AN EVOLUTIONARY SYSTEMS APPROACH TO CONSTRUCTION ENGINEERING IN MOZAMBIQUE

Thesis by

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To my Parents

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ABSTRACT

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Mozambique was a Portuguese province governed in terms of Portuguese legislation and principles. After the Mozambican independence in June 1975, and during the decade thereafter, all Portuguese legislation were re-evaluated and replaced by new legislation based on socialist/communist philosophies, ultimately culminating in a centralised economy, which was governed according to Marxism/Leninism principles. In terms of this maxim, the primary objectives was to favour and protect state owned companies, resulting in the nationalisation of almost all of the private sector, thus eradicating competitiveness among the economic operators, and leaving the country to become one of the poorest in the world.

The implemented political philosophy and associated economic principles furthermore impacted so adversely on the economy that critical changes were required to save the economy from collapse. New economic and political reforms and directives were introduced, moving the country from a socialist orientation to an open economy, a process that was implemented with the support of the International Monetary Fund and the World Bank. This process was highly complex and arduous, culminating in more often than not, failed implementations in the various sectors of the economy. One such sector, the Construction Engineering Industry is faced with collapse as a result of the complexities of the transition process.

Against this background, 'corrective' economic legislation aimed to restructure the economy, was designed and implemented, only to result in high taxes and duties being paid by private companies. The present decline in foreign direct investment in the Construction Engineering Industry due to the current social and political uncertainty is of particular concern. More specific, the high interest bank rates on loans, the high duty rates for construction materials to be imported, the current judicial system which is viewed as ineffective in solving complex problems involving the industry, unfair labour laws which protect unproductive workers, and the high levels of bureaucracy, are all factors impacting adversely on any management effort to ensure the sustainability and growth of the Construction Engineering Industry in Mozambique.

The Southern African Development Community (SADC) was constituted with the aim of creating an integrated and harmonious development strategy for each of its member countries, due to the fact that each country has its own culture, political dispensation, judicial system, labour laws and economic and fiscal structures. As the Construction Engineering Industries within each SADC country, by implication are subjected to differentiated operating environments and unique complexities, the solution as proposed by the SADC has the potential to culminate in a feasible option for the industry as a whole. For the Construction Engineering Industry of Mozambique however, the proposed solution of the SADC would not serve as a viable or feasible solution. This is due to the fact that the Construction Engineering Industry in Mozambique is not stable and close to collapse as a result of the plethora of inhibiting factors adversely impacting the industry. Against this background the research problem for this thesis reads as follow:

> *"The Construction Engineering Industry in Mozambique is operating within the context of an unstructured complex management paradigm, calling for an evolutionary solution to mitigate the complexities and ensure sustainability and growth"*

The primary objective of this thesis is to establish to what extent an evolutionary systems approach model could facilitate paradigmatic change in the management of

construction engineering in Mozambique to ensure its sustainability and growth. This objective will be met through:

- An in depth analysis of the complex phenomena pertaining to the construction engineering industry in Mozambique deploying the enquiry capabilities of the Biomatrix Systems Approach.
- Benchmarking the operating environments of the Construction Engineering Industries of South Africa and Mozambique.
- The formulation of an evolutionary, unique viable approach so structured to address the complexity associated with construction engineering in Mozambique. This evolutionary approach will be fundamentally based on the Systems Approach and associated Viable Systems Model, juxtaposed with this authors' own contribution, to ultimately facilitate paradigmatic change in the Mozambican Construction Engineering Industry to mitigate the research problem set for this thesis.

For the purpose of clarity, 'Engineering Construction' as it is known in the South African context, is commonly referred to within the Mozambican context as 'Construction Engineering'.

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CHAPTER 1: SCOPE OF THE RESEARCH

CHAPTER 1

SCOPE OF THE RESEARCH

> *"…Whatever type of research or approach is adopted, there are several fundamental stages in the research process which are common to all scientifically based investigations".*
>
> ***Hussey & Hussey (1997)***

1.1 INTRODUCTION AND BACKGROUND

According to Waterhouse & Vijfhuizen (2001:16), Portugal began colonising Mozambique in 1505. As Portugal extended its influence over the territory, European settlers were subject to a set of formal written laws. Much of this was derived from Portuguese law. The indigenous population however was exempted from these laws, and were governed by custom law under the jurisdiction of local chiefs. In 1964 the Libertation Front of Mozambique (Frelimo), launched the struggle for liberation against colonial rule, which culminated in Mozambique's independence in 1975. As a result, a significant number of Portuguese settlers left the country, culminating in a severe shortage of experienced professional and skilled workers, as colonial rule imposed restricted educational opportunities for the African population (Waterhouse & Vijfhuizen, 2001:16).

