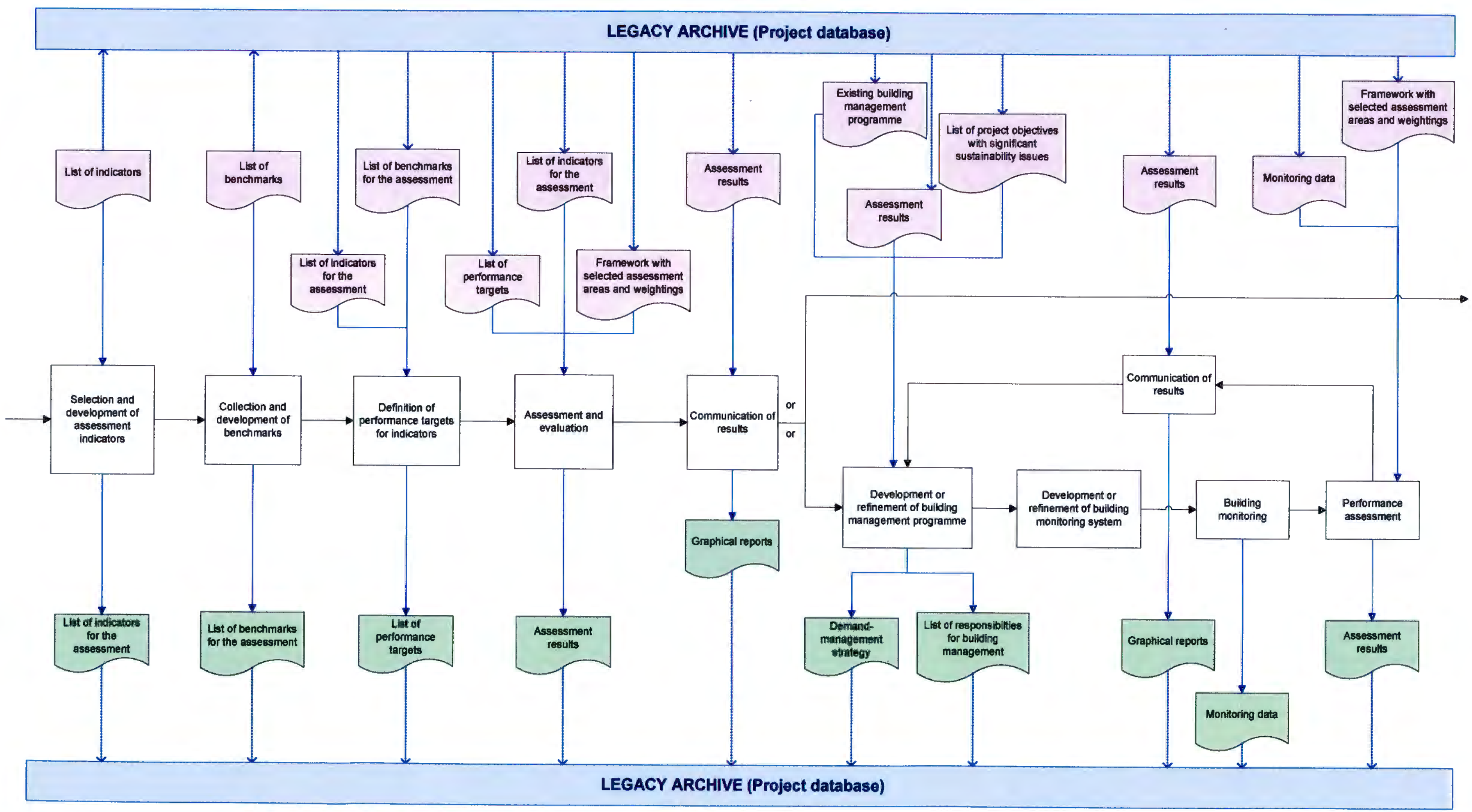
Furthermore, for the purposes of building refurbishment it will be necessary to review aspects of building functionality to extend the building's useful lifespan. Therefore, the scoping stage of the audit ought to foster a longer term outlook, so that stakeholders will not focus solely on immediate and short-term user needs, as building occupants and occupant requirements may change over time (Whyte and Gann, 2001). Hence, the potential for building adaptation to different use patterns and functions needs to be considered in the planning of refurbishment. This would entail the identification of how a given building is to be used, how its use might change and the factors that affect these changes (Ryd, 2004). Moreover, the issues of resource consumption and environmental impacts in terms of building operation, maintenance, renewal and decomissioning should also be taken into account.

Later in scoping, stakeholders will select significant assessment issues, identify assessment areas and establish an assessment framework. Afterwards indicators can be selected or developed and benchmarks collated. Stakeholders will decide together upon performance targets for indicators in accordance with the project values and vision. This will be followed by the actual assessment and evaluation stage, using the same logic as in the other scenarios.

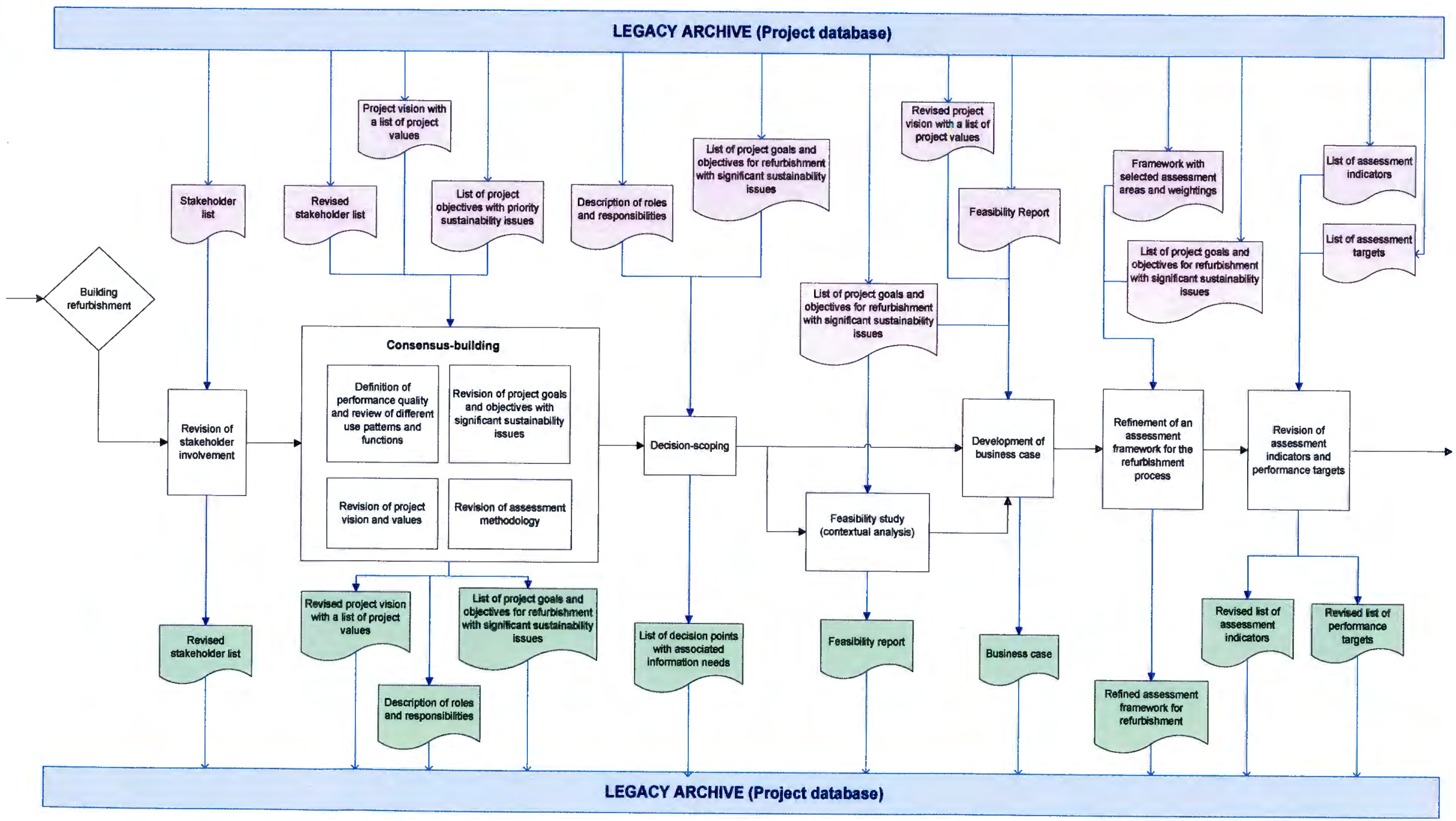
Process Map 3: Building Performance Assessment Using the Model for Building Sustainability Assessment (1/4)



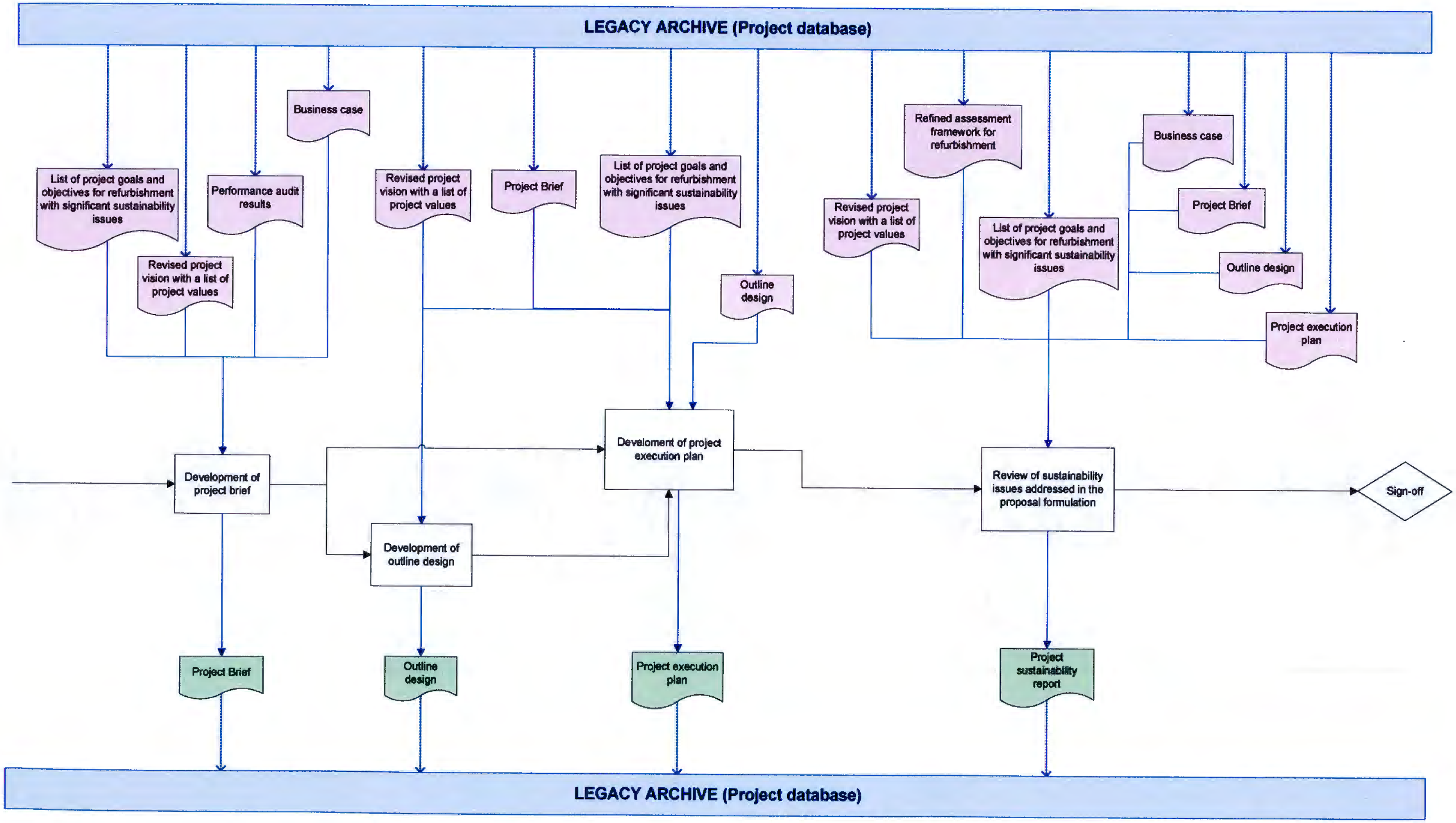
Process Map 3: Building Performance Assessment Using the Model for Building Sustainability Assessment (2/4)



Process Map 3: Building Performance Assessment Using the Model for Building Sustainability Assessment (3/4)



Process Map 3: Building Performance Assessment Using the Model for Building Sustainability Assessment (4/4)



The communication of assessment results to various stakeholders should not be limited to a simple presentation of data. Instead, stakeholders will be encouraged to participate in the interpretation of measurements and in the identification of the most satisfactory practical solutions that can enhance the quality of building performance. Hence, there is a need to ensure that the model provides different presentation formats, and that it offers a forum for stakeholder dialogue and mutual problem-solving, i.e. effective communication for the attainment of shared meaning.

After the results have been communicated, decisions can be made regarding the potential needs in building performance improvement. Hence, the process participants will establish building management strategies that will support the desired building functions.

Furthermore, the results of the audit can at this stage inform strategic planning and the development of the project brief for any refurbishment works. The transition from the audit into the refurbishment process would require the revision, and possibly refinement, of the project vision and values as well as the assessment framework by stakeholders.

It is important that the model facilitates information exchange and sustains dialogue among process participants (e.g. by establishing a line of communication between building occupants and facility managers) during project planning and execution of the building audit or refurbishment. Through application of the model, the process of service delivery and the associated allocation of responsibilities for performance quality should become transparent to all stakeholders. Moreover, all process information and outputs are to be stored in the Legacy Archive. Information and data captured in such a database will not only help to document the building's history and help solve any management problems, but they can also be used for a number of other purposes. For instance, the results of performance monitoring may form the basis for obtaining eco-labelling in terms of resource consumption. The information can also be used in the development of an Environmental Management System (EMS) (e.g. in the development of an environmental policy, action plan with targets and timescales) and provide benchmarks for continuous performance improvement.

The model will not attempt to provide a basis for comparing the building's performance with that of other buildings, since the quality of performance is dependent on an individual context. Any meaningful comparison of sustainability of building initiatives is therefore difficult. However, the model will facilitate the exploration of opportunities for incorporating sustainability thinking into the problem-solving stage that characterises any building improvement or enhancing initiatives. Moreover, it will offer a forum for building users and other stakeholders to understand why the building functions in a particular way, how to better interact with the building in use, and how make it more responsive. The model may also be integrated with a Life Cycle Assessment (LCA), which assesses energy and material flows throughout the building's lifespan, or other more technically sophisticated tools to provide stakeholders with more specific information about their buildings.

6.4 DISCUSSION OF THE MODEL'S USER PERSONAS

The successful application of the model will be directly related to users' satisfaction with the actual building assessment process and its outcomes. Hence, one of the most important aspects of the model should be its ability to adapt building assessment to the cultural, organisational and social environments within which building projects take place (Wideman, 2001). Understanding a project's environment requires identifying "*stakeholders and their ability to affect its successful outcome*" (*ibid.*:1). Therefore, a discussion of building stakeholders in terms of the anticipated patterns of their interaction with the model would assist in the actual design and operationalisation of this method.

Various stakeholder groups that will participate in the building process and will engage concurrently in the assessment process would have certain expectations regarding the tangible and intangible outputs of the model and its functionality. The model's users will be at the same time also responsible for the assessment outcomes, as they will provide inputs and manage the assessment process. Therefore, in designing the model, which is to become an effective method for the project sustainability appraisal, the awareness of potential benefits, responsibilities, challenges and difficulties that may be faced by its users becomes essential.

This is why the development of the functional specification for the model entails a consideration of the model's users in terms of their interactions with the model and the benefits and challenges associated with it. The model's users would include not only those directly responsible for the coordination of the building assessment process, but also those who would participate in the process and have a stake in the outcomes of the assessment. The following sections present a discussion of user groups and their potential interaction with the model.

6.4.1 Building Client(s) and End-User(s)

Depending on the scale of the building project, the client may be the end-user or remain a separate agent in the process. In the latter case, this stakeholder group would have to include the actual building occupiers if possible. The identification of building end-users may be problematic in the initial proposal formulation, or even during the building delivery. It is essential that the interests and needs of building end-users are given due consideration in the process, however idealistic this may be given the speculative nature of some building developments.

Involvement in the building sustainability assessment would require the client to give up certain amount of control over the process and the final product. This is due to the fact that sustainability assessment places the building project in a socio-economic and environmental context, which imposes some external conditions on the project conceptualisation and building production. The client needs to agree that the needs of other stakeholders are also to be secured in the assessment process. At the same time, by using the model, the client will be more directly involved in the building process. Consequently the client's needs and interests may be more clearly reflected in the project vision, business case and brief, and thus more readily implemented by the project team. Moreover, the model will offer the client a mechanism for quality assurance of the building process and the final product. A direct involvement in the model's application will result in greater process transparency and accountability to the client. Hence, the client will gain a fuller understanding of the process and of any problems that may be encountered. Furthermore, by taking a longer-term view of the project, the client can also appreciate and harvest the non-monetary benefits of sustainability assessment reflected in end-user satisfaction, longer building life-span and reduced environmental impacts of the building.

The participation of end-users in the building assessment can be considered as an empowering exercise. The model will require the client and end-users to establish clear ends and means that would delineate the building process and product. The end-users will be given an opportunity to name their preferences and to make sure that their needs and quality perceptions are taken into account during building design and production. Moreover, by co-operating with the members of building design, production and operation teams, end-users can learn how to interact with the building in the most optimal manner.

The model will require consistent commitment from clients and end-users throughout the assessment process. The client and end-users need to actively participate in the development of project values, vision, goals as well as in the establishment of the assessment framework. During the operational stage, the end-users (e.g. office workers or residential tenants) could be involved in a monitoring programme and provide feedback on building performance (e.g. thermal comfort, moisture control, resource consumption, waste management). Although the model would place certain burdens on the client and end-users, the value of assessment outcomes to these stakeholders should well outweigh potential difficulties stemming out of their active participation in the project.

6.4.2 Planning and Design Team

The building planning and design team may include representatives from the disciplines of urban planning, architecture, structural and mechanical engineering, and interior design. However, the team might also involve quantity surveyors, suppliers and specialist contractors who also contribute design and management expertise to the project. In the traditional building process, the design team possesses the greatest degree of influence over the final building product, and therefore plays a leading role in the building project (Turin, 2003).

The use of the model by the planning and design team would require changing the existing professional culture to incorporate new modes of working. The greatest challenge will be posed by the need for an integrated design, which is key in any sustainability initiative. Integrated design means that these professionals would have to collaborate from the early stages of planning and conceptual design to detailed design and project model development, instead of providing separate inputs in a sequential manner. By considering simultaneously the issues of building form, function and context (i.e. stakeholder needs as well as the socio-economic and environmental conditions), the team could achieve design synergies.