After Mozambican independence, Frelimo embarked on a highly centralised, pro-socialist development program, which included the nationalisation of almost all of the private sector including land, the initiation of state farming and the socialisation of rural areas. The ultimate objective being to increase agricultural production and facilitate rapid industrialisation. In terms of this maxim, the primary objective of the Government was to favour and protect state owned companies, thus eradicating competitiveness among the economic operators. By the mid 1980's, it became clear that the government's agricultural policies were not working and were contributing

to an economic crisis, leaving the country to become one of the poorest in the world. This was also fuelled by sanctions imposed by the South African government of the time, further impacted upon by the war against the Mozambican National Resistance (Renamo), and sporadic droughts and floods.

The implemented political philosophy and associated economic principles, adversely impacted upon the sustainability of the Mozambican national economy, and in 1983 the government realised that changes should be urgently made in order to save the economy. New economic and political reforms and directives were introduced, whereby state control was reduced and structural adjustment programs accepted, thus moving the country from a socialist orientation to an open economy. These changes were facilitated solely with the support of the International Monetary Fund and the World Bank. This process was highly complex and arduous, with implementation infrastructures not correctly structured, adversely impacting upon the economy as a whole. Furthermore, this created a business environment which was extremely difficult to manage, with the Construction Engineering Industry, being one of the industries most adversely impacted upon, and which is facing inevitable decline and ultimate collapse.

Against this background, 'corrective' economic legislation aimed to restructure the economy was designed and implemented, only to result in high taxes and duties being paid by the private sector. To this extent, the present decline in foreign direct investment in the Construction Engineering Industry points to the current social and political uncertainty and is of particular concern if viewed against the potential collapse of business infrastructures. More specific, the high bank interest rates on loans, the high duty rates for construction materials to be imported, the current judicial system that is viewed as ineffective in solving complex problems involving the construction industry, unfair labour laws which protects unproductive workers, and the high levels of bureaucracy and corruption, are all factors impacting adversely on any management effort to ensure the sustainability and growth of the Construction Engineering Industry in Mozambique. The socioeconomic impact is equally diverse. Many formal sector jobs have been lost and few new jobs have been created. Furthermore, there has been a rapid 'informalisation' of the economy whereby only a

minority are benefiting from this economic growth, and there is a growing gap between the rich and poor.

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Systems Approach and associated Viable Systems Model to ultimately facilitate paradigmatic change in the Mozambican Construction Engineering Industry to mitigate the research problem set for this thesis.

1.2 THE SYSTEMS APPROACH: A HOLISTIC PERSPECTIVE

Churchman (1979:8) defines the systems approach as: "*…the only one approach to the way in which humans should respond to reality. It is one of the approaches based on the fundamental principle that all aspects of the human world should be tied together in one grand rational scheme, just as astronomers believe that the whole universe is tied together by a set of coherent laws"*

The 'systems approach' serves as holistic framework for a plethora of 'derived' systems falling within the context of the systems approach. It is acknowledged that various authoritative authors attribute various 'derived' systems as falling within the context of the systems approach, each culminating in a different format for the classification of such systems. As new systems dynamics develop over time, the classifications of systems falling within the ambit of the systems approach are expanded upon. The attention of the reader is drawn to the fact that the primary focus of this thesis will be centred on 'problem solving of real world phenomena'. To mitigate such real world phenomena, a solution will be formulated based on the ruling principles of the Systems Approach and associated Viable Systems Model, juxtaposed with this author's own contribution, ultimately culminating in the evolutionary systems approach, being applied as a solution to the research problem.

1.3 THE RESEARCH PROCESS

According to Hussey & Hussey (1997:15), there are several fundamental stages in research process, which are common to all scientific based investigations, namely:

- The identification of the research topic.
- Definition of the research problem.
- Determining how the research is going to be conducted.
- Collection of the research data.
- Analysis and interpretation of the research data.

- Writing up of the thesis.

Against the background of the fundamental stages of the research process as described by Hussey & Hussey (1997), the concept provides insight into 'how' the research will be conducted. Within the context of the research process, the 'research problem', the research questions and associated 'investigative questions' can be formulated.

The problem statement and associated research questions in this thesis will be approached using the question hierarchy of Emory & Cooper, (1995:56-59), adapted by this author to suit the requirements of the research study and graphically depicted in Figure 1.1 for ease of reference.