More importantly, the planning and design team would be responsible for fostering the principles of sustainability and concepts (e.g. eco-efficiency, life cycle considerations, performance approach, whole-building design, or open building) in terms of a building's product specification and detailed design. These principles and concepts will not only inform the choice of building assessment criteria and indicators, but will also guide decision-making at each stage of building planning and design. Therefore, the use of the model by this stakeholder group may require conducting extensive research and learning; firstly to get acquainted with the concepts and, secondly, to implement them in practice. The proposed concepts should provide the team with guidance and the means to design a building that is energy-, water-, material- and location-efficient, with minimum waste, environmental impact and health risk, and which is also context-sensitive (Kaatz *et al.*, 2003).

The model will provide the planning and design team with an opportunity to optimise the quality of building services by giving them a framework to integrate sustainability issues and allowing a more comprehensive view of building issues. This team should interact with all other stakeholder groups and present their working progress in formats that are easily comprehended by other stakeholders. This interaction would result in valuable benefits to the planning and design team. As the model will facilitate the capturing of the client and users requirements, which are translated into project goals and objectives, the team will be guided in its work with more specific and accurate information. For instance, on-going dialogue with other stakeholders during the planning and design process should help avoid any drastic changes in design at the later stages of the building process. Moreover, by conducting a dialogue with the implementation team, the final building should perform more closely to the design specifications.

As a crucial stakeholder group in the building process, the planning and design team should be actively involved in the development of project values. The team also needs to help translate stakeholders' needs into project goals and building functional requirements. In addition, this team will play a leading role in establishing the assessment framework, selecting indicators and benchmarks, as well as in setting realistic performance targets. Through their involvement in the assessment these professionals will be provided with immense learning and capacity-building opportunities. Consequently, the knowledge and skills gained in this process can be used on other projects.

6.4.3 Implementation Team

This stakeholder group may comprise specialist manufacturers and suppliers, contractors and sub-contractors. Their active involvement in the building process is usually marked during construction. However, the participation of the implementation team (or their key representatives) in the briefing process is crucial. For instance, the implementation team may provide building designers with practical advice on the aspects of functionality, buildability, and technological alignment.

The implementation team should be encouraged to participate in the early stages of building appraisal, so that its members can also contribute to the establishment of project goals and values. This would provide them with a better understanding of the project vision and requirements. Consequently, through empowerment gained from collaborative work with other project stakeholders and partnering relationships on site, the implementation team may be better equipped to deliver quality during construction works. In addition, the knowledge of sustainability considerations relevant to the actual construction stage, which will be discussed by project stakeholders during learning workshops and included in the assessment framework, will be crucial in the structuring of training and capacity-building programmes for construction workers. These programmes would focus on the areas of EMP, H&S and material quality control, as well as on the cultural diversity among the workers – an issue so vital in the new South Africa.

6.4.4 Facility Manager(s) and Operator(s)

An active participation of a potential facility operator (or at least a specialist in facility management) in the building sustainability assessment, and through this in the actual building process, can lead to the delivery of a more *responsive* building. The facility manager will provide practical information regarding building maintenance, which should inform the establishment of project goals and the development of the project brief. Experience of buildings in-use allows the facility manager to identify potential problems that may result from design deficiencies or inadequate construction practice at earlier stages of the building process. Moreover, by having an opportunity to meet with the client and building users to discuss their requirements, needs and values, the facility manager can develop a fruitful co-operation with the occupiers during building operation and maintenance.

Furthermore, the development of building operation and maintenance programme during the building process will require an active involvement of the facility manager to elaborate on the issues of building monitoring, history keeping, performance measures and maintenance scheduling. Hence, the facility manager will be responsible not only for managing building services and its maintenance works, but also for managing a building monitoring system and feedback streams. Building monitoring plays a significant role in helping building professionals to understand and improve elements of building performance (Bordass *et al.*, 2001) (during subsequent refurbishment or on new projects). It is also invaluable in providing baseline information for a post-occupancy evaluation and performance benchmarking (e.g. an energy audit), as well as for regular *in-house* audits. Therefore, the facility manager should participate in the conceptualisation and operationalisation of the monitoring system and the performance assessment framework, so that integrity and continuity of building information is maintained throughout the building's life cycle.

6.4.5 Project Management Team

The model can be used by the project management team as a tool for an effective and efficient implementation of the project. Although the model will impose additional responsibilities and tasks on the project management team and other stakeholders (e.g. research and collaborative learning, dialogue and negotiation, assessment and evaluation), it would help achieve a *best-fit* building solution (apart from fostering sustainability) – if quality, customer/user satisfaction and long-term financial viability are considered as major criteria of success. The implementation of building sustainability assessment would not need to prolong the actual building process. In fact, a decision-scoping procedure can complement scheduling techniques used in construction, such as Critical Path Methods (CPM) (Dawood *et al.*, 2005) to ensure that information exchange between stakeholders occurs in an effective and timely manner. Moreover, if stakeholders participate in a transparent process where responsibilities, tasks and expectations are clearly defined, the project should run more smoothly.

Due to a participatory character of building sustainability assessment, the project management team would not be responsible only for the management of project activities, but also for the management of stakeholder participation. Newcombe (2003:847) lists two principles of stakeholder management:

> *"Principle 1: The project should be managed for the benefit of all its stakeholders: its clients, suppliers, owners, employees, and local community. The rights of these groups must be ensured, and, further, the groups must participate in decisions that substantially affect their welfare.*
>
> *Principle 2: Project Managers bear a fiduciary (trustee) relationship to the stakeholders and to the project as an abstract entity. They must act in the interests of stakeholders as their agent, and must act in the interests of the project to ensure its survival."*

These principles should guide the project management team in the execution of building assessment that emphasises the value of broader stakeholder participation.

In the beginning of the assessment process, the project management team will have to identify key stakeholders. A stakeholder mapping technique can be used to support this task (Newcombe, 2003). Only then can the interests of all stakeholder groups be brought to the fore. Different stakeholders will be characterised by different levels of predictability of their actions in the building process, as well as different levels of engagement and power. Using the model to establish a common project vision can help avoid certain conflict between stakeholders, especially around long-term versus short-term objectives, quality versus quantity, and control versus independence (*ibid.*). When any conflict arises, the project management team will have to act as a negotiator in the process.

The project management team should also assist stakeholders in their interactions with the model and in their collaboration to produce specific assessment outputs. For instance, the project management team (possibly assisted by a sustainability consultant) will set up learning workshops and meetings for relevant stakeholders and facilitate the integration of information (in terms of a language and format), necessary for such meetings and produced during these meetings. If some stakeholders cannot be readily identified early in the building process, then the team should ensure that specialist advice in relevant areas is provided for an informed decision-making.

Hence, the project management team will be responsible for the execution of activities that comprise any building project and those added from the assessment. The latter will include the establishment of project values and goals and the integration of assessment outputs into the project business case, brief, execution plan and other relevant policies and programmes that assist stakeholders in implementing sustainability during building design, production, operation and decomissioning. This means that the project management team would address the assessment needs while organising the information management system and setting up a communication process.

The project information management system should be supported by a database (e.g. the Legacy Archive) that captures all information outputs produced during the project's life cycle (refer to Section 6.3.2). The project management team would supervise the information capturing and dissemination among project stakeholders. Moreover, the system should store information from all assessments produced during subsequent stages of the building process. This is important for the purposes of documenting the conceptual premises of implementing sustainability within a given project. More importantly, information captured from building monitoring, which should also be stored in this database, could provide the basis for performance benchmarking or eco-labelling.

Tasks described in the above paragraphs represent good practice in project management. It is important to note that building assessment will produce additional information that should be effectively managed during the building process by the project management team.

6.4.6 Other Interested and Affected Parties

The model offers a platform for other interested and affected parties to raise their concerns during the assessment process. Other *external* stakeholders who might have an interest in the building process, and who should therefore have an opportunity for participation, may include an approving authority, financial institution, suppliers of services (e.g. water, gas, electricity or sewage) and neighbours.

These stakeholders create a part of an external context which shapes the building process. Hence they should be consulted, if not involved, during the problem definition and solving components of the scoping stage. Moreover, they may also be interested in the building's history and process transparency. With the use of the Legacy Archive, which captures data from the building process and assessment, these stakeholders can be provided with easy access to the information necessary for any approvals or control.

6.4.7 Benefits and Challenges Shared by All Stakeholders

As the model will encourage dialogue and the spirit of teamwork, it will provide opportunities for greater interaction between project stakeholders throughout the building assessment and actual building process. Therefore the main shared benefits that should stem out of the model's use include collaborative learning and improved communication. Collaborative learning will result mainly from participation in problem definition and solving that take place during building assessment. Communication between stakeholders will be improved through a better understanding of the process, individual tasks and responsibilities. Moreover, by developing a commitment to the principles of sustainable development stakeholders may be more prepared to accommodate the needs of others and those imposed by the project's external context. This will facilitate the development of common project values, vision and objectives, and the desired conflict avoidance.

The model will be also likely to pose certain challenges to all stakeholders. Some of them would result from a broader stakeholder participation in the assessment process. The challenges may include a language barrier (e.g. technical and non-technical), knowledge gaps (due to different specialisations), and cultural differences (i.e. different modes of practice). If these issues are not managed early in the process, they may lead to tensions and conflicts between various stakeholder groups. The resolution of the issue of power distribution – from the client and design team to other stakeholders throughout the process – is also vital for the model's optimal use. Moreover, conflict may arise during the establishment of project values, development of project vision and identification of significant project issues. Conflict resolution, process transparency and open communication are key in addressing these problems

The model does not offer any fixed operational solutions to stakeholders. For instance, the assessment framework needs to be modified to suit each assessment situation. Similarly, the selection of indicators, benchmarks and targets is unique for each assessment. Thus, stakeholders will be challenged to co-operate proactively in order to manage these tasks in an effective manner. Since the building assessment will be driven by a mutual stakeholder effort, all participants in the processes will be responsible for the quality of its outcomes.

Stakeholders could participate in the building sustainability appraisal process (i.e. Scenario 2) within Activity Zones, grouped according to the activities in which they are involved (refer to Section 4.3.4), which would facilitate their collaboration. However, for the purpose of describing benefits and challenges faced by specific process participants, various stakeholder groups have been discussed separately.

The discussion of the model's user personas is the final element of the functional specification presented in this chapter. The model, based on a philosophical reflection on the practice of building sustainability assessment, proposes a number of solutions that may enhance the capacity of building assessment methods to foster sustainability in construction. The following section gives a précis of the findings from the workshop with South African built environment practitioners, which aimed to validate the concepts presented in this chapter.

6.5 FINDINGS OF THE VALIDATION WORKSHOP

The participants who attended the workshop comprised two architects, two civil engineers and a property developer. Apart from the workshop co-ordinator, two other participants also had academic experience as well as experience in practice. All participants were familiar with the issues of sustainable construction and sustainable development. All of them were knowledgeable about the current *status quo* of the South African construction sector. Some of the participants were also acquainted with building sustainability assessment and conversant with the attributes of traditional assessment methods.

The participants were presented with a précis of this chapter (i.e. pre-workshop notes) and a PowerPoint presentation (see Appendix B), which described the model and the assumptions and reasoning behind its development. During this presentation there was an opportunity to raise questions with the workshop co-ordinator. This enabled the participants to gain a full understanding of the workshop's subject and purpose. Before the general discussion commenced, the following questions were put forward to provide a focus for the discussion (however it was not limited to these questions):

- Are the three use scenarios recognisable to practitioners?
- Can the value of the model as a building enhancement tool be easily recognised?
- Are the key functionalities of the model (i.e. integration, transparency and accessibility, and collaborative learning) reasonable?
- Is an assessment tool developed on these premises likely to foster sustainability within the built environment and the construction industry?
- What aspects of building assessment are crucial in the South African context?
- Does the model satisfactorily accommodate the iterative nature of design and management activities?

Initial comments referred to the three functionalities of the model, namely, integration; transparency and accessibility; and collaborative learning. The participants recognised that there were several levels at which integration would take place during the process of building assessment if the model was used as a framework. The model provides for the integration of building stakeholders in terms of their values and perspectives, and for the integration of building practices. Integration was also recognised as being promoted through transdisciplinary delineation of the scope of considerations for the assessment process. The participants agreed that the model, as presented, allowed for an initial definition of a problem that would subsequently guide the entire assessment process; problem definition and development of solutions being sought with respect to a specific context of the project.

Another crucial point made by the practitioners was that any building sustainability assessment process should not be perceived, or function, as an *add-on* to the building process. The practitioners recognised form their experience a need to integrate building assessment with existing project activities and processes. Hence, there was a consensus about the fact that building sustainability assessment should not be a discrete activity within the building process, but it should aim to become an internal part of normal project delivery practice.

The participants acknowledged that integration, in its broad sense, should be supported by communication competence, which in turn influences process transparency and accessibility – i.e. the second functionality promoted by the model. Transparency was seen as key to communicating a shared understanding of the assessment process to all building stakeholders. Transparency is also required in designing stakeholder involvement in building assessment through the allocation of responsibilities. It was agreed by the participants that the ideal point for tackling these issues would be at the beginning of the assessment process. This position validates the argument that building sustainability assessment needs to be internalised by the project team, to ensure that appropriate assessment-related activities are conducted consistently at each phase of the building process.

Accessibility was discussed with regard to potential language barriers arising from the technical language of the construction sector and also that surrounding sustainable development. A point raised was that this issue could be viewed also as a reflection of power imbalance in the process. Generation of dialogue between stakeholders was seen as essential for a successful assessment and project implementation, but also to foster collaborative learning. The practitioners also expressed a need to provide some sort of a 'catalyst' to sustain stakeholder engagement during the assessment process. They agreed that the role of an assessment facilitator can be initially played by a specialist consultant, and later by the project manager who has enough knowledge about sustainable design and construction.

The participants noted that building sustainability assessment communicated via the model should ensure a mutual development of building stakeholders in terms of acquiring knowledge, changing perceptions and practices through the mechanisms of dialogue and feedback (so that lessons can also be drawn from any mistakes). Collaborative learning was recognised by the practitioners as a significant functionality of the model that might help avoid the development of a 'black-box' system, whereby no discussion and explanation of the consequences of decisions made during the process is provided. A need to document any building process, so that lessons can be learnt for future projects, was also recognised by the practitioners.

It was concluded that knowledge would emerge from a dialogue between a group of building stakeholders involved in a collaborative process and sharing the same level of awareness. It was acknowledged by the participants that the scoping procedure applied in the model would play an important role in this regard, as it would provide an inter-subjective agreement surrounding the issues that form the scope of assessment. Scoping was seen as a key departure point from existing assessment methods with which they were familiar (e.g. SPeAR or SBAT). The participants appreciated the role of scoping in introducing and validating stakeholders' choices, and allowing for creative thinking, although the caveat was added that there needed to be *buy-in* from all involved in the building project.

The participants pointed out that these three functionalities could be viewed as benchmarks of what is delivered through building assessment and how. Subsequently, the discussion moved on to the model's use scenarios.

As the most significant decisions are taken during the structuring of a project brief, *Scenario 1* was seen as presenting the best opportunity to apply a strategic approach into the process of building sustainability assessment. Here the comments were that building assessment could be used to identify opportunities to implement sustainability-guided solutions to add value to the project, rather than to concentrate on mitigation measures. Hence, the model was seen as proactively facilitating the definition of initial project goals, objectives and some benchmarks that would better reflect the project's context.

Scenario 2 was defined so as to allow the issue of continuous improvement in terms of the quality of the process and stakeholder capacity-building to be tackled. The participants agreed that the adoption of the Process Protocol provided a clear illustration of what the building project involves. However, the familiarity of South African practitioners with this form of process thinking was seen as likely to be limited. Therefore, it was suggested that external expertise would be needed initially to allow project participant to navigate their way through the process. A comment was also made about the need to spell out practical implications of building sustainability appraisal. However, this would only be possible with an operationalised tool developed out of the model, which lies outside the scope of this research.

In terms of the model's user personas, the workshop participants suggested an alternative categorisation of building stakeholders by grouping them into decision-makers, cost bearers and impact bearers. Again, it was noted that obtaining *buy-in* from all involved parties would be indispensable throughout the process. As the model is intended to promote the establishment of a common project vision and shared values at the assessment outset, building stakeholders would have an opportunity to express their expectations and requirements, which should enhance their commitment to the implementation of the established project objectives and targets.

Moreover, the workshop participants emphasised the importance of involving service providers in any building project sustainability appraisal. An example was given by the property developer of a failure to get the local energy utility, to proactively engage in the development process (i.e. a mixed development with residential housing, retail and public services) in a disadvantaged residential area in Cape Town. Instead of looking for such design solutions that would enable the developer to reduce demand for electricity, the utility was only keen to determine how much energy would be consumed and that the greatest infrastructure possible was provided. The practitioners agreed that service providers should be in the best position to identify sustainable consumption patterns for their clients. Yet they often take a narrow view in that they are interested in profits without referring to their capacity to provide the required services in a long-run. Hence, utility providers and local authorities should also understand the ideals of sustainability and project objectives, so that they can become more likely to change their standard delivery practices to support any integrated design solutions. Consequently, the practitioners acknowledged that there was a need to broaden stakeholder participation in building developments. It was concluded that the localisation of building sustainability assessment within the building process should be tackled together with the organisation of stakeholder involvement in building assessment. This may require some reorganisation of traditional stakeholder participation patterns in building projects.

Furthermore, a successful implementation of building sustainability assessment in South Africa would require providing a project champion as an interim measure, together with adequate guidelines until some kind of maturity of sustainability knowledge is present in the field. In addition, it was pointed out that the issues of potential power imbalance in the building process needed to be given significant consideration, thus conflict resolution techniques should be integrated with building assessment.

Process maps presented to the participants helped to depict the potential for process integration. Whilst they improve process transparency and enable to identify steps and tools necessary to guide the process, the process maps look complicated at the first glance and practitioners had reservations about the level of familiarity with process thinking in the South African context. It was suggested by the participants that the maps could be used to explain the assessment process to the project team, but would be better used as tools by the project manager and/or process facilitator to guide their work. However, it can be argued that when South African practitioners recognise the value of process thinking, they will appreciate the enhanced transparency and clarification that process maps provide to all stakeholders.

The practitioners agreed that the model would promote sustainability thinking in construction and help change existing practices. However, its effectiveness in fostering sustainability would be enhanced, or limited, by other things developing in parallel. For instance, there is a need for sustainability education for built environment professionals. Access to champions and guidelines to promote sustainable construction is also required. In addition, regulations and other incentives are very important to drive sustainable construction in South Africa. Thus, the building sustainability assessment model must not be seen in isolation, but as complementary to other initiatives that foster sustainability in the field of construction management.

The last point of discussion concerned the issue of benchmarking. In contrary to green building assessment systems that rely on relative measurements and benchmarking against a 'typical building' (e.g. GBTool), the model would not allow for a direct comparison of buildings' performance since sustainability appraisal is argued as being context-specific. This may be a drawback for organisations that want to benchmark their performance in the field. However, the participants also agreed that the value of issue prioritisation offered by the model may be more important than benchmarking in the South African context in an attempt to drive 'better' and 'improved practice', as opposed to identifying 'best practice'. It was stated that a list of principles to guide the design and production of buildings and some rough relative comparison of building performance should be sufficient at the moment. The reason for this is that there is still too little capacity to make measurements and benchmark building performance in South Africa.

The key findings of the workshop can be summarised in the following points:

- The practitioners validated the need to integrate building assessment with the activities and processes that take place within building projects. Hence, any effective building sustainability assessment method should not function as an *add-on* to the building process.

- Integration of participants, working modes and issues promoted by the model was seen by the practitioners as necessary to drive sustainable construction practice. Transparency of the process and the issue of communication competence were also viewed as crucial for effective implementation of building sustainability assessment. Collaborative learning was seen by the practitioners to be the most significant role of building assessment for the South African construction sector, which is in an urgent need for capacity-building and for increasing the construction sector's sustainability knowledge base.
- The scoping procedure applied in the model was recognised as being a key departure point from existing *sustainable* building assessment methods. Scoping was seen as having the potential to promote creative problem solving, allowing for the development of an inter-subjective understanding of significant assessment issues at a project level, and promoting stakeholder dialogue that stimulates collaborative learning.
- The model's use scenarios were validated by the participants who pointed out the need for gaining *buy-in* from all stakeholders throughout the assessment process.
- The argument to broaden stakeholder participation in the building process was also supported. Hence, the emphasis placed on this issue in the specification for the model was appreciated by the practitioners.
- The participants argued for the need to document a project's history, and hence any project sustainability appraisal, to avoid making repeatable mistakes in future projects, and especially to build the necessary knowledge base within the sector. This indicates the value of creating and maintaining the Legacy Archive as an integral part of any building assessment.

In conclusion, all questions presented to the participants received positive response. The workshop provided the necessary external validation and commentary on the research ideas and outputs presented in this thesis.

6.6 CONCLUDING REMARKS – COMMUNICATING THE THEORY FOR BUILDING ASSESSMENT THROUGH THE PROPOSED MODEL

This chapter outlines the functional specification for the model for building sustainability assessment. The emphasis has been placed on the context in which the model would operate rather than on its technical characteristics. This is due to the fact that the purpose of this thesis was not to produce an operational building sustainability assessment method, but to focus on the underlying philosophy that informs building sustainability assessment practice. The specification refers to different services that the model should provide to its users. Hence, apart from offering the basis for an adequate and valid evaluation of the building's intended and actual performance, the model is discussed in terms of its three other functionalities (i.e. outcomes). The three key outcomes of the model identified in this thesis include:

- Integration of sustainable development principles and thinking into the building project conceptualisation and execution;
- Enhanced transparency and accessibility of building assessment and the actual building process to all stakeholders; and
- Provision of an effective educational medium for all stakeholders involved.

The process view employed in the development of the model draws attention to such aspects as information exchange, knowledge transfer, and clear description of stakeholders' roles and responsibilities. Hence, this approach has helped enhance the model's capacity to deliver the desired outcomes.

The model is presented as a generic method with customisation opportunities to suit the context of its application. Three potential use scenarios for the model have been identified. These include the formulation of a building project proposal, building project sustainability appraisal and building performance audit. The use of these three scenarios has shown a dynamic nature of the model, which should easily respond to its application needs. For instance, Scenario 2 has revealed the model's potential to effectively improve building design on one hand, and to enhance the entire building process on the other.

Process maps, which have been used to describe each use scenario, present the integration of the assessment methodology with the actual building project activities. The maps indicate what a building assessment endeavour would involve, what it would draw upon, and how it might impact on the project's organisation and its outputs, as well as on building stakeholders. The process maps also indicate where the building assessment methodology interfaces with existing project activities and processes, providing stakeholders with an opportunity to arrange their projects to better incorporate the sustainability agenda.

Moreover, different user groups of the model have been identified. The discussion of key benefits and challenges associated with the model's use supports possible verification of its capacity to meet users' needs and to reach its intended audience.

It has been argued in this thesis that the effectiveness of the model will depend on how it can influence decision-making in construction, and more specifically during the building process. As shown in the use scenarios, the model is context-sensitive and optimises project outcomes by referring to the original problem definition (i.e. justification of the project need). Moreover, the model is applied in the formulation of the project vision and values, which should guide decision-making in the entire building process. Another important value-adding aspect of the model is its problem-solving capacity. The model not only guides the project team in addressing sustainability issues during building design and construction, but also provides stakeholders with a platform for co-design and co-production of solutions.

The model of building sustainability assessment aims to foster the sustainability of any building initiative. It does not provide any direct measure of building performance that can be subsequently compared with that of other buildings. However, the model allows for the benchmarking of building performance in particular areas (e.g. energy, water consumption or waste generation) for labelling purposes. More importantly, the model documents the context in which sustainability has been addressed, with all the challenges faced and opportunities discovered by building stakeholders.

Furthermore, the model highlights the importance of the human element in the building project. The model addresses the issues of individual awareness, practical knowledge and capacity of stakeholders. By broadening stakeholder participation in the assessment process and certain project activities, the model can be made *sensitive* to any cultural differences among stakeholders. Thus, the model offers a platform for the transfer of tacit knowledge, which is revealed through the discussion of values and experience between stakeholders (Luck, 2003). The model also assists stakeholders in the development of a common language and shared understanding of the assessment and building process.

While ensuring a dynamic interaction between the model and the building project, necessary for attaining the required level of information integration, it is essential to address the issues of process transparency and accessibility. The information management system that supports building assessment would need to include methods for information translation and structuring. For instance, it is necessary to provide for the translation of different points of view, needs and requirements from experts to other participants of the process and vice-versa (Enserink and Monnikhof, 2003). Information structuring is essential to make that knowledge usable during the assessment. Hence effort should be channelled into the development of adequate information presentation and communication formats during building sustainability assessment.

The integration of the model with the building process shifts the emphasis from building assessment towards building enhancement. The functional specification helps to communicate this new idea. The incorporation of the process view has revealed new important roles that building assessment methods can play in construction. The issues of broader stakeholder participation, improved communication and collaborative learning come to the fore.

Conducting the validation workshop was a necessary element of the methodology of this research. As this thesis reflects a theory building exercise, the workshop provided a necessary element of external validation and commentary from South African built environment practitioners. The concepts and reasoning embedded in the specification for the model, presented in this chapter, were endorsed by the workshop participants. Positive feedback was received on the proposed key functionalities of building sustainability assessment and the model's explication in terms of its potential application situations (i.e. use scenarios). The process maps that illustrate the use scenarios were recognised as useful in enhancing the transparency of the assessment process, and in stimulating a conversation about the services that building assessment methods could provide to a diverse range of building stakeholders.

Comments made by workshop participants support and complement the findings and conclusions reached in the process of conceptualising and developing the specification for the building sustainability assessment model. The following chapter draws together final conclusions that emerge from the research. It also presents recommendations for an improved practice of building assessment and proposed directions for future research.

Chapter 7

CONCLUSIONS, RECOMMENDATIONS AND DIRECTIONS FOR FUTURE RESEARCH

7.1 INTRODUCTION – REVISITING THE PREMISES OF THE THESIS

This thesis set out to identify measures that can improve the practice of building sustainability assessment to make it more effective in fostering sustainable development in the construction industry. It has been argued throughout the thesis that the existing, established building assessment methods that aim to promote sustainable construction do not effectively incorporate the principles and objectives of sustainable development in their frameworks and methodologies. Consequently, the potential of these tools to assist building stakeholders in implementing sustainability is compromised.

This thesis has made the argument for re-examining the premises of building sustainability assessment practice in order to identify the desired qualities of any building sustainability assessment method and to clarify the potential roles of building sustainability assessment in promoting sustainable construction. This required reflection on the *why* of building assessment practice – the theoretical and philosophical basis for what is done. Hence, this thesis has focused on the philosophical and theoretical underpinnings of building sustainability assessment practice by investigating to the praxiology of building assessment.

The theory advanced in this thesis provides the basis for the development of a functional specification for a building sustainability assessment model. This conceptual model is helpful in communicating the theoretical constructs proposed in this thesis to enhance the practice of building assessment, especially with regard to fostering the sustainability of building developments. Moreover, the model contributes to the debate as to whether building assessment can in theory and in practice invoke a shift in construction practice towards enhanced quality, effectiveness and efficiency of the building process. It builds on the qualities of existing building assessment methods and incorporates insights gained from reviews of Environmental Assessment practice and the Process Protocol.

The following sections outline the final conclusions and research findings presented in this thesis. Recommendations on the application of the findings are proposed, and the direction for future research stated. The chapter concludes with a brief discussion of the research findings in the context of the research aim and objectives stated at the outset of the research.

7.2 THESIS CONCLUSIONS

The conclusions of this thesis relate to the research questions and objectives set out in Sections 1.4 and 1.6. The conclusions are drawn with the aim of presenting implications of the research findings to the field of building assessment. In this way, the knowledge generated through this research will be shown to enrich the theory of building assessment practice.

7.2.1 Fostering Sustainable Development in Construction through Building Assessment Methods

The effectiveness of building sustainability assessment methods in addressing sustainable development in the construction sector and the built environment depends on the extent to which they influence decision-making processes in construction. Ideally, the sustainability considerations introduced into the building project via building sustainability assessment should inform and shape the building proposal, and the design, construction, operation and decommissioning of a building. By providing the means for stakeholder learning about the issues pertinent to sustainable construction and enhancing communication between stakeholders, a building sustainability assessment method can provide an effective decision-making support system for a building project. However this implies different expectations regarding the potential functionalities of building sustainability assessment methods.

It has been emphasised in this thesis that building sustainability assessment methods have a mission of changing the professional building culture and practice to support the agenda of sustainable construction. A significant aspect of the effectiveness in promoting the ideals of sustainable development in the built environment through building sustainability assessment is the ability to invoke a shift from a collective duty towards individual responsibility among building stakeholders. Sustainable construction requires a fundamental change in the values of built environment practitioners and other stakeholders, and the introduction of transdisciplinary thinking into building practice. The individual responsibility of building stakeholders and changes in building practice in favour of a more integrated and collaborative approach can help ensure that the principles of sustainable development are applied on subsequent building projects and at different levels of decision-making in construction. Arguably, a successful change in the attitude and values of project stakeholders on any project will outlast any practical outcomes and outputs of building sustainability assessment.

Broader participation of professional and lay building stakeholders in building sustainability assessment is central to achieving this task. However, stakeholder participation poses a number of challenges. The most difficult task would be to address potential power imbalances and conflicts. These may arise from unequal access to resources and information, different perceptions on development, and different value-sets held by participants. Hence, it is necessary that participants develop shared project values during building sustainability assessment through the process of mutual adjustment. Any building assessment method should therefore act as an educational and empowerment medium that promotes collaboration among building stakeholders. In order to support decision-making at a project level more effectively, building sustainability assessment should also facilitate communication and negotiation between stakeholders and act, as what Gann *et al.* (2003) call, a *tool for thinking*.

The infusion of the sustainability agenda in the construction sector has been reflected in the evolution of building assessment practice. The review of established building assessment methods has indicated a shift in the assessment methodology from *green* to *sustainable*. As a result, the scope of established *sustainable* building assessment has been extended to embrace biophysical, social and economic building issues, and the assessment is based on measuring a distance to pre-established targets. This thesis argues that attention should also be paid to the potential operationalisation of sustainable development principles in building assessment and, through this, in the building process. Consequently, this research has begun to indicate wider implications of introducing sustainability into the practice of building assessment, including the necessary changes in emphasis and the appreciation of new assessment outcomes.

A deeper theoretical and philosophical reflection has been shown to be required for the identification of fundamental changes that are needed in the practice of building sustainability assessment, so that it does not result in superficial and cosmetic modifications of building developments. While aiming to advance the practice of building sustainability assessment, it is useful to search for relevant interventions that are implemented in other areas of expertise that have been faced with similar challenges.

7.2.2 Enhancing the Practice of Building Assessment by Learning from Environmental Assessment and the Process Protocol

This thesis has reviewed Environmental Assessment and the Process Protocol as sources for new and innovative thinking, in order to gain insights that can be valuable for the proposed enhancement of the practice of building sustainability assessment. The following conclusions are reached based on lessons gained from the review of Environmental Assessment and the Process Protocol.

Integration is viewed as a fundamental aspect of any sustainability assessment process. Building sustainability assessment needs not only to address, but also to integrate the biophysical, socio-cultural, political and economic aspects of a building development. In this way sustainability assessment will be more comprehensive and incisive in terms of the range of issues addressed compared to *green* building assessment, and more proactive. The integration of issues and insights during building sustainability assessment should allow for the identification of interactions and synergies between different factors, including the indirect positive and negative implications of a proposed building development. Hence, building sustainability assessment could contribute to a more optimised performance of any assessed building and simultaneously increase the overall sustainability of a building development. Building sustainability assessment should also facilitate the integration of stakeholders' values, needs and preferences into the design, delivery and operation of a built product. This approach enables to enhance the perceived quality and desirability of the end-product and, consequently, to extend its useful lifespan. With regard to construction practice, the sustainability agenda calls for the integration of different types of knowledge and experience (e.g. technical and indigenous knowledge, explicit and tacit knowledge). Therefore, building sustainability assessment requires the participation of both professional and lay building stakeholders. Preferably, such participation should take a form of collaboration, where stakeholders combine their efforts in the spirit of teamwork guided by a common project vision. Broad stakeholder participation needs to be promoted in South Africa, so that its construction industry can capitalise on the rich knowledge base of indigenous practices. In addition, in order to increase the relevance of building assessment outputs, the assessment process should be closely integrated with the actual building process (or a project's cycle) in terms of the information flows.

As sustainable development is a value-laden concept, any building sustainability assessment process is inevitably based on values. Consequently, a building sustainability assessment system may be based to a large extent on qualitative evaluation rather than objective measurements. However, broader representation of building stakeholders in the assessment process (i.e. lay and professional) can positively contribute towards its increased inter-subjectivity. Building sustainability assessment should be driven by values shared by all stakeholders, as they collectively identify significant assessment issues and agree upon the assessment targets. Therefore, the establishment of shared values through the process of mutual adjustment becomes a significant component of building sustainability assessment.

This adjustment of views and values should be supported by social learning, so that building stakeholders are guided in their decision-making by local and global contexts.

By adopting a scoping procedure derived from the Environmental Assessment practice, building sustainability assessment can be made more flexible, sensitive and responsive to the context of its application. Scoping enables a problem-based approach to building sustainability assessment, whereby a proposed building development is analysed in terms of the opportunities and challenges posed by its specific socio-economic and biophysical settings. This approach addresses issues that are often difficult to tackle using standard building assessment frameworks. These may include, for instance, the sensitivity of the receiving natural environment or the issues of equity and cultural identity – so vital in the South African context. Hence, scoping does not only help to respond to the specific context of the South African built environment and the construction industry, it also provides the means for infusing sustainability principles in a building development. As indicated by the practice of Environmental Assessment, scoping is not only used for the purpose of reducing the number of issues addressed during the assessment process to the most significant ones, but it also fulfils other roles in the process. For instance, scoping provides forums for stakeholder learning and capacity-building, and shapes the design and content of subsequent stages of the assessment process. Therefore, scoping should be viewed as a critical stage of any building sustainability assessment, as it significantly influences the effectiveness of the assessment process and the quality of its outcomes.

It has also been argued in this thesis that any building sustainability assessment method should facilitate broader stakeholder representation and involvement in the assessment process. Participation in building assessment cannot be limited to the sourcing of information and presentation of results. Preferably, building stakeholders should be directly involved in the assessment activities. In this way new knowledge and experience gained during building assessment can benefit building stakeholders in their professional and private lives. The Process Protocol proposes an innovative approach to participation in the building process. Basing on the concept of Activity Zones, stakeholders who participate in building assessment should be grouped in terms of their responsibilities and tasks, and not interests. This approach would be especially useful when building assessment is closely linked with the actual building process. Providing meaningful stakeholder participation in building sustainability assessment is undoubtedly a challenging task. It requires enhancing assessment transparency and accessibility, especially in terms of communication competence. Emphasis would have to be placed on overcoming technical language barriers and on the establishment of information needs (i.e. timing, form and content) during the assessment. It is also important to ensure that stakeholders understand the assessment process (including its methodology, inputs and outputs), and that they have clear expectations regarding its outcomes. By having an opportunity to co-design the assessment process and, more importantly, to co-produce project solutions, stakeholders are more likely to develop a commitment to the sustainability agenda and take ownership of the assessment process and the building project. Achieving stakeholder commitment to the project's vision is essential for the effectiveness of building sustainability assessment.

Social, collaborative learning and knowledge transfer are the most significant outcomes of any sustainability assessment process. Sustainable construction requires a fundamental reappraisal of the industry's purpose and priorities. It is through education and the resulting shift in the values held by building stakeholders that building sustainability assessment will exert a positive influence on human behaviour and, consequently, affect the interactions between the built and natural environments. Stakeholder participation in the building sustainability assessment process provides ample opportunity for the generation and transfer of explicit and tacit knowledge (i.e. the *know-how*). For instance, stakeholders gain knowledge on the implications of the sustainability agenda for the built environment and the construction industry. Subsequently, they learn about practical ways of addressing sustainability within the building project. Direct experience of participation in building sustainability assessment activities may help building stakeholders to intuitively apply the knowledge and skills gained from the assessment in new construction projects, even if such projects are not guided by any explicit reference to the sustainability principles.

The potential for improving the effectiveness of building sustainability assessment is not limited solely to the consideration of technical and methodological characteristics of a building assessment system. It also focuses on the services that building sustainability assessment can provide to building stakeholders in addition to the direct inputs from the assessment into the building project. This task can be facilitated by the application of the process view of building sustainability assessment and the building project. Consequently, the building sustainability assessment process and the building project can be presented as a progression of activities in time. The use of process maps helps indicate key decision-points in a building project and to identify associated decision needs. As a result, it is possible to design an assessment process that will provide relevant inputs into the building project in a timely manner. Hence, process mapping can present the assessment arrangements in a transparent way. The process view draws attention to process-related aspects of building assessment and to its social dimension. Since the choice of significant assessment issues, selection of assessment indicators and establishment of targets form crucial components of building sustainability assessment, the assessment process can be viewed as a product of social discourse between project stakeholders. Therefore, a building sustainability assessment method will act as a communication aid for building stakeholders.

7.2.3 Suggesting Measures for More Effective Building Sustainability Assessment through the Functional Specification for the Building Sustainability Assessment Model

The lessons gained from the review of Environmental Assessment and the Process Protocol have been incorporated into the functional specification for the building sustainability assessment model presented in this thesis. Developing the functional specification has enabled the research to focus on the process- and service-related aspects of building assessment that fosters sustainability of building developments. The primary value of this conceptual model is that it provides grounds for the discussion of potential enhancements to the building sustainability assessment practice. The reconsideration of issues raised during the development of the model, which were subjected to deliberation by South African built environment practitioners during the validation workshop, leads to a number of conclusions.

The potential functions of building sustainability assessment should be specified prior to any discussion on its effectiveness. Hence, it is necessary to indicate what services such an assessment should provide for the construction industry and building stakeholders. The effectiveness of any building sustainability assessment method can be subsequently evaluated in terms of how it meets the expectations of building stakeholders, and whether it accomplishes its full potential. Consideration should be given to direct assessment outputs as well as its outcomes. It has been shown with the proposed model that the integration of building assessment with the actual building process (a project's cycle) changes the nature of assessment outputs. Since building assessment outputs are viewed as inputs into the building process, their specific timing, content and form become important. Moreover, the key outcomes of the model (integration, transparency and accessibility, and social learning) should not only improve the model's performance, but also its effectiveness in enhancing the sustainability of a building initiative.