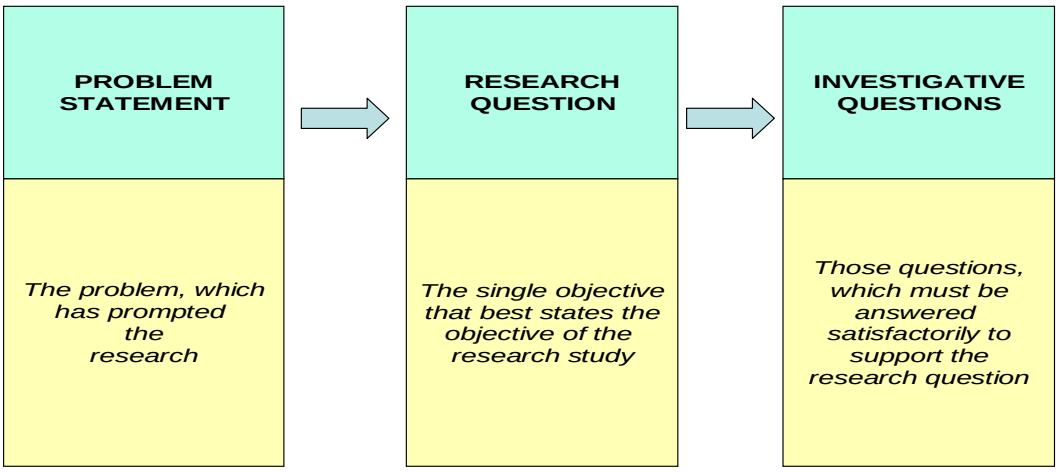

Figure 1.1: The Question Hierarchy. (Adapted from Emory and Cooper, 1995:56-59)

This question hierarchy approach, assumes the research problem statement to be composed of a hierarchy of questions with a descending level of specificity. The aim of the adapted question hierarchy is to achieve a focus on the research problem, as a result of increasingly descriptive questions.

1.3.1 The research problem

The obvious analogy which can be drawn from the background provided in the introductory paragraph to this thesis is that in Mozambique, the governmental, economic and business environments are impacting adversely upon construction

engineering companies, to the extent that companies in this industry can not be sustained, ultimately leading to closure. As a result, the research problem for this thesis reads as follows:

> *"The Construction Engineering Industry in Mozambique is operating within the context of an unstructured complex management paradigm, calling for an evolutionary solution to mitigate the complexities and ensure sustainability and growth"*

1.3.2 The research question

Research questions, according to Leedy & Ormrod (2001:60), "…provide another means for guiding and directing researchers' thinking and are more common in qualitative (phenomenological) studies". Within the ambit of qualitative research, Hussey & Hussey (1997:126), citing Kerlinger (1986), suggest that good research questions for quantitative (positivistic) research should, "…express a relationship between variables, be stated in ambiguous terms in question form, and imply the possibility of empirical testing".

Against the background of the formulated research problem, the research question for this thesis reads as follow:

> *"To what extent will an evolutionary Systems Approach facilitate paradigmatic change in the management of Construction Engineering in Mozambique, to ensure its sustainability and growth?"*

1.3.3 Investigative questions

In the support of the research question, the following investigative questions will be included in the research:

- How does the Biomatrix Systems Approach and the Viable Systems Model map to a holistic 'systems approach' perspective?

- To what extend can elements of the Biomatrix Systems Approach be deployed to act as an enquiry mechanism to ultimate culminate in an 'ideal design' for the Construction Engineering Industry in Mozambique?
- How can the Viable Systems Model serve as the primary mechanism in the formulation of the Evolutionary Systems Approach which will be mapped onto the (to be) formulated ideal design?

1.4 RESEARCH DESIGN AND METHODOLOGY

The research in this thesis refers to research in the 'social world' as opposed to in the 'physical and natural world'. Furthermore, the proposed research in the 'social world' will be 'theoretical' (as opposed to empirical), which will be based on the qualitative (phenomenological) paradigm. Within the context of this qualitative paradigm, the research will primarily utilise 'case study research', although certain elements of the concept of methodological triangulation will be used in instances were the case study method falls short of the research requirements. Case study research and methodological triangulation calls for closer scrutiny.

1.4.1 Case study research

Some of the more salient aspects of case study research described by Yin (2003), and which specifically pertain to this thesis are listed below for ease of reference:

- A case study is an empirical enquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident.
- Case study research aims not only to explore certain phenomena, but also to understand them in a particular context.
- 'How' and 'Why' questions are explanatory, and likely to be used in case study research.
- A case study illuminates a decision or set of decisions – why they were taken, how they were implemented, and with what result.
- The case study as a research strategy comprises an all-encompassing method – with logic of design incorporating specific approaches to data collection and

data analysis. In this sense, the case study is not either a data collection tactic or merely a design feature alone, but 'a comprehensive research strategy'.

- Case study research uses multiple methods for collecting data, which may be both qualitative and quantitative.
- A case study is typically used when contextual conditions are the subject of research.

According to Hussey & Hussey (1997:66), case studies are often described as explanatory research used in areas where there are few theories or a deficient body of knowledge as in the case of the Construction Engineering Industry in Mozambique. In addition, the following types of case studies can be identified:

- **Descriptive case studies:** Where the objective is restricted to describing current practice