A building sustainability assessment method should be dynamic in nature and responsive to any application needs. The model proposed in this thesis has been discussed in terms of its three potential application scenarios, namely, the development of project proposal, project sustainability appraisal and building performance audit. As the model provides a different contribution in each of the three cases, its generic framework has to be customised to suit the needs of each application. By presenting different scenarios for the application of the model, it becomes possible to consider how building stakeholders can best benefit from building assessment. No assessment tool can be successful unless it is perceived as useful and is accepted by its target audience.

The use of process mapping in presenting the model's use scenarios has facilitated the adoption of a process view, which is necessary for the effective customisation of any building assessment to the context of its application. Process maps help to illustrate what the building project involves, i.e. what resources it draws upon, what activities need to be performed, what independencies exist between those activities; and allow for the design of the building assessment process accordingly. In addition, process mapping provides useful means for making explicit the consideration of such issues as information exchange, communication between building stakeholders and resulting knowledge transfer. It becomes apparent that the integration of building sustainability assessment with the building process needs to be undertaken in the areas of information management and stakeholder participation. Furthermore, by adopting the process view in the integration of building sustainability assessment with the building project cycle, it becomes easier to address the issues of an assessment *follow-up*, including any building monitoring and feedback mechanisms. The assessment follow-up needs to be viewed as an integral part of building assessment to ensure that actual building performance is consistent with design intentions. More importantly, post-assessment feedback provides a valuable source of knowledge and experience that can benefit not only the practice of building assessment, but also the quality of future building projects.

Furthermore, scoping proves to be the most critical stage of building assessment in each of the model's use scenarios, especially with regard to its key functionalities. Scoping includes a preliminary situational analysis with the review of the project need, the project's socio-economic and biophysical contexts and the identification of significant assessment issues. It is during this stage that stakeholders establish common project values and build commitment towards the assessment objectives. Scoping also embraces various learning opportunities, as stakeholders can be presented with different conceptual approaches to sustainability, e.g. the Daly Triangle and Dooyeweerd's framework (see Sections 2.1.5 and 5.4.1). Subsequently, participants delineate the assessment methodology and agree upon issues of information management.

The model for building sustainability assessment is not based on any fixed assessment framework, as different assessment situations require different methodological approaches and practical solutions. Scoping provides the necessary flexibility to the assessment process by allowing for the selection of criteria and indicators that best address the identified significant assessment issues. This component of the model was seen by the workshop participants as a key departure point from other *sustainable* building assessment methods, such as SPeAR and SBAT.

7.2.4 Aligning Building Assessment with the Building Process

The notion of aligning building assessment with the building process to improve the effectiveness of the assessment and the quality of the building project has been argued from the outset of this thesis. Embracing this notion in the development of the model's specification leads to the following conclusions:

It was acknowledged by the South African built environment practitioners that building assessment cannot effectively function as an *add-in* to the building process, but should be integrated with existing activities. It was also confirmed during the validation workshop that more inclusive stakeholder participation in the building process, facilitated via building sustainability assessment, is a vital step to ensuring that sustainability in construction is fostered in a wider social context and not solely in terms of technical interventions. Arguably, the infusion of sustainability in the built environment requires promoting the practice of co-design, which combines expert knowledge with values and preferences of communities by integrating producers and users in the building process.

The application of the process view in the conceptualisation of the building assessment process and the building project enables to discover a value-adding potential of building sustainability assessment. A dynamic integration of the building sustainability assessment process with the building project shifts the emphasis from the assessment to a proactive project appraisal. Hence, building sustainability assessment should no longer been seen as evaluating building performance, but be seen as a means to transform the context in which it is applied by incorporating the principles of sustainable development directly into the building process.

Moreover, the integration of building sustainability assessment with the building process will drive continuous improvement in construction in terms of stakeholders' capacity-building and a consistent aim for 'better' practice. Therefore, it may be speculated that the role of building sustainability assessment methods will evolve from *assessment* towards *enhancement*. This, in turn, can result in greater appreciation of the additional services that building sustainability assessment can provide to building stakeholders, such as education, communication, negotiation, and decision-making support.

The shift in emphasis from *assessment* to *enhancement* in the practice of building sustainability assessment requires that new and existing building assessment methods adapt better to the needs of the building process. At the same time, the integration of building sustainability assessment into the building project requires changing existing managerial practices in building processes. Through the coordination of activities and responsibilities within the building process and building assessment, building sustainability assessment can become an element of quality control within the building project. The specification for the model shows that building sustainability assessment can contribute towards solving a number of problems inherent in construction practice, e.g. in the development of poor design and project briefs.

7.3 PROPOSED RECOMMENDATIONS

The following sections discuss the potential utilisation of the research findings. Recommendations are proposed with regard to three main areas of intervention that can improve the effectiveness of building assessment in fostering sustainability within the construction industry and the built environment. These areas are:

1. Amendments to the practice of building sustainability assessment;
2. Proposed modifications of building assessment methodology; and
3. Shifting emphasis from building assessment to building enhancement.

The proposed improvements can be implemented by building assessment practitioners in these three areas separately. However, addressing them simultaneously would lead to the synergy of efforts and, hence, reinforce the positive outcomes.

7.3.1 Amending the Process of Building Sustainability Assessment

A fundamental requirement of building assessment methods that aim to advance the sustainability of building projects is to promote the principles of sustainable development. These principles need to guide the selection of significant assessment issues and, more importantly, be embedded in the practice of building sustainability assessment. For instance, the principles of inter- and intra-generational equity require securing broader stakeholder representation in the process of building assessment.

This thesis has made the case that stakeholder participation in building assessment should be ensured in any new building sustainability assessment system, but it can also be implemented in existing building assessment methods. When identifying opportunities for stakeholder involvement in particular assessment activities, attention should be paid to capitalising on the different modes of learning and knowledge transfer. These can take a form of individual research, participation in learning workshops and teamwork (for instance during the selection of significant assessment issues or establishment of targets). Ensuring communication competence throughout building assessment is central to improved transparency and accessibility of the assessment process and its educational functionality. Information needs to be exchanged in a language that is accessible to stakeholders at a particular stage of building assessment. Thus initiatives such as the Process Protocol have an important role to play in reducing the technical barriers to effective communication. It may also be assumed that with the progression of the assessment process stakeholders will become familiar with some of the technical terms used by different built environment professions. Communication should be also supported by visual aids whenever possible, especially during the presentation of assessment results (e.g. using spider diagrams).

Any building sustainability assessment is by nature a product of social discourse between building stakeholders. Hence, stakeholder participation should not be viewed as an additional organisational or financial burden, but a necessary element of any building sustainability assessment process. This can improve the delivery of building projects in the way they are delivered (process) and what is delivered (product).

The model's specification presented in this thesis, and described using process maps, is intended to stimulate debate about the importance of participation in building assessment. Although the process maps presented in this thesis focus on the information flows between the building assessment process and the project activities, such maps could also help to delineate patterns of stakeholder participation that would be optimal or at least acceptable for particular building projects. Moreover, the use of process maps in building sustainability assessment should reduce any potential confusion regarding stakeholders' responsibilities and the timing of their involvement.

Furthermore, any building sustainability assessment method should facilitate the integration of sustainability considerations into decision-making throughout the building project cycle. This can be achieved, for instance, by the incorporation of a decision-scoping procedure and the establishment of a shared information management system for the assessment and the building process.

The research has also indicated the benefits of aligning any building assessment process with the overall building process. A more progressive move would be to introduce building assessment into the domain of project management; away from its current role as a discrete auditing activity, separate from the mainstream concerns of the project management team. Consequently, the emphasis would be placed again on the development of a common understanding of the functions and objectives of building sustainability assessment among stakeholders, as well as on securing communication competence. This approach offers better customisation opportunities of the building assessment process to the context of its application (e.g. a building project appraisal or performance audit). More importantly, through such integration with the building process, building sustainability assessment may become an effective agent of change within professional construction practice. If the activities of building sustainability assessment are viewed as an integral part of the building process, then a sustainability appraisal will inevitably become a part of mainstream project delivery practice.

7.3.2 Methodological Approaches to Sustainability in Building Assessment

This thesis has shown that addressing sustainability of a building development requires new methodological solutions in building sustainability assessment; that it is not sufficient just to expand the scope of considerations addressed by building assessment to include environment, social and economic issues. Building sustainability assessment needs to provide a means for addressing these three interwoven realities of a building development by recognising the integration and interdependencies of sustainability considerations.

Although the current technical capacity to measure sustainability is still limited, for instance, in terms of the availability of sustainability indicators, the conceptual ability to address sustainability of building developments needs to be continuously stimulated. This means that the quest for advancing the effectiveness of building sustainability assessment cannot be discouraged by the existing technical challenges. By proposing new methodological approaches to building sustainability assessment, the context in which sustainability considerations are addressed can be significantly enriched. This can certainly amplify the value-adding aspects of the assessment process in appraising the sustainability of a building development.

The third fundamental principle of sustainable development that refers to the protection of the carrying capacity of the natural environment remains difficult to operationalise in any sustainability assessment. However, building sustainability assessment needs to promote a range of concepts that help to address this principle (e.g. the environmental utilisation space or the ecological footprint). This requires retaining certain degree of flexibility in the assessment methodology, in that an assessment method should offer a platform for stakeholder learning and debate, and a possibility to select or develop appropriate indicators for the assessment process. If a building sustainability assessment method is based on a fixed framework of assessment issues, the ability to introduce different sustainability-related concepts and customise the assessment process is highly limited. Hence, the recommendation to adopt a scoping procedure, as illustrated on the example of the model proposed in this thesis.

This research has also indicated that another methodological aspect that should be further debated by practitioners and other users of building sustainability assessment methods is a potential need to redesign an assessment framework. Established *sustainable* building assessment systems are based on three pillars of sustainable development, namely, environmental, social and economic. However, the classification of assessment issues into one of these categories can sometimes be problematic (e.g. some issues cannot be treated strictly as social or economic). An alternative approach to redesigning the assessment framework could be to select components that represent significant normative aspects of building sustainability assessment. This could be achieved by focusing on desired assessment end-points, for instance performance excellence, process enhancement, stakeholder satisfaction and environmental sensitivity. Arguably, ensuring that the building sustainability assessment process is based on principles that define sustainability is more important than any literal reference to environmental, social and economic dimensions of sustainable development in the assessment framework. A useful starting point would be to reflect upon such principles listed by Gibson (2001) (see Section 4.5.3) and on the possibilities to address them in building sustainability assessment.

Furthermore, a debate on sustainability within the built environment and the construction sector needs to be enriched by widening the range of concepts discussed by building stakeholders. For instance, the Daly Triangle (see Section 2.1.5) can help introduce the consideration of different types of capital and the discussion of means versus ends in construction. In addition, it is necessary to begin to specify whether a particular building assessment promotes weak or strong sustainability, as this has significant implications for the rationale of decision-making during building assessment.

7.3.3 Enhancing the Building Process through a Building Project Sustainability Appraisal

Building sustainability assessment should not be viewed as an instrument to produce sustainable buildings. It is rather one of the means for enhancing the quality of decision-making and processes within the building project by incorporating the philosophy of sustainable development. As sustainability is a dynamic reality, building sustainability assessment can be perceived as a way to facilitate and document the process and efforts undertaken by building stakeholders to harvest the benefits and respond to the challenges posed by sustainability in the context of a particular building development. This was seen as a yet another fundamental requirement of any building sustainability assessment method by South African built environment practitioners.

Hence, it is crucial to ensure that the application of building sustainability assessment is not only a *once-off* situation. Instead, building sustainability assessment should be an integral part of the building process and provide mechanisms for continuous improvement even during a building's operation, as the contextual factors (e.g. stakeholder needs or availability of resources), technical ability and available knowledge change in time. Consequently, building stakeholders should engage in a debate about the potential roles of building sustainability assessment and its integration with other available instruments that help foster sustainability of building developments and the construction sector in general.

This thesis has indicated that building sustainability assessment can provide a range of services to building stakeholders depending on an application situation (i.e. whether it is used to appraise the building project or for a building's performance audit) and an emphasis on specific outcomes (e.g. broader stakeholder participation in the building process and/or more effective knowledge transfer between project participants). It is apparent that building sustainability assessment cannot be concerned only with building design features and the choice of construction techniques or materials, but also with social and technical processes that produce buildings. The principal role of building sustainability assessment is changing from that of offering a technical aid in a project appraisal towards the one of offering a management aid in the building process. In this way, building sustainability assessment becomes a means to provide space for reflection upon the priorities in decision-making and methods used in construction.

Building sustainability assessment should be therefore geared towards proactive improvement and enhancement of a building development with regard to the building process and its product. This approach supports a conviction of the author that sustainability thinking should ultimately be embedded in mainstream building management activities. Building sustainability assessment is not an end in itself. It is a means towards achieving better quality of the built environment, harmonious relationship between the built and natural environments and a *sustainable society*.

7.4 DIRECTIONS FOR FUTURE RESEARCH

Due to the novelty of research presented in this thesis, which aims to enhance the practice of building assessment in fostering sustainable development, a number of themes and directions for further investigation have emerged. Some of the key issues that present vital extensions of this particular research are discussed in the following paragraphs.

The next step in developing the model for building sustainability assessment would be to operationalise the conceptual model outlined in this thesis, so that it can be empirically tested and validated against real projects. Operationalisation would involve creating a structural framework for building assessment, including assessment components, criteria and, possibly, sub-criteria. In addition, emphasis should be placed on the search for, and the development of, sustainability indicators that could be used by stakeholders to populate the framework. Such indicators differ from traditional metrics in that they are based on the reference to a threshold of irreversible change or to time-frames and/or spatial dimension. Another indispensable feature of the model that needs to be developed is its graphical interface supported by appropriate software. This would not only facilitate the communication of information and assessment results to stakeholders but also the capturing of assessment data and the monitoring of progress. Consequently, the operationalisation of the model would also require establishing an electronic database which would support an information management system and, hence, help create a shared Legacy Archive for the building project and building assessment. The information management system could be supported by existing decision-support software or other appropriate computer-based tools used in project management. The applicability of computer software to the needs of building assessment and its integration with building project's activities requires further investigation.

The model's operationalisation also comprises the establishment of procedures that would guide building stakeholders through building assessment, and at the same time ensure quality control over the assessment process. Such procedures are especially important for a scoping stage of building assessment so that ambiguity and vagueness can be avoided. Stakeholders should be assisted during activities when consensus is built regarding the establishment of shared values and vision, identification of significant assessment issues, and the selection of appropriate indicators and targets for the assessment. Procedures should be provided not only for problem-definition and reshaping during scoping, but also for subsequent stages of building assessment in order to ascertain the model's problem-solving capacity. Apart from procedures and guidelines for building sustainability assessment, it is also necessary to consider the need for a project champion, who would facilitate stakeholder participation in the assessment process and coordinate the assessment-related activities. This role should be ideally played by the project manager. However, an external specialist needs to be invited if there is insufficient internal expertise on sustainability issues in the project management team.

Another important issue that has emerged out of this research and deserves deeper investigation is the need to pursue an integrated approach in building sustainability assessment. It is therefore necessary to seek for measures that allow an effective integration of sustainability-based principles and concepts into the building assessment process and framework. In addition, an interesting extension of this research would be the exploration of the implications of weak and strong sustainability paradigms for building sustainability assessment, and what measures can facilitate an effective and consistent implementation of the chosen approach. It is also worth investigating whether any alternative categorisation of assessment issues (i.e. instead of environmental, social and economic) would have any influence over stakeholders' perceptions regarding the desirability of building assessment and its value-adding function to building developments.

An equally important extension of the research presented in this thesis would be to seek opportunities to align observations and insights from building sustainability assessment with other trends that are emerging in construction. For instance, these may include the implementation of the process view, design management, value management or stakeholder management, among others. Building sustainability assessment will only become mainstream when aligned with, and absorbed by, other trends and activities in construction. Consequently, further research could focus on how to shape and reinforce project culture with the use of appropriate tools (including building assessment) and management strategies to advance the sustainability of construction projects. The need for such research has been also identified by others (e.g. Bartlett and Guthrie, 2005).

7.5 THE ACHIEVEMENT OF THE RESEARCH AIM AND OBJECTIVES

This thesis has contributed to the theory of practice in the field of building assessment by proposing measures to enhance the effectiveness of building assessment in promoting sustainability in construction. This was achieved by developing the functional specification for the building sustainability assessment model for the South African built environment. However, as the research has addressed the issues of building assessment practice that are relatively general in nature, the conclusions and recommendations proposed in this thesis relate to more than the South African context in that they are more universal and far wider reaching.

The research proposition, which stated that Environmental Assessment and the Process Protocol can provide significant insights and valuable lessons for improving the practice of building assessment and promoting broader stakeholder involvement, proves to be valid. Undoubtedly, these two sources of expertise have helped push the frontiers of sustainability thinking in the context of building assessment. The need to effectively incorporate the principles of sustainable development in the frameworks and methodologies of building sustainability assessment systems, which was postulated as another research proposition, has been identified as an urgent priority.

Moreover, this research has indicated that addressing the practice of building sustainability assessment might have even a greater overall impact on the construction industry, in terms of infusing the agenda of sustainability, than developing or refining yet another building sustainability assessment method for South Africa. It is argued that the effectiveness and relevance of building assessment can be advanced by aligning its methodology with the building process, as illustrated in this thesis using the model. Hence, the third proposition stated in the beginning of this thesis is also upheld. Integration of building assessment with the building process has not only allowed for the development of use scenarios for the model, thus making it responsive to the context of its application, but has also revealed new roles that building sustainability assessment can play in fostering sustainability in construction. These roles, presented as key functionalities of the model, include integration, transparency and accessibility, and collaborative learning.

An important conclusion that emerges out of this research is that building sustainability assessment methods can facilitate the transition towards sustainable lifestyles among building stakeholders, which involves changes in behaviour and culture. This can be achieved if building stakeholders are proactively involved in building sustainability assessment, so that they can individually assimilate the values of sustainability promoted and created during the process. Broadened stakeholder participation in building assessment and construction projects is especially vital in South Africa, as it allows for individual empowerment and contributes to the creation and transfer of knowledge within the sector.

The issue of knowledge generation and transfer regarding sustainable construction forms a strategic component of an *African Plan for Action* – the product of a regional Sustainable Building Conference that took place in Stellenbosch in September 2004, which gathered 134 delegates from 21 African countries (du Plessis, 2005). It emerged out of the conference that there was a need for mechanisms to evaluate and monitor construction projects that promote the ideals of sustainable development. The results of evaluation and monitoring should be captured to provide basis for the generation of new knowledge. However, "*for knowledge to be of value*", it needs to be shared by stakeholders through the processes of active learning, collaboration and wider dissemination (*ibid.*:411). The findings, conclusions and recommendations of this thesis respond directly to the needs identified by the participants of the African conference.

REFERENCES

Aouad, G., Cooper, R., Kagioglou, M. and Sexton, M. (1999) *The Development of a Process Map for the Construction Sector*, Working Groups W65/W55, South Africa.

Arup (2000) *SPeAR: A Sustainability Assessment Methodology*, Launch Paper, July, Arup Environmental.

Azar, C., Holmberg, J. and Lindgren, K. (1996) Methodological and Ideological Options: Socio-ecological indicators for sustainability, *Ecological Economics*, 18(2), pp. 89-112.

Babbie, E. (1995) *The Practice of Social Research*, 7th Edition, Wadsworth, Belmont, California.

Baccarini, D. (1999) *Project Management 641*, Course materials, School of Architecture and Planning, Curtin University of Technology (available at: http://www.e-campus21.com/courseware/notes/CourseMaterials/MPM/pm641/paper8.pdf) (accessed on 15.02.2005).

Bakens, W.J.P. (ed) (1997) *Future Organisation of the Building Process*, CIB Working Commission W82, Publication 172, ISBN 90-6363-005-0.

Baldwin, R., Yates, A., Howard, N. and Rao, S. (1998) *BREEAM'98 for Offices*, Building Research Establishment, Garston.

Barker, G. and Kaatz, E. (2001) *Environmental Sustainability Assessment Methods for Buildings in South Africa*, Department of Environmental and Geographical Science, University of Cape Town, Cape Town.

Barraclough, S. (1990) *Popular Participation*, a paper presented at a regional workshop on Participatory Forest Projects, Addis Ababa.

Bartlett, H. and Guthrie, P. (2005) Understanding the Implementation of Sustainability Principles in UK Educational Building Projects, in *Proceedings of the 2005 World Sustainable Building Conference: Action for Sustainability*, 27-29 September, Tokyo, Japan, (CD-ROM, Paper No. 15-004, Abstract, p. 288), pp. 4027-4034.

Basden, A. (2002) The Critical Theory of Herman Dooyeweerd? *Journal of Information Technology*, 17(4), pp. 257-269.

Basden, A. (n.d.) *The Dooyeweerd Pages* –website (available at: http://www.isi.salford.ac.uk/dooy/index.html) (accessed on 27.09.2004).

Bass, S., Dalal-Clayton, B. and Pretty, J. (1995) Participation in Strategies for Sustainable Development, *Environmental Planning Issues*, No. 7, International Institute for Environment and Development (available at: http://www.iied.org/docs/spa/epi7.pdf) (accessed on 12.08.04).

Beanlands, G. (1988) Scoping Methods and Baseline Studies in EIA, in P. Wathern (ed): *Environmental Impact Assessment: Theory and Practice*, Routledge, London: New York, pp. 33-46.

Beder, S. (2000) Costing the Earth: Equity, Sustainable Development and Environmental Economics, *New Zealand Journal of Environmental Law*, Vol. 4, pp. 227-243 (available at: http://www.uow.edu.au/arts/sts/sbeder/esd/equity.html) (accessed on 15.04.2004).

Bell, S. and Morse, S. (2003) *Measuring Sustainability: Learning from Doing*, Earthscan, London.

Berry, D.M., Daudjee, K., Dong, J., Nelson, M.A. and Nelson, T. (2001) *User's Manual as a Requirements Specification*, Technical Report CS 2001-17,Computer Science Department, University of Waterloo, Ontario.

Birkeland, J. (2002) *Design for Sustainability: A Sourcebook of Integrated Ecological Solutions*, Earthscan.

Bisset, R. (1996) *Environmental Impact Assessment: Issues, Trends and Practice*, Environment Economics Unit, United Nations Environment Programme, Nairobi, Kenya.

Blaikie, N. (1993) *Approaches to Social Enquiry*, Polity Press, Cambridge.

Bolton Institute (n.d.) Learning to learn in Psychology, *Student Workbook II: Thinking about experiments* (available at http://www.sar.bolton.ac.uk/ltl/default.htm) (accessed on 01.12. 2004).

Bond, A. and Steward, G. (2002) Environment agency scoping guidance on the environmental impact assessment of projects, *Impact Assessment and Project Appraisal*, 20(2), pp. 135-142.

Bond, R., Curran, J., Kirkpatrick, C., Lee, N. and Francis, P. (2001) Integrated Impact Assessment for Sustainable Development: A Case Study Approach, *World Development*, 29(6), pp. 1011-1024.

Bordass, B., Leaman, A. And Ruyssevelt, P. (2001) Assessing building performance in use 5: Conclusions and implications, *Building Research and Information*, 29(2), pp. 144-157.

Bourdeau, L. (1999) Sustainable development and the future of construction: a comparison of visions from various countries, *Building Research and Information*, 27(6), pp. 354-366.

Brown Weiss, E. (1992) Intergenerational equity: a legal framework for global environmental change, in E. Brown Weiss (ed): *Environmental change and international law: New challenges and dimensions*, Chapter 12, United Nations University Press, Tokyo (available at: http://www.unu.edu/unupress/unupbooks/uu25ee/uu25ee0z.htm) (accessed on 16.04.2004).

Brown, A.L. and Hill, R.C. (1995) Decision-scoping: Making EA learn how the design process works, *Project Appraisal*, 10(4), pp. 223-232.

Building Research Establishment (BRE) (2004) *BREEAM 98 for Offices*, (available at: http://www.buildingdesign.co.uk/arch/bre-1/bre-1.htm) (accessed on 05.04.2004).

Buselich, K. (2002) *An outline of current thinking on sustainability assessment*, A background paper prepared for the Western Australian State Sustainability Strategy, Institute for Sustainability and Technology Policy, Murdoch University, Western Australia (available at: http://www.sustainability.dpc.wa.gov.au/docs/BGPapers/KathrynBuselich.pdf) (accessed on 27.07.2004).

Canter, L. and Clark, R. (1997) NEPA Effectiveness – A Survey of Academics, *Environmental Impact Assessment Review*, 17(5), pp. 313-328.

Canter, L. W. (1996) *Environmental Impact Assessment*, 2nd Edition, McGraw-Hill Inc, New York.

Carlson, P. and Lundgren, J. (2002) Environmental status of buildings: New features in the Swedish system for environmental auditing and assessment of buildings, in *Proceedings of the 3rd International Conference on Sustainable Building*, Oslo, 23-25 September (CD Rom, Paper No. 076, Abstract p. 369).

Carter, N. (2001) Understanding Sustainable Development, seminars extracted from Chapter 8 of *The Politics of the Environment*, Cambridge University Press (available at: http://www.fathom.com/course/21701763/session2.html) (accessed on 15.04.2004).

Chaliand, G. (n.d.) *Third World: Definitions and descriptions*, Third World Traveller – website (available at: http://www.thirdworldtraveler.com/General/ThirdWorld_def.html) (accessed on 19.04.2004).

Chau, C.K., Lee, W.L., Yik, F.W. and Burnett, J. (2000) Towards a successful voluntary building environmental assessment scheme, *Construction Management and Economics*, 18(8), pp. 959-968.

CIRIA (n.d.) CIRIA website: Conference *Towards Sustainable Construction – why become sustainable?* (available at: http://www.ciria.org/conferences_sustainability_working_fair.htm) (accessed on 29.04.2004).

Cole, R.J. (2005) Building Environmental Assessment Methods: Redefining Intentions, in *Proceedings of the 2005 World Sustainable Building Conference: Action for Sustainability*, 27-29 September, Tokyo, Japan, (CD-ROM, Paper No. 04-048, Abstract, p. 140), pp. 1934-1939.

Cole, R.J. (2004) Changing context for environmental knowledge, *Building Research and Information*, 32(2), pp. 91-109.

Cole, R.J. (2003) Introduction: Knowledge, Values and Building Design, in R.J. Cole and R. Lorch (eds): *Buildings, Culture and Environment: Informing Local and Global Practices*, Blackwell Publishing Ltd., Oxford, pp. 1-8.

Cole, R.J. (2000) Building environmental assessment methods: Assessing construction practices, *Construction Management and Economics*, 18, pp. 949-957.

Cole, R.J. (1999) Building environmental assessment methods: Clarifying intentions, *Building Research & Information*, 27 (4/5), pp. 230-246.

Cole, R.J. and Larsson, N. (2002) GBTool *User Manual, Green Building Challenge*, International Initiative for Sustainable Built Environment (iiSBE) (available at: http://greenbuilding.ca/down/gbc2002/GBC2k2_Manual.pdf) (accessed on 20.11.2002).

Cole, R.J. and Larsson, N. (1999) GBC'98 and GBTool: Background, *Building Research & Information*, 27 (4/5), pp. 221-229.

Cole, R.J., Lidnsey, G. and Todd, J.A. (2000) Assessing life cycles: Shifting from green to sustainable design, *Proceedings: International Conference Sustainable Building 2000*, 22 – 25 October 2000, Maastricht, the Netherlands, pp. 22-24.

Cooper, I. (1999) Which focus for building assessment methods – environmental performance or sustainability? *Building Research and Information*, 27(4/5), pp. 321-331.

Cooper, R., Kagioglou, M., Aouad, G., Hinks, J., Sexton, M. and Sheath, D. (1998) The Development of a Generic Design and Construction Process, European Conference, *Product Data Technology (PDT) Days*, March 1998, Building Research Establishment, Watford, UK.

Costanza, R., Daly, H.E. and Bartholomew, J.A. (1991) Goals, agenda and policy recommendations for ecological economics, in R. Constanza (ed): *Ecological Economics: The science and management of Sustainability*, Columbia University Press, New York, pp. 1-20.

Council for Scientific and Industrial Research (CSIR) (2001) *The Sustainable Building Assessment Tool (SBAT) Housing* – DRAFT, CSIR Boutek, Pretoria.

Crawley, D. and Aho, I. (1999) Building environmental assessment methods: applications and development trends, *Building Research & Information,* 27 (4/5), pp. 300-308.

Dag Hammarskjöld Foundation (2003) *A brief overview of the Dag Hammarskjöld Foundation* – website (available at: http://www.dhf.uu.se) (accessed on 13.04.2004).

Dalal-Clayton, B. and Sadler, B. (2004*) The Status and Potential of Strategic Environmental Assessment (SEA)*, Draft Report, International Institute for Environment and Development, London (available at: http://www.iied.org/spa/sea.html#chap) (accessed on 12.08.04).

Daly, H. E. (1973) *Toward a Steady State Economy*, W. H. Freeman and Company, San Francisco.

Daly, H. E. (1991) Elements of Environmental Macroeconomics, in R. Costanza (ed): *Ecological Economics: The science and management of sustainability*, Columbia University Press, New York, pp. 44-45.

Daly, H.E. and Cobb, J.B. (1990) *For the Common Good*, Green Print, London, pp. 195-197.

Daniels, S.E. and Walker, G.B. (1996) Collaborative Learning: Improving Public Deliberation in Ecosystem-based Management, *Environmental Impact Assessment Review*, 16(2), pp. 71-102.

Davidson, C.H. (1998) The Information Problem in Building – Causes and Effects, in C.H. Davidson (ed): *Information in the Building Industry - Problems and Solutions*, Module 2, First Edition, IF Research Corporation and CIB, Montreal (available at: http://www.grif.umontreal.ca/pages/modul2.htm) (accessed on 27.10.2005).

Davis-Case, D., Granholm, H. and Voipio V. (eds) (1992) *Planning and Management of Participatory Forest Projects*, Vol. 2, Forestry Training Programme, Helsinki.

Dawood, N., Scott, D., Sriprasert, E., and Mallasi, Z. and (2005) The Virtual Construction Site (VIRCON) Tools: An industrial evaluation, *ITcon*, Vol. 10, pp. 43-54 (available at: http://www.itcon.org/data/works/att/2005_5.content.01487.pdf] (accessed on 10.06.2005).

Dawson, D. (2003) One Community or Two Solitudes: Epistemology, and Praxiology of Canadian and American Leisure Research, *Journal of Leisure Research*, 35(3), pp. 325-330.

De Beer, C.S. (1994) Disciplines, Professions and Practices, in C.S. de Beer, C.S. and A.P.J. Roux (eds): *Theory, Practice and the Professions*, Papers presented at an interdisciplinary symposium at the Department of Information Science, University of South Africa, 24-25 August, 1992, pp.5-16.

Del Furia, L. and Wallace-Jone, J. (2000) The effectiveness of provisions and quality of practices concerning public participation in EIA in Italy, *Environmental Impact Assessment Review*, 20(4), pp. 457-479.

Dell'Isola, A. (1997) *Value Engineering: Practical Applications for Design, Construction, Maintenance and Operations*, RS Means, Kingston, MA.

Devine-Wright, P., Fleming, P.D. and Chadwick, H. (2001) Role of social capital in advancing regional sustainable development, *Impact Assessment and Project Appraisal*, 19(2), pp. 161-167.

Diesendorf, M. (2000) Sustainability and sustainable development, in D. Dunphy, J. Benveniste, A. Griffiths and P. Sutton (eds) *Sustainability: The corporate challenge of the 21st century*, Allen & Unwin, Sydney, pp. 19-37.

Dimitrijevic, B. and Davidson, C. (2004) *Agenda 21: Information and Documentation – A Research Agenda*, Performance Based Building Thematic Framework, PeBBu Domain 9: Information and Documentation (available at: http://www.pebbu.nl/maincomponents/ scientificdomains/terminateddomains) (accessed on 14.10.2004).

Dooley, J.H. and Fridley, J.L. (1998) *Stakeholder influence on design of aquatic habitats*, Presentation at the 1998 ASAE Annual Meeting, July 12-16, Orlando, Florida (available at: http://www.elwdsystems.com/pdf/dooley_fridley.pdf) (accessed on 19.05.2004).

Dower, N. (1998) Development Ethics, in R. Chadwick (ed): *Encyclopaedia of Applied Ethics*, Academic Press, San Diego, Vol. 1, pp. 755-766.

Dresner, S. (2002) *The Principles of Sustainability*, Earthscan Publications Ltd., London.

du Plessis, C. (2005) Action for sustainability: preparing an African plan for sustainable building and construction, *Building Research and Information*, 33(5), pp. 405-415.

du Plessis, C. (2002) *Agenda 21 for Sustainable Construction in Developing Countries*, A discussion document, CIB & UNEP-IETC, CSIR Boutek Report No Bou/E0204, Pretoria.

du Plessis, C. (2001) Sustainability and sustainable construction: the African context, *Building Research and Information*, 29(5), pp. 374-380.

du Plessis, C. (1999) Sustainable development demands dialogue between developed and developing worlds, *Building Research and Information*, 27(6), pp. 378-389.

Duncan, T. (1994) Principles of sustainable development, in *Off course: Restoring the balance between Canadian society and the environment*, International Development Research Centre (IDRC), Ottawa, pp. 57-66.

Durban Metro (1999) *Durban Sustainability Indicators*, Durban Metro State of the Environment and Development (available at: http://www.ceroi.net/reports/durban/ indicatr/aboutind.htm) (accessed on 07.08.2003).

Egan, J. (Construction Task Force) (1998) *Rethinking Construction*, DETR, UK.

Eggenberger, M. and Partidário, M.R. (2000) Development of a Framework to Assist the Integration of Environmental, Social and Economic Issues in Spatial Planning, *Impact Assessment and Project Appraisal*, 18(3), pp. 201-207.

Eigenraam, M., Ridley, A., Stoneham, G., Howden, P., Barr, N., Beverly, C. and Avery, A. (2000) *Testing current recommended practice for long-term sustainability: Landmark Sustainability Indicators Review*, MDBC Landmark Project, Task 3, Phase I, Department of Natural Resources and Environment, East Melbourne (available at: http://www.landmark.mdbc.gov.au/d_loads/d_loads.htm) (accessed on 28.01.2003).

Enk, G.A. and Hornick, W.F. (1983) Human Values and Impact Assessment, in F.A. Rossini and A.L. Porter (eds): *Integrated Impact Assessment*, Westview Press, Boulder, Colorado, pp. 56-71.

Enserink, B. and Monnikhof, R.A.H. (2003) Information Management for Public Participation in Co-design Process: Evaluation of a Dutch Example, *Journal of Environmental Planning and Management*, 46(3), pp. 315-344.

Environment Agency (2004) *Sustainable Construction: Position Statement*, (available at: http://www.environment-agency.gov.uk) (accessed on 29.04.04).

Erickson, P.A. (1979) *Environmental Impact Assessment: Principles and Applications*, Academic Press Inc., New York: London.

Faludi, A. (1986) *Critical Rationalism and Planning Methodology*, Pion Limited, London.

Faludi, A. (1973) *Planning Theory*, Pergamon Press, New York.

Farrell, A. and Hart, M. (1998) What does sustainability really mean? The search for useful indicators, *Environment*, 40(9), pp. 4-12.

Fowles, B. (2000) Transformative Architecture: A Synthesis of Ecological and Participatory Design, in W. Fox (ed): *Ethics and the Built Environment*, Professional Ethics, Routledge, London: New York, pp.102-114.

Frick, T. (1998) *R690: Application of Research Methods to IST Issues*, Instructional Systems Technology, Indiana University (available at: http://education.indiana.edu/ist/ courses/r690.html) (accessed on 05.11.2004).

Friedman, J. (1998) The New Political Economy of Planning: The Rise of Civil Society, in M. Douglas and J. Friedman (eds): *Cities for Citizens: Planning and the Rise of Civil Society in a Global Age*, Wiley, Chichester, England, pp. 19-35.

Fuggle, R.F. and Rabie, M.A. (1992) *Environmental Management in South Africa*, Juta & Co, Wetton.

Gann, D.M. (2003) Trading Places – Sharing Knowledge about Environmental Building Techniques, in R.J. Cole and R. Lorch (eds): *Buildings, Culture and Environment: Informing Local and Global Practices*, Blackwell Publishing Ltd., Oxford, pp. 37-56.

Gann, D.M., Salter, A.J. and Whyte, J.K. (2003) Design Quality Indicator as a tool for thinking, *Building Research and Information*, 31(5), pp. 318-333.

Gasparski, W.W. (1996) Praxiology and Ethics: The Business Ethics Case, in L. Ryan and W.W. Gasparski (eds): *Human Action in Business: Praxiological and Ethical Dimensions*, Praxiology: The International Annual of Practical Philosophy and Methodology Series, Transaction Publishers, pp. 3-19.

George, C. (1999) Testing for Sustainable Development through Environmental Assessment, *Environmental Impact Assessment Review*, 19(2), pp.175-200.

George, C. (2001) Sustainability appraisal for sustainable development: integrating everything from jobs to climate change, *Impact Assessment and Project Appraisal*, 19(2), pp. 95-106.

Ghauri, P. and Grønhaug, K. (2002) *Research Methods in business studies: A practical guide*, Prentice Hall, Harlow, UK.

Gibberd, J. (2003) *Integrating sustainable development into briefing and design processes of buildings in developing countries: an assessment tool*, Thesis Submitted in Partial Fulfilment of the Requirements of the Degree of Doctor of Philosophy in Architecture, Faculty of Engineering, Built Environment and Information Technology, University of Pretoria (available at: http://upetd.up.ac.za/thesis/available/etd-06142004-144252/) (accessed on 20.05.2005).

Gibberd, J. (2002) The Sustainable Building Assessment Tool: Assessing how buildings can support sustainability in developing countries, Paper presented during the *Built Environment Professionals Conference*, Sandton, Johannesburg, South Africa (available at: http://www.csir.co.za/akani/2002/nov/gibberd_sandton.pdf) (accessed on 03.06.2004).

Gibson, R.B. (2001) *Specification of sustainability-based environmental assessment decision criteria and implications for determining "significance" in environmental assessment*, Canadian Environmental Assessment Agency Research and Development Programme (available at: http://www.sustreport.org/downloads/Sustainability,EA.doc) (accessed on 27.07.2004).

Gilbert, A. (1996) Criteria for Sustainability in the Development of Indicators for Sustainable Development, *Chemosphere*, 33(9), pp. 1739-1748.

Gilham, A. (1998) Strategies for Change – Understanding Sustainable Development from a Construction Industry Perspective, in *Proceedings of the CIB World Building Congress: Construction and the Environment*, 7-12 June, Gävle, Sweden.

Glaser, B.G. and Strauss, A. (1967) *The Discovery of Grounded Theory: strategies for qualitative research*, Aldine de Gruyter, New York.

Goodland, R. and Daly, H. (1995) Environmental Sustainability, in F. Vanclay and D.A. Bronstein (eds): *Environmental and Social Impact Assessment*, International Association of Impact Assessment, John Wiley & Sons Ltd, Chapter 14, pp. 303-322.

Graham, P. (1998) Using Environmental Assessment Techniques to get the Big Picture: A review of current techniques in the context of sustainable construction, *Proceedings Green Building Challenge*, Vancouver, NRC Canada, October.

Groăk, S. (1992) *The Idea of Building: Thought and action in the design and production of buildings*, E & FN Spon, London.

Grobler, L.J., Knoetze, T. and Truter, R. (1997) *BEARS Building Environmental Assessment and Rating System for South Africa: For existing commercial buildings*, Version 1.1, CSIR Building and Construction Technology, Pretoria.

Grygianiec, M. (n.d.) *The reistic, or concretistic, approach: Tadeusz Kotarbisnki*, Athenaeum Reading Room (available at: http://evans-experientialism.freewebspace.com/kotarbinski02.htm) (accessed on 06.11.2004).

Hamam, R. (1999) *Towards Sustainability via Participation? Environmental evaluation* and land use planning in the Garden Route, South Africa, Unpublished MSc dissertation, UCT.

Hampton, D. (n.d.) Sense and Sustainability, *Construct Focus*, Issue 4, CIOB website (available at: http://www.constructfocus.com/issue4/management.php+hampton+Sir+Neville+Simms+&hl=en) (accessed on 21.07.2005).

Harashina, S. (1995) Environmental Dispute Resolution Process and Information Exchange, *Environmental Impact Assessment Review*, 15(1), pp. 69-80.

Hardi, P. and Zdan, T. (1997) *Assessing Sustainable Development: Principles in Practice*, The International Institute for Sustainable Development, Canada.

Hart, M. (1997) *Sustainable Community Indicators Training Manual, Sustainable Measures*, North Andover, MA (available at: http://www.sustainablemeasures.com/Training/pdf/HEDTrMan.pdf) (accessed on 02.08.2003).

Hawken, P. (1993) *The Ecology of Commerce.* Harper, New York.

Häkkinen, T. (2001) *Cite-related Sustainability Indicators: State-of-the-art*, CRISP (available at: http://crisp.cstb.fr/PDF/reports/stateofartmaaliskuu.pdf) (accessed on 22.112002).

Hedehus, P. (2002) Maximum Environmental Benefit for Money, in *Proceedings of the 3rd International Conference on Sustainable Building*, Oslo, 23-25 September (CD Rom, Paper No. 317, Abstract p. 393).

Hediger, W. (1999) Reconciling 'weak' and 'strong' sustainability, *International Journal of Social Economics*, 26(7-9), pp. 1120-1143.

Heifetz, R.A., and Sinder, R.M. (1988) Political leadership: Managing the public's problem solving, in R.B. Reich (ed): *The Power of Public Ideas*, Harvard University Press, Cambridge, pp. 179-203.

Hill, R.C. (2004) *Theory for the Practice of Environmental Assessment: Mutual Adjustment, Critical Rationality and Power in Planning and Decision Making*, An Unpublished PhD Thesis, Department of Environmental and Geographical Science, Faculty of Science, University of Cape Town, March 2004.

Hill, R.C. (1999) *Report on August 1998 conference in South Africa on Sustainability in the Built Environment*, Department of Environmental and Geographical Science, University of Cape Town.

Hill, R.C. and Bowen, P. (1997) Sustainable construction: principles and a framework for attainment, *Construction Management and Economics*, 15(3), pp. 223-239.

Hill, R.C., Pienaar, J., Bowen, P.A., Kusel, K. and Kuiper, S. (2002) The transition to sustainability in the planning, construction, and management of the built environment in South Africa, *International Journal of Environmental Technology and Management*, 2(1-3): 200-224.

Hoch, C. (1984) Doing good and being right, *Journal of the American Planning Association*, 48(4), pp. 333-345.

Holdren, J.P., Daily, G.C. and Ehrlich, P.R. (1995) The meaning of sustainability: biogeophysical aspects, in M. Munasinghe and W. Shearer (eds): *Defining and Measuring Sustainability: The Biogeophysical Foundations*, The United Nations University and The World Bank, Washington DC, pp. 3-17.

Hughes, R. (1998) Environmental Impact Assessment and Stakeholder Involvement, *Environmental Planning Issues*, No. 11, International Institute for Environment and Development (available at: http://www.iied.org/docs/spa/epi11.pdf) (accessed on 12.08.2004).

Institute for Building Environment and Energy Conservation (2004) *CASBEE – Comprehensive Assessment System for Building Environmental Efficiency*, JSBC Japan Sustainable Building Consortium (available at: http://www.ibec.or.jp/CASBEE/english/ detail2.htm) (accessed on 18.05.2004).

International Council for Research and Innovation in Building and Construction (CIB) (1999) *Agenda 21 on Sustainable Construction*, CIB Publication 237 (available at: http://www.cibworld.nl/pages/begin/AG21.html) (accessed on 16.04.2004).

International Union for Conservation of Nature and Natural Resources (IUCN) (1991) *Caring for the Earth: A Strategy for Sustainable Living*, IUCN, UNEP, WWF, Gland, Switzerland.

International Union for Conservation of Nature and Natural Resources (IUCN) (1980) *World Conservation Strategy: Living Resources Conservation for Sustainable Development*, Gland, Switzerland.

Jasch, C. (2000) Notes from the Field: Environmental performance evaluation and indicators, *Journal of Cleaner Production*, 8(1), pp. 79-88.

Johnson, B.L. (1999) Introduction to the special feature: adaptive management - scientifically sound, socially challenged? *Conservation Ecology*, 3(1):10 (available at: http://www.consecol.org/vol3/iss1/art10) (accessed on 21.07.2005).

Kaatz, E., Bowen, P.A., Hill, R.C., Shakantu, W., Root, D. and Opperman, L. (2003) *The Sustainability Assessment of Buildings: A Proposed Model – The Biophysical Component*, Department of Construction Economics and Management, University of Cape Town, Unpublished Report.

Kagioglou, M., Cooper, R., Aouad, G. and Sexton, M. (2000) Rethinking Construction: The Generic Design and Construction Project Protocol, *Engineering, Construction and Architectural Management*, 7(2), pp. 141-153.

Kagioglou, M., Cooper, R., Aouad, G., Hinks, J., Sexton, M. and Sheath, D.M. (1998) *A Generic Guide to the Design and Construction Process Protocol*, University of Salford.

Kalay, Y.E. (1999) Performance-based design, *Automation in Construction*, 8(4), pp. 395-409.

Kaplan, A. (1964) *The Conduct of Inquiry*, Chandler Publishing Company, San Francisco, California.

Kashyap, M., Khalfan, M.M.M. and Zainul-Abidin, N. (2003) A proposal for achieving sustainability in construction projects through concurrent engineering, in *Proceedings of COBRA 2003*, Conference organized by RICS foundation, University of Wolverhampton, pp. 127-138.

Kerlinger, F.N. (1986) *Foundations of Behavioural Research*, 3rd Edition, CBS Publishing Japan Ltd, New York.

Khalfan, M. *et al.* (2003) *Sustainability and the Process Protocol*, Presentation by Loughborough University Team, C-Sand Meeting, LSE, 16 September 2003 (available at: http://www.c-sand.org.uk/Research/Sustainability_ProcessProtocol_files/frame.htm) (accessed on 27.09.2004).

King Committee on Corporate Governance (2002) *King Report on Corporate Governance for South Africa (King Report II)*, Institute of Directors in Southern Africa, March 2002, South Africa.

Kirkpatrick, C. and Lee, N. (1999) Integrated Appraisal and Decision-Making, *Environmental Impact Assessment Review*, 19(3), pp. 227-232.

Kohler, N. (2003) Cultural Issues for a Sustainable Built Environment, in R.J. Cole and R. Lorch (eds): *Buildings, Culture and Environment: Informing Local and Global Practices*, Blackwell Publishing Ltd., Oxford, pp. 83-108.

Kolb, D.A. (1984) *Experiential Learning: Experience as the Source of Learning and Development*, Englewood Cliffs, Prentice-Hall, New York.

Kørnøv, L. and Thissen, W.A.H. (2000) Rationality in decision- and policy-making: implications for strategic environmental assessment, *Impact Assessment and Project Appraisal*, 18(3), pp. 191-200.

Kuhn, T.S. (1970) *The Structure of Scientific Revolutions*, University of Chicago Press, Chicago.

Larsson, N.K. (1998) *A Strategy for GBC-2000 and Beyond*, Natural Resources Canada, Ottawa.

Larsson, N.K. and Cole, R.J. (2001) Green Building Challenge: The development of an idea, *Building Research and Information*, 29(5), pp. 336-345.

Lawrence, D.P. (1997) The Need for EIA Theory-Building, *Environmental Impact Assessment Review*, 17(2), pp. 79-107.

Leaman, A. (2003) User Needs and Expectations, in R.J. Cole and R. Lorch (eds): *Buildings, Culture and Environment: Informing Local and Global Practices*, Blackwell Publishing Ltd., Oxford, pp. 154-176.

Lee, A., Cooper, R. and Aouad, G. (2000a) A Methodology for Designing Performance Measures for the UK Construction Industry, *Bizarre Fruit Postgraduate Research Conference on the Built and Human Environment*, Salford, 9-10 March, pp. 30-41.

Lee, A., Wu, S., Cooper, R. and Aouad, G. (2000b) The Process Protocol, a Solution for the Problems of Construction, *International Conference for Business Ethics*, New York.

Lee, N. (2002) Integrated Approaches to Impact Assessment: Substance or Make-Believe?, in *Environmental Assessment Yearbook 2002: The EA agenda for Johannesburg and beyond*, Institute of Environmental Management and Assessment, University of Manchester.

Leknes, E. (2001) The Roles of EIA in the Decision-Making Process, *Environmental Impact Assessment Review*, 21(4), pp. 309-334.

Levin, H. (1996) *Hal Levin reminds everyone what is sustainable*, Green Building Discussion, Environmental Building News (available at: http://www.buildinggreen.com/ elists/greencodes.html #gr01157) (accessed on 15.06.2001).

Lindstad, A., Baraz, S. and Hamza, M. (2002) A Green Promise: Pilot Green School – Roxburgh Park, Melbourne, Australia, in *Proceedings of the 3rd International Conference on Sustainable Building*, Oslo, 23-25 September (CD Rom, Paper No. 131, Abstract p. 210).

Livesey, C. (n.d.) *"A" Level Sociology A Resource-Based Learning Approach Theory and Methods*, Unit M3: Methodologies [1], Sociology Central (available at: http://www.sociology.org.uk/ctheory1.htm) (accessed on 05.11.2004).

Lombardi P.L. (2001) Responsibilities towards the coming generations: forming a new creed, *Urban Design Studies*, 7, pp. 89-102.

Luck, R. (2003) Dialogue in Participatory Design, *Design Studies*, 24(6), pp. 523-535.

Lustig, M., and Koester, J. (1993) *Intercultural Competence: Interpersonal Communication Across Cultures*, Harper Collins, New York.

Magee, B. (1998) *The Story of Philosophy*, Dorling Kindersley, London.

Mannheim, K. (1936) *Ideology and utopia: An introduction to the sociology of knowledge*, K. Paul Trench, Trubner & co., London.

McAllister, H.C. (nd) *Problem Solving and Learning* (available at: http://www2.hawaii.edu/ suremath/learn.html) (accessed on 03.02.2005).

McDonald, G.T. and Brown, L. (1995) Going Beyond Environmental Impact Assessment: Environmental Input to Planning and Design, *Environmental Impact Assessment Review*, 15(6), pp. 483-495.

Meadows, D. (2002) Dancing with Systems, *The Systems Thinker*, 13(2) (available at: http://www.sustainabilityinstitute.org/pubs/Dancing.html) (accessed on 20.04.04).

Meadows, D. (1998) *Indicators and Information Systems for Sustainable Development: A Report to the Balaton Group*, The Sustainability Institute, Hartland (available at: http://www.sustainabilityinstitute.org/pubs/Indicators&Information.pdf) (accessed on 25.03.2004).

Meadows, D.H., Meadows, D.L. and Randers, J. (1992) *Beyond the limits*, Post Mills VT, Chelses Green Publishing.

Meadows, D.H., Meadows, D.I., Randers, J., and Behrens III, W.W. (1972) *The Limits to Growth: A Report to The Club of Rome*, Potomac Associates, Washington, D.C.

Meppem, T. and Gill, R. (1998) Planning for Sustainability as a Learning Concept, *Ecological Economics*, 26(2), pp. 121-137.

Milner, S.J., Bailey, C., Deans, J. and Pettigrew, D. (2005) Integrated impact assessment in the UK- use, efficacy and future development, *Environmental Impact Assessment Review*, 25(1) pp. 47-61.

Monnikhof, R.A.H. and Edelenbos, J. (2001) Into the Fog? Stakeholder Input in Participatory Impact Assessment, *Impact Assessment and Project Appraisal*, 19(1), pp. 29-39.

Morgan, R.K. (1998) *Environmental Impact Assessment: A Methodological Perspective*, Kluwer Academic Publishers, Dordrecht, The Netherlands.

Morris, P.G.W. (1994) *The Management of Projects*, Thomas Telford, London.

Morrison-Saunders, A. and Bailey, J. (2000) Transparency in Environment Impact Assessment Decision-Making: Recent Developments in Western Australia, *Impact Assessment and Project Appraisal*, 18(4), pp. 260–270,

Morse, S., McNamara, N., Acholo, M. and Okwoli, B. (2001) Sustainability indicators: the problem of integration, *Sustainable Development*, 9(1), pp. 1-15.

Mouton, J. (1996) *Understanding Social Research*, J.L. van Schaik Publishers, Pretoria.

Mouton, J. (1990) On Values and Objectivity in Social Science, in J. Mouton and D. Joubert (eds): *Knowledge and Methods in the Human Sciences*, HSRC Series in Methodology, Human Research Council, Pretoria, pp. 39-54.

Mouton, J. and Marais, H.C. (1990) *Basic Concepts in the Methodology of Social Sciences*, HSRC Publishers, Pretoria.

Mulvihill, P.R. and Jacobs, P. (1998) Using Scoping as a Design Process, *Environmental Impact Assessment Review*, 18(4), pp. 351-369.

Newcombe, R. (2003) From client to project stakeholders: a stakeholder mapping approach, *Construction Management and Economics*, 21(8), pp. 841-848.

Nishioka, S. (1999) Fairness and Local Environmental Concerns in Climate Policy, in F.L. Toth (ed): *Fair Weather? Equity Concerns in Climate Change*, Earthscan, London, pp. 133-144.

Noble, B.F. (2002) The Canadian experience with SEA and sustainability, *Environmental Impact Assessment Review*, 22(1), pp. 3-16.

Noble, B.F. (2000) Strengthening EIA through Adaptive Management: A Systems Perspective, *Environmental Impact Assessment Review*, 20(1), pp. 97-111.

Norton, B.G. (1992) A New Paradigm for Environmental Management, in R. Costanza, B.G. Norton and B.D. Haskell (eds): *Ecosystem Health: New Goals for Environmental Management*, Island Press, Washington DC, pp. 23-41.

O'Riordan, T. (ed) (2000) *Environmental Science for Environmental Management*, Second Edition, Pearson Education Limited, Essex.

O'Riordan, T. and Sewell, W.R.D. (1981) Some Concluding Observations, in T. O'Riordan and W.R.D. Sewell (eds): *Project Appraisal and Policy Review*, John Wiley, Chichester, pp. 279-302.

O'Riordan, T. and Voisey, H. (eds) (1997) the Political Economy of Sustainable Development in *Sustainable Development in Western Europe: Coming to Terms with Agenda 21*, Frank Cass, London, pp. 1-23.

OECD (2003) *The OECD environment programme: Environmentally Sustainable Building: Challenges and Policies*, Executive Summary (available at: http://www.oecd.org/dataoecd/19/5/2715115.pdf) (accessed on 05.05.2004)

Ofori, G. (1998) Sustainable construction: Principles and a framework for attainment - comment, *Construction Management and Economics*, 16(2), pp. 141-145.

Ortolano, L. and Shepherd, A. (1995) Environmental Impact Assessment, in F. Vanclay and D.A. Bronstein (eds): *Environmental and Social Impact Assessment*, John Wiley & Sons Ltd, Sussex, England, pp. 3-30.

Paavola, J. and Adger, W.N. (2002) Knowledge and Participation for Sustainability? Science and Justice in Adaptation to Climate Change, *Proceedings of the Berlin Conference on Human Dimensions of Global Environmental Change*, 6-7 December 2002 (available at: http://www.fu-berlin.de/ffu/akumwelt/bc2002/proceedings/bc_2002_paavola.pdf) (accessed on 11.05.2004).

Pearce, A.R., and Fischer, C.L.J. (2001) *Resource Guide for Systems-Based Sustainability Analysis of Building 170*, Ft. McPherson, Atlanta, GA. Report to the Army Environmental Policy Institute, Atlanta, GA, May (available at: http://maven.gtri.gatech.edu/sfi/resources/ pdf/TR/TR038.PDF) (accessed on 15.04.2004).

Pearce, A.R. and Vanegas, J.A. (2002) Defining Sustainability for Built Environment Systems, *International Journal of Environmental Technology and Management*, Special Issue on Sustainability and the Built Environment, 2(1), pp. 94-113.

Pearce, D. (1995) *Blueprint 4: Capturing Global Environmental Value*, Earthscan, London.

Pearce, D.W., Atkinson, G.D. and Dubourg, W.R. (1994) The economics of sustainable development, *Annual Review of Energy and the Environment*, Vol. 19, pp. 457-74.

Pearce, D., Markandya, A. and Barbier, B. (1989) The Meaning of Sustainable Development in Blueprint for a Green Economy in *Blueprint for a Green Economy*, Earthscan, London, Chapter 2, pp. 28-50.

Peet, R. (1998) *Modern Geographical Thought*, Blackwell, Oxford.

Persson, U. (2002) Managing sustainable construction – A steering model for the building process, in *Proceedings of the 3rd International Conference on Sustainable* Building, Oslo, 23-25 September (CD Rom, Paper No. 056, Abstract p. 287).

Petrina, S. (in press) Organizing Knowledge for Instruction, in *Curriculum and Instruction for Technolog Teachers*, Chapter 2, pp. 54-87(available at: http://www.curricstudies.educ.ubc.ca/programs/tsed/research/books/C&I/booklayout/chap2.pdf) (accessed on 05.11.2004).

Pope, J. (2003) Sustainability Assessment: What is it and how do we do it?, *International Sustainability Conference on Regional Governance for Sustainability*, 17 - 19 September 2003, University of Notre Dame, Fremantle, Western Australia (available at: http://www.sustainability.dpc.wa.gov.au/conferences/refereed%20papers/Pope,J%20-%20paper.pdf) (accessed on 29.07.2004).

Pope, J., Annandale, D. and Morrison-Saunders, A. (2004) Conceptualising sustainability assessment, *Environmental Impact Assessment Review*, 24(6), pp. 595-616.

Popper, K.R. (1974) Replies to My Critics, in P.A. Schilpp (ed): *The Philosophy of Karl Popper*, Volume 1, Open Court, La Salle, Illinois, pp. 961-1197.

Porter, A.L. and Rossini, F.A. (1983) Why Integrated Impact Assessment, in F.A. Rossini and A.L. Porter (eds): *Integrated Impact Assessment*, Westview Press, Boulder, Colorado, pp. 3-16.

Post, R., Kolhoff, A. and Velthuyse, B. (1998) Towards Integration of Assessments, in *New Experiences on EIA in the Netherlands: Process, Methodology, Case Studies*, MER, Commission for Environmental Impact Assessment, Utrecht, pp. 27-33.

Post, R.A.M., Kolhoff, A.J. and Velthuyse, B.J.A.M. (1998) Towards Integration of Assessment with reference to Integrated Water Management Projects in Third World Countries, *Impact Assessment and Project Appraisal*, 16(1), pp. 48-53.

Pruitt, D.G. and Carnevale, P.J. (1993) *Negotiation in Social Conflict*, Open University Press, Buckingham.

Rao, S., Yates, A., Brownhill, D. and Howard, N. (2000) *EcoHomes: The environmental rating for homes*, BRE, Watford.

Rayner, S. and Malone, E.L. (2001) Climate change, poverty, and intragenerational equity: the national level, *International Journal of Global Environmental Issues*, 1(2), pp. 175-202.

Republic of South Africa: Government Communication and Information System (GCIS) (2001) Environmental Management, in *South African Yearbook 2001/2002*, Chapter 9, Universal Printers, Durban (available at: http://www.gcis.gov.za/docs/publications/ yearbook02/contents.pdf) (accessed on 22.07.2005).

Republic of South Africa: Department of Housing (2000) *National Housing Code* (available at: http://www.housing.gov.za/code/default.asp) (accessed on 27.09.2003).

Republic of South Africa (RSA) (1998) National Environmental Management Act (NEMA), Act No. 107, *Government Gazette*, No. 19519, Notice 1540, Government Printer, Pretoria.

Republic of South Africa (RSA) (1997a) Housing Act, No. 107, *Government Gazette*, No. 18521, Notice 1661, Government Printer, Pretoria.

Republic of South Africa (RSA) (1997b) The Identification Under Sections 21 of Activities Which May Have a Substantial Detrimental Effect on the Environment, *Government Gazette*, No. 5999, Notice 1182, Government Printer, Pretoria.

Republic of South Africa (RSA) (1996) Constitution of the Republic of South Africa, Act No. 108, *Government Gazette*, No. 17678, Notice 2083, Government Printer, Pretoria.

Republic of South Africa: Department of Finance (1996) *Growth, Employment and Redistribution: A Macroeconomic Strategy* (available at: http://www.finance.gov.za/documents/gear/all.pdf) (accessed on 20.07.2005).

Republic of South Africa (RSA) (1994) White Paper on Reconstruction and Development, *Government Gazette*, Notice 1954, No. 16085, Government Printer, Pretoria.

Republic of South Africa: Department of Environmental Affairs (DEA) (1992a) *Glossary of Terms Used in Integrated Environmental Management*, Guideline Document 6, Pretoria.

Republic of South Africa: Department of Environmental Affairs (DEA) (1992b) *Guidelines for Report Requirements*, Guideline Document 3, Pretoria.

Republic of South Africa: Department of Environmental Affairs (DEA) (1992c) *Guidelines for Scoping*, Guideline Document 2, Pretoria.

Richardson, D. (1997) The Politics of Sustainable Development, in S. Baker, M. Kousis, D. Richardson and S. Young (eds): *The Politics of Sustainable Development Theory, Policy and Practice within the European Union*, Global Environmental Change Series, Routledge, London, UK.

Ridgway, B.M. and Codner, G.P. (1994) *Design, Management and the Environment*, Presented at the International Association of Impact Assessment Annual Meeting, 14-18 June 1994, Quebee City, Canada.

Robinson, J., 2004. Squaring the Circle? Some thoughts on the idea of sustainable development, *Ecological Economics*, 48(4), pp. 369-384.

Roodman, D.M. and Lenssen N. (1995) *A Building Revolution: How Ecology and Health Concerns are Transforming Construction*, Worldwatch Paper 124, Worldwatch Institute, Washington, DC.

Root, D.S. (2000) *The Influence of Professional and Occupational Cultures on Project Relationships Mediated through Standard Forms and Conditions of Contract*, An Unpublished PhD Thesis, University of Bath, November 2000.

Ryd, N. (2004) Facilitating construction briefing – From the client's perspective, *Nording Journal of Surveying and Real Estate Research*, 1(1), pp. 86-101.

Saarikoski, H. (2000) Environmental Impact Assessment (EIA) as Collaborative Learning Process, *Environmental Impact Assessment Review*, 20(6), pp. 681-700.

Sadler, B. (1996) *Environmental Assessment in a Changing World: Evaluating Practice to Improve Performance*, International Study of the Effectiveness of Environmental Assessment, Final Report, Canadian Environmental Assessment Agency and International Association for Impact Assessment, Ottawa, Canada (available at: [http://www.iaia.org/Non_Members/EIA/EAE/EAE_10E.PDF) (accessed on 21.07.2004).

Salford University (2002) *Sustainability Management in the Process Protocol*, unpublished report.

Schumacher, E.F. (1974) *Small is Beautiful: A Study of Economics as if People Mattered*, Abacus Edition, Sphere Books, Ltd, London.

Scrase J.I. and Sheate W.R. (2002) Integration and integrated approaches to environmental assessment. What do they mean for the environment? *Journal of Environmental Policy and Planning*, 4(4), pp. 275-294.

SDCN (1999) SD Gateway, The Sustainable *Development Timeline* has been prepared by the International Institute for Sustainable Development as part of the Sustainable Development Communications Network (SDCN), (available at: http://www.sdgateway.net/introsd/timeline.htm) (accessed on 13.04.2004).

Seaden, G. (2003) The Role of the Client in Shaping the Satisfactory Outcome of the Construction Process, in R.J. Cole and R. Lorch (eds): *Buildings, Culture and Environment: Informing Local and Global Practices*, Blackwell Publishing Ltd., Oxford, pp. 130-153.

Shakantu, W, Kaatz, E. and Bowen, P. (2002) Partnering with Small, Micro- and Medium Enterprises (SMMEs) to meet socio economic sustainability objectives at Cape Town International Convention Centre (CTICC), in *Proceedings of the 1st International Conference on Creating a Sustainable Construction Industry in Developing Countries*, Stellenbosch, South Africa, 11-13 November, 2002, pp. 277-286

Sheath, D., Woolley, H., Cooper, R., Hinks, J. and Aouad, G. (1996) A Process for Change – the Development of a generic design and construction process protocol for the UK construction industry, in *Proceedings of the International Construction Information Technology Conference (InCIT'96)*, The Institution of Engineers, April, Sydney, Australia.

Shepherd, A. and Bowler, C. (1997) Beyond Requirement: Improving Public Participation in EIA, *Journal of Environmental Planning and Management*, 40(6), pp. 725-738.

Shepherd, A. and Ortolano, L. (1996) Strategic Environmental Assessment for Sustainable Urban Development, *Environmental Impact Assessment Review*, 16(4-6), pp. 321-335.

Simanowitz, A., Johnson, S. and Gaventa, J. (2000) *Making impact assessment more participatory*, Ford Foundation Sponsored Development Finance Impact Assessment Planning Workshop, Working Paper No. 2, Imp-Act, The Institute of Development Studies, University of Sussex, UK.

Sinclair, J. and Diduck A. (1995) Public Education: An Undervalued component of the Environmental Assessment Public Involvement Process, *Environmental Impact Assessment Review*, 15(3), pp. 219-224.

Smith, A.W. (2001) *Functional Specification Documents: A tutorial for creation and process* (available at: http://www.mojofat.com/tutorial/) (accessed on 17.01.2005).

Sowman, M., Fuggle, R. and Preston, G. (1995) A Review of the Evaluation of Environmental Evaluation Procedures in South Africa, *Environmental Impact Assessment Review*, 15(1), pp. 45-67.

Steiner, E. (1988) *Methodology of Theory Building*, Educology Research Associates, Sydney (available at: http://www.indiana.edu/~tedfrick/steiner/ theory1.pdf) (accessed on 29.10.2004).

Stern, D.G. (2003) The Practical Turn, in S.P. Turner and P.A. Roth (eds): *The Blackwell Guide to the Philosophy of the Social Sciences*, Blackwell Publishing, Oxford, pp.185-206.

Susskind, L.E. (1983) The Uses of Negotiation and Mediation in Environmental Impact Assessment, in F.A. Rossini and A.L. Porter (eds): *Integrated Impact Assessment*, Westview Press, Boulder, Colorado, pp. 154-169.

Talbot, R. (2003) *Sustainability and the Built Environment: Capacity Building in Scottish Local Government*, A Thirdwave Working Paper, Thirdwave Scotland Limited, Edinburgh (available at: http://www.thirdwave.org.uk/supportdocs/capbldg.pdf) (accessed on 26.04.2004).

Tasmanian State Government (2002) *Tasmanian Government Project Management Guidelines*, Version 5.0, Inter Agency Policy and Projects Unit, Government Information and Services Division, Department of Premier and Cabinet, Tasmania (available at: http://www.projectmanagement.tas.gov.au/) (accessed on 14.02.2005).

The European Commission (2001) *Sustainable Construction Final Report: The scale of the sustainability issues and challenges confronting the Construction Industry* (available at: http://europa.eu.int/comm/enterprise/construction/suscon/finrepsus/sucop1.htm) (accessed on 05.05.2004).

Thomson, D.S., Austin, S.A., Devine-Wright, H. and Mills, G.R. (2003) Managing value and quality in design, *Building Research and Information*, 31(5), pp. 334-345.

Todd, J.A., Crawley, D., Geissler, S. and Lindsey, G. (2001) Comparative assessment of environmental performance tools and the role of the Green Building Challenge, *Building Research and Information*, 29(5), pp. 324-335.

Toth, F.L. (2001) Decision Analysis for Climate Change: Development, Equity and Sustainability Concerns, *International Journal of Global Environmental Issues*, 1(2), pp. 223-240.

Turin, D.A. (2003) Building as a process, *Building Research and Information*, 32(2), pp.182-187.

Turner, B. (1988) Connoisseurship in the Study of Organisational Cultures, in Bryman, A. (ed): *Doing Research in Organisations*, Routledge, London, pp. 108-122.

Uher, T.E. (1999) Absolute Indicators of Sustainable Construction, in *Proceedings of COBRA 1999*, Conference organized by RICS foundation, University of Salford, UK, pp. 243-253.

UK Government Sustainable Development (n.d.) *Analysis of the Responses to the UK Government's Consultation Paper on Sustainable Construction*, (available at: http://www.sustainable-development.gov.uk/consult/construction/response/index.htm) (accessed on 05.05.2004).

United Kingdom: Highways Agency (2003) *Developing Performance Specifications Consultation Document* (available at: http://www.highways.gov.uk/roads/projects/misc/dps/01.htm) (accessed on 20.01.2005).

United Kingdom: Office of Government Commerce (2003) *Achieving Excellence in Construction Procurement Guide 03: Project procurement life cycle: the integrated process* (available at: http://www.ogc.gov.uk/sdtoolkit/reference/achieving/index.html) (accessed on 14.02.2005).

United Nation Environmental Programme (UNEP) (2002) *GEO: Global Environment Outlook 3: Past, present and future perspectives*, Earthscan (available at: http://www.unep.org/Geo/geo3/english/overview/012.htm) (accessed on 19.04.2004).

United Nations (1992) *Report of the United Nations Conference on Environment and Development*, UNCED Report.

United Nations (1990) *Bergen Ministerial Declaration on Sustainable Development in the ECE Region*, UN Document, A/CONF.151/PC/10.

United Nations Development Programme (UNDP) (1998) *Environmental Data Report*, pp. 66-85.

United Nations Human Settlements Programme (UN-HABITAT) (1996) *The Habitat Agenda*, Chapter 3: Commitments, Section B: Sustainable Human Settlements (available at: http://www.unhabitat.org/declarations/ch-3b.htm) (accessed on 28.04.2001).

United States Green Building Council (USGBC) (2003) *LEED Version 2.1 Registered Project Checklist* (available at: http://www.usgbc.org/Docs/LEEDdocs/LEED-NC%20checklist-v2.1.xls) (accessed on 05.04.2004).

United States Green Building Council (USGBC) (2002) *LEED Reference Guide*, Version 2.0 (available at: http://www.usgbc.org/LEED/publications.asp#LEEDRS20) (accessed on 24.08.2002).

van Wyk, L. (2004) Sustainable Construction Activities, Part 2 of *A Review of the South African Construction Industry*, CSIR Boutek, BOU/1343, Pretoria, South Africa.

van Wyk, L. (2003) Economic, Regulatory and Public Sector Capacity Influences on the Construction Industry, Part 1 of *A Review of the South African Construction Industry*, CSIR Boutek, BOU/1344, Pretoria, South Africa.

Vanegas, J.A. and Pearce, A.R. (2000) Drivers for Change: An Organizational Perspective on Sustainable Construction, in *Proceedings of the Construction Congress VI*, February 20-22, Orlando, FL.

Veleva, V., Hart, M., Greiner, T. and Crumbley, C. (2001) Indicators of Sustainable Production, *Journal of Cleaner Production*, 9(5), pp. 447-452.

Voinov, A.A. (1998) Paradoxes of Sustainability, *Journal of General Biology*, 59(2), pp. 209-218.

Voinov, A.A. and Smith, C. (1994) Dimensions of Sustainability, in *Ecosystem Health & Medicine*, 1st International Symposium, June 19-23, 1994, Ottawa, Canada.

Von Schirnding, Y. (2002) *Health in Sustainable Development Planning: The Role of Indicators*, World Health Organisation (available at: http://www.who.int/mediacentre/events/IndicatorsFrontpages.pdf) (accessed on 02.09.2003).

Von Weizsäcker, E. (2000) Efficiency and Justice, *Resurgence*, Issue 202, pp. 20-27.

Walker, B., Carpenter, S., Anderies, J., Abel, N., Cumming, G., Janssen, M., Lebel, L., Norberg, J, Peterson, G. and Pritchard, R. (2002) Resilience Management in Social-economic Systems: A Working Hypothesis for a Participatory Approach, *Conservation Ecology*, 6(1), 14p (available at: http://www.consecol.org/vol16/iss1/art14) (accessed on 23.04.2004).

Walker, D. and Hampson, K. (2003) Developing cross-team relationships, in D. Walker and K. Hampson (eds): *Procurement Strategies: A Relationship-based Approach*, Blackwell, Oxford, pp. 169-200.

Wathern, P. (ed) (1988) *An Introductory Guide to EIA in Environmental Impact Assessment: Theory and Practice*, Routledge, London: New York, pp. 3-30.

Webler, T., Kastenholz, H. and Renn, O. (1995) Public Participation in Impact Assessment: A Social Learning Perspective, *Environmental Impact Assessment Review*, 15(5), pp. 443-463.

Weterings, R. and Opschoor, J. B. (1994) *Towards Environmental Performance Indicators Based on the Notion of Environmental space*, Advisory Council for Research on Nature and the Environment, Rijswijk.

Whyte, J. and Gann, D.M. (2001) Forum: Closing the loop between design and use: Post-Occupancy Evaluation, *Building Research and Information*, 29(6), pp. 460-462.

Wideman, R.M. (2001) *Managing the Project Environment*, AEW Services, Vancouver, (available at: http://maxwideman.com/papers/projenviron/projenviron.pdf) (accessed on 12.05.2005).

Wikipedia (2005) *Answers.com*, GuruNet Corp. (available at: http://www.answers.com/topic/developed-country) (accessed on 22.07.2005).

Wilkins, H. (2003) The Need for Subjectivity in EIA: Discourse as a Tool for Sustainable Development, *Environmental Impact Assessment Review*, 23(4), pp.401-414.

Winch, G.M. and Carr, B. (2001) Processes, maps and protocols: understanding the shape of the construction process, *Construction Management and Economics*, 19(5), pp. 519-531.

Winch, G., Usmani, A. and Edkins, A. (1998) Towards total project quality: a gap analysis approach, *Construction Management and Economics*, 16(2), pp. 193-207.

Wood, C. (1995) *Environmental Impact Assessment: A Comparative Review*, Longman, Essex, England.

World Bank (1999) Public Consultation in the EA Process: A Strategic Approach, *Environmental Assessment Sourcebook Update*, No. 26, Washington, D.C.

World Bank (1996) Challenges of Managing the EA Process, *Environmental Assessment Sourcebook Update*, No. 18, Washington, D.C.

World Business Council for Sustainable Development (WBCSD) (2000) *Eco-efficiency: Creating more value with less impact* (available at: http://www.wbcsd.org/DocRoot/02w8IK14V8E3HMIiFYue/EEcreating.pdf) (accessed on 02.04.2003).

World Council on Environment and Development (WCED) (1987) *Our Common Future* – Brundtland Report, Oxford University Press, Oxford.

Wu, S., Fleming, A., Auoad, G. and Cooper, R. (2001) The Development of the Process Protocol Mapping Methodology, *First International Conference of Postgraduate Research in the Built and Human Environment*, 15-16 March, University of Salford, UK.

Zainul-Abidin, N., Khalfan, M.M.A. and Kashyap, M., (2003) Moving towards more sustainable construction, in *Proceedings of COBRA 2003*, Conference organised by RICS Research Foundation University of Wolverhampton, UK, pp. 88-102 .

Zaltman, G., Pinson, C.R.A. and Angelmar, R. (1977) *Metatheory and Consumer Research*, Holt, Rinehart and Winston, New York.

Zimmerman, A. and Martin, M. (2001) Post-Occupancy Evaluation: benefits and barriers, *Building Research and Information*, 29(2), pp. 168-174.

APPENDIX A

INFORMATION ON THE VALIDATION WORKSHOP

Date: 25 October 2005

Time: 13.00 – 16.00

Place: Postgraduate Seminar Room, Department of Construction Economics and Management, University of Cape Town (UCT)

List of participants:

Gita Goven – an architect specialising in sustainable design and a partner at ARG Design in Cape Town; Email: gita@argdesign.co.za, Tel.: +27 (0)21 488 2666

Sandy Rippon – a self-employed architect who co-operates with the Environmental Evaluation Unit at the Department of Environmental and Geographical Sciences, UCT; Email: rippon@enviro.uct.ac.za, Tel.: +27 (0)21 650 2879

Garth Blassipoles of KFD Wilkinson – a civil engineer who specialises in infrastructure projects (e.g. the new Domestic Departures Terminal at the Cape Town International Airport), a director of KFD Wilkinson Consulting Engineers; Email: kfdw@iafrica.com, Tel.: +27 (0)21 425 1610

Wayne van de Vent – a director of Futuregrowth Asset Management and a head of Property Team in Cape Town; Email: wayne@futuregrowth.co.za, Tel.: +27 (0)21 659 5430

Dr. Richard Hill – a lecturer at the Department of Environmental and Geographical Sciences, UCT; Email: hill@enviro.uct.ac.za, Tel.: +27 (0)21 650 2786

Workshop coordinator: Dr. David Root – a senior lecturer at the Department of Construction Economics and Management, UCT; droot@eng.uct.ac.za, Tel.: +27 (0)21 650 4456

Workshop Agenda:

13.00 – 13.30: Light lunch

13.30 – 14.00: PowerPoint presentation by Dr. David Root (refer to Appendix B)

14.00 – 16.00: Discussion

APPENDIX B

POWERPOINT PRESENTATION FOR THE VALIDATION WORKSHOP

A Model for Assessing Building Sustainability

Validation Workshop
25th October 2005

Dr Dave Root and Ms Ewelina Kaatz

UCT – Department of Construction Economics & Management

Objective of the Workshop

- Present a building sustainability assessment model to industry practitioners
- Validation of:
  - The assumptions used in the model's development
  - The logic of reasoning in the model
  - Relevance and applicability of selected principles and concepts
  - Potential effectiveness in producing desired outputs and outcomes

UCT – Department of Construction Economics & Management

Objective of the Workshop

- Functional Specification
  - Focus on the function/performance related aspects
  - Scenarios for the model's use
  - Potential users of the model
  - Not looking at the operationalisation of the model

UCT – Department of Construction Economics & Management

Workshop Questions (1)

- Are the three use scenarios recognisable to practitioners?
- Can the value of the model as a building process enhancement tool be easily recognised?
- Are the primary roles of the model (integration, transparency and accessibility, collaborative learning) reasonable?

UCT – Department of Construction Economics & Management

Workshop Questions (2)

- Would an assessment tool developed on these principles be likely to foster sustainability within the construction and property sectors?
- What aspects of building assessment are crucial in the South African context?
- Does the model satisfactorily accommodate the iterative nature of many design and management activities?

UCT – Department of Construction Economics & Management

Specifying a Building Sustainability Assessment Model

- Lessons gained from
  - Existing building assessment tools (BREEAM, LEED, GBTool, SPeAR and SBAT),
  - Environmental Assessment
  - Process Protocol
- Identification of key outcomes
- Outcomes used as main functions of the model

UCT – Department of Construction Economics & Management

Key Outcomes Identified

- *Integration* – of SD principles, stakeholder values and perspectives
- *Transparency & Accessibility* – open participation and communication competence
- *Collaborative Learning* – active involvement and knowledge transfer

UCT – Department of Construction Economics & Management

Integration

- Principles of sustainable development explicitly integrated with project goals and objectives
  - e.g. inter- and intra-generational equity
- Integration of sustainability conditions into the *problem definition & solution*
  - e.g. context, quality, self-sufficiency, regeneration, adaptability

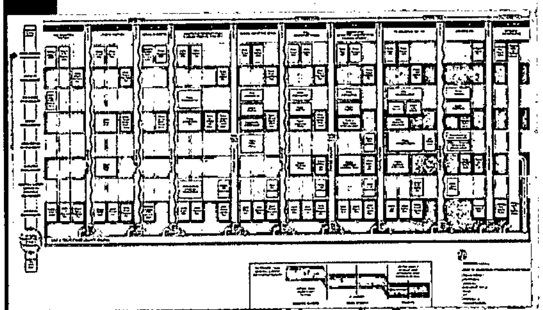
UCT – Department of Construction Economics & Management

Transparency & Accessibility

- Incorporation of the *process view* of building/infrastructure provision (Process Protocol)
- Transparency in the co-ordination of activities and allocation of responsibilities throughout the assessment process
  - Identification of decision-points and information needs (timing, format, content and source)
  - Use of process mapping to integrate the assessment with the project delivery process

UCT – Department of Construction Economics & Management

Process Protocol



UCT – Department of Construction Economics & Management

Transparency & Accessibility

- Elimination of potential barriers to participation – e.g., language barriers, knowledge gaps, sequential involvement in the process
  - Use of visual aids to communicate assessment results
  - Development of communication strategy and information management system

UCT – Department of Construction Economics & Management

Collaborative Learning

- Model as an educational medium for all stakeholders involved
  - Mutual development of a project vision and values
  - Mutual development of terms of reference for the assessment process
  - Scoping to facilitate problem-definition and problem-solving
  - Integrated design

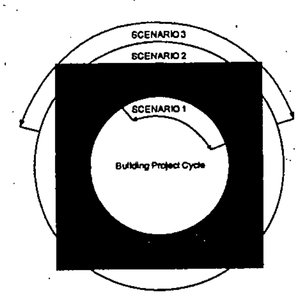
UCT – Department of Construction Economics & Management

Use Scenarios

- *Scenario 1*: Development of project proposal
- *Scenario 2*: Project sustainability appraisal
- *Scenario 3*: Building performance audit
- Project may embody more than one scenario
- Generic framework of the model customised to suit each application scenario

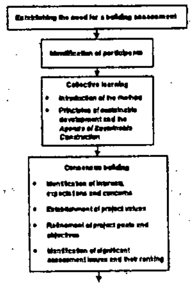
UCT – Department of Construction Economics & Management

Use Scenarios



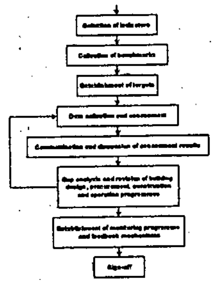
UCT – Department of Construction Economics & Management

Generic Representation of the Model (1/2)



UCT – Department of Construction Economics & Management

Generic Representation of the Model (2/2)



UCT – Department of Construction Economics & Management

Scenario 1: Development of a Building Project Proposal

- Opportunity to integrate socio-economic and biophysical objectives with strategic project goals
- Project vision based on SD principles and reflected in the business case and project brief
- Scoping: problem-definition & problem-solving
- Proposal grounded in the existing socio-economic context should respond to stakeholder neede and aim to enhance the natural environment
- Applicable to new and existing facilities

UCT – Department of Construction Economics & Management

Scenario 2: Building Project Sustainability Appraisal

- Building project sustainability appraisal – a dynamic evaluation and facilitation of activities that comprise a building project
- Assessment to correspond with and facilitate project decision-making (concerned with problem definition and co-production of problem solution)
- Localisation of the model within the building process (i.e. its adaptation into the project context)

UCT – Department of Construction Economics & Management

Scenario 2: Building Project Sustainability Appraisal

- Model to be introduced into the domain of project management
- Social and technical processes treated as complementary
- To check if sustainability objectives have been met and SD principles incorporated in the building process
- Process Protocol as a generic representation of a building project

UCT – Department of Construction Economics & Management

Scenario 2: Building Project Sustainability Appraisal

- Possible redesign of a traditional SD assessment framework (i.e. social, economic and environmental components) to reflect pro-active and effect-orientated character of appraisal
- Graphical illustration of progress in achieving SD objectives at subsequent stages of the building project cycle

UCT – Department of Construction Economics & Management

Scenario 3: Building Performance Audit

- Evaluation of building/infrastructure performance concerned with the quality of services and a building's impact and interaction with surroundings
- NB examination of existing context and determination of desired building performance in a goal-orientated manner
- Refinement of the assessment framework for the planning of building refurbishment

UCT – Department of Construction Economics & Management

Scenario 3: Building Performance Audit

- Difficulty in comparing total performance with that of other buildings (context-dependent)
- Possibility of benchmarking performance in specific areas (e.g. energy use or water consumption)
- Incorporation of sustainability thinking into the problem-solving

UCT – Department of Construction Economics & Management

Model's User Personas

- Model's successful application directly related to users' satisfaction with the assessment process and its outcomes
- Discussion of anticipated patterns of users' interactions with the model
- Identification of potential benefits, responsibilities, difficulties and challenges

UCT – Department of Construction Economics & Management

Model's User Personas

- Building client(s) and end-user(s)
- Planning and design team
- Implementation team
- Facility manager(s) and operator(s)
- Project management team
- Other interested and affected parties

UCT – Department of Construction Economics & Management

Benefits

- Immense opportunities for collaborative learning
- Improved communication between project stakeholders
- Better understanding of sustainability considerations and deepened commitment to project vision

UCT – Department of Construction Economics & Management

Challenges

- Necessity to overcome language barriers, knowledge gaps and cultural differences
- Conflict-avoidance mechanisms – esp. during the establishment of project values and the prioritisation of sustainability issues
- Need for individual/team research

UCT – Department of Construction Economics & Management

Concluding Remarks

- A '*tool for thinking*' (Gann *et al.*, 2003)
- Building assessment not perceived as an additional activity or phase in the building process but infused into project management
- Use of process maps to represent the model and facilitate the discussion of its functionality
- Emphasis shifts from building *assessment* to building *enhancement*

UCT – Department of Construction Economics & Management

Workshop Questions (1)

- Are the three use scenarios recognisable to practitioners?
- Can the value of the model as a building process enhancement tool be easily recognised?
- Are the primary roles of the model (integration, transparency and accessibility, and collaborative learning) reasonable?

UCT – Department of Construction Economics & Management

Workshop Questions (2)

- Would an assessment tool developed on these principles be likely to foster sustainability within the construction and property sectors?
- What aspects of building assessment are crucial in the South African context?
- Does the model satisfactorily accommodate the iterative nature of many design and management activities?

UCT – Department of Construction Economics & Management

APPENDIX C

THE FRAMEWORK OF SUSTAINABLE ISSUES AND ACTIVITIES OF A CONSTRUCTION PROJECT BASED ON DOOYEEWERD'S MODALITIES

Source: Zainul-Abidin, N., Khalfan, M.M.A. and Kashyap, M., (2003), pp. 94-100.

Modality	Sustainability activities within Process Protocol phases
1. Numerical	***Land use*** - Selection of area for development - Quantity of earth extraction (cut and fill) ***Quantity of materials*** - Avoid wastage of materials - Proportion of natural resources with reuse / salvage materials - Accurate calculation of quantity in BQ - Quantity of materials (in stock, delivery, on order) ***Energy consumption*** - Number of building services required, number of windows, etc. ***Workers welfare*** - Number of equipment / facilities required for employees (company car, mobile phone, computers, etc.) ***Form and space*** - Calculation of gross floor area (GFA), circulation area, height of building, number of floors, size of landscape, number of building services required, etc. - Accurate measurement in the design ***Whole life cost*** - Calculation of life cost for materials and building - Calculation / estimation of cost throughout the project ***Management and control*** - Time allocated for each activity - Calculation for cash flow, payments, etc. - Number of work packages ***Employment / Skill base*** - Number of consultants / designers appointed - Number of contractors / sub-contractors / suppliers ***Viability of the project*** - Estimation of potential profits - Estimation of benefits and costs of the project
2. Spatial	***Location / Land use*** - Study site topography, area for development and landscape area - Identify potential for future or extended development at the surrounding area ***Form and space*** - Schematic design (size, shape and space) - Consider space when deciding the gross floor area, circulation area and landscape area - Planning on parking spaces

2. Spatial (cont.)	***Management and control (site)*** - Space allocation on site for storage of material, plant and equipment; - Loading and unloading of equipment and materials, utilities, lorries, etc.
3. Kinematics	***Location*** - Availability of public transport nearby - Travel distance to site (by workers, users) - Distance to nearby services or facilities (restaurants, shops, petrol) - Easy access to site (does it require temporary access?) ***Transportation and movement*** - Distance, routes and means for materials delivery - Transportation for people at and to site - Travel plan to avoid traffic congestion - Arrangement on site to ease movement within the site compound - Promote car sharing ***User comfort and satisfaction*** - Ease of movement inside building (install services such as lift and escalators, spacious circulation area) - Good ventilation (air movement) ***Accessibility*** - Accessibility to building (entrance, transporting equipment, etc.) - Access for disabled people ***Employment*** - Select local contractors and suppliers (shorter travel distance)
4. Physical	***Location / Land use*** - Conduct site investigation (study topography, landscape, water course, soil, etc.) ***Material / Energy consumption*** - Reduce consumption of natural materials and more on recycled materials - Choose low-embodied energy materials ***Pollution control*** - Avoid pollution to water, air and ground ***Waste hierarchy*** - Effective handling, transporting and storing of material to avoid damage - Avoid over-purchase - Ensure waste material and products are capable of being recycled and used by others ***Ecology and biodiversity*** - Make use of natural beauty and resources (e.g. trees for shading and cooling effect) - Produce design which can blend well with its surrounding ***Heritage and amenity*** - Preserving heritage and cultural value - Optimal use of existing buildings (avoid total demolition, refurbish and maintain good structure) - Study local amenity - Produce quality structure ***Effective management and control*** - Optimum use of all sources of capital (natural, human, financial, social and manufactured) - Produce quality structures
5. Biological	***Land use*** - Avoid greenfield sites and promote the development of brownfield sites ***Materials*** - Avoid hazardous materials - Encourage the use of sustainable materials

5. Biological (cont.)	***Pollution control / Waste minimisation / Transportation*** - Avoid contamination to ground and water - Minimise pollution to air - Protect environment by reducing waste - Shorter travel distance to reduce air pollution ***Ecology*** - Protect natural habitat, ecosystem and natural areas - Preserve natural beauty ***Health and safety / Workers' welfare*** - Activate health and safety procedures - Provide safety equipment to workers - Impose health and safety regulations ***User comfort*** - Design for healthy indoor environment - Incorporate safety aspects in design ***Legislation compliance*** - Comply with all environmentally related legislations
6. Sensitive	***Material selection and energy consumption*** - Design for healthy indoor environment - Select materials from sustainable source and aim to reduce energy consumption (sensitive to natural source) ***Pollution control*** - Take action to reduce pollution caused by the construction activities ***Ecology and biodiversity / Heritage and amenity*** - Sensitive about natural habitat, heritage site, etc. ***User comfort / Satisfaction*** - Design user-friendly structures and for the needs of the disabled - Promote healthy indoor environment (avoid hazardous materials and equipment, good ventilation, regular cleaning and maintenance, etc.) - Be aware of special requirements of the building (e.g. effective noise barrier, allocation of large equipment) ***Workers' welfare / Learning opportunity*** - Provide training and workshops to improve knowledge and productivity - Improve workers' benefits - Provide technology and facilities to speed up work and improve efficiency - Provision of safety equipment ***Community welfare*** - Minimal disruption to local community (noise, dust and traffic) ***Aesthetic / Visual*** - Produce structure which have positive visual impact and bring harmony to its surrounding ***Effective management and control*** - Managing project in best possible way (make decision after careful consideration, choose best procurement route, appoint the most suitable consultants and contractors, choose best design, etc.) ***Viability / Social benefit / Business enhancement*** - Satisfying the needs of client - Satisfying the needs of society - Increase the value of project outcome (high quality, value for money)
7. Analytic	***Land utilisation*** - Collection of data from site investigation - Study previous use of the site - Analysis of land contamination (if any)

7. Analytic (cont.)	***Materials*** - Analysis of the best / most suitable / alternative materials to be used in the project - Consideration of life cycle cost for the materials ***Employment*** - Evaluation of background and experience of consultants / contractors before employment (especially experience with "sustainable" projects) ***Effective management and control*** - Make use of various tools and techniques to analyse, assess and evaluate performance or options - Make decisions after thorough evaluation - Continuously control and manage the project progress and cost - Collect data from feasibility study, environmental assessment, life cycle costs, risk and value analysis, etc.
8. Historical	***Workers' learning opportunity*** - Opportunity to gain knowledge on new technology - Improving skills through training and workshops ***Employment / Skill base*** - Disseminate knowledge and creativity in design (i.e. how to make use of natural resources (wind, trees, solar) optimally) - Use previous experience and relationships to handle the project - Experience with sustainable project is an advantage ***Effective management and control*** - Use previous data / projects as reference - Use of technology to improve and speed up project process
9. Communi-cative	***Form and space*** - Design should have distinctive features which inform the viewers of the building function ***Communication and information circulation*** - Use communication technology to bring people together and to circulate information - Documents and record keeping to store information for future reference - Put barrier around project site to acknowledge outsiders to keep out from the site which is normally dangerous - Put up signboard and safety signs to warn them of any danger ***Social and authority involvement*** - Appoint public relation officers to represent and communicate with the public on behalf of the developers - Liaison with authority in gaining approval
10. Social	***Social involvement*** - Interact with the local community to gain co-operation throughout the project - Maintain good relationships with local community ***Management and control / Communication*** - Bring people together and work as a team - Maintain effective communication and good relationship among project participants ***Social benefit / Viability*** - Produce buildings that bring benefits to society and clients and which can attract the buyers ***Legislation compliance*** - Maintain good relationship with authorities
11. Economic	***Location*** - Choose strategic location for development

11. Economic (cont.)	***Materials*** - Avoid wastage of material (reduce project cost) - Sell or re-use material wastes ***User comfort*** - Design for healthy indoor environment to attract buyers and customers - Improve value by improving quality and functions ***Workers' welfare and learning opportunity*** - Attend training to increase productivity / workmanship among workers ***Whole life cost*** - Design with the aim to reduce maintenance / operating cost ***Employment / Skills base*** - Evaluate background and financial stability of consultants and contractors before being appointed to avoid any difficulties at later stage ***Management and control*** - Maintain good and quality workmanship (reduce damage and maintenance cost) - Adopt effective site management - Adopt effective management and control to ensure smooth running of the project process ***Viability*** - Investigate market to ensure profitability or investment return - Design aesthetically pleasing structures to attract buyers and customers ***Social benefit / Cost*** - Proceed with development which can benefit the society i.e. which improves service in that area, can create more jobs, etc. ***Competitive effect / Business enhancement*** - Produce high quality, sustainable, state of the art buildings or structures to improve image of the industry and to enhance business opportunity for future projects ***Legislation compliance*** - Avoid legal costs and delay by complying to all related regulations
12. Aesthetic	***User comfort / Satisfaction*** - Positive internal design which makes the users feel comfortable and harmony ***Form and space*** - Careful selection of colours, form, layout and distribution of the building ***Aesthetic / Visual*** - Produce buildings which can bring positive visual impact to society and surrounding amenity - Produce building which can attract peoples (buyers, investors, customers)
13. Juridical	***Workers' welfare / Health and safety / Social welfare*** - Responsibility to protect workers (safety equipment, training, insurance, inspection of plant and machinery) - Responsibility to protect public from any harm from the site ***Employment (appointment of consultants / contractors)*** - Awarding contract through contract documents which describe the rights and responsibilities of the signing parties ***Legislation compliance*** - Be aware of all related legislation and comply with it - Sell or re-use waste material - Appoint legal advisors - Compliance to building guidelines or requirements when designing and constructing

14. Ethical	***Workers welfare*** - Treat workers with fairness and equally ***Social welfare*** - Have concern for neighbours (minimise disturbances, protect environment, minimise pollution, etc.) ***Employment / Management and control*** - Conduct project in a professional way (based on code of conduct) - Maintain good relationships among participants, authority and community
15. Credal	***Effective management and control*** - Continuous monitoring of project progress to keep it on track - Ensure that the aim and objectives are achievable - Commitment from all the project participants to ensure the success of the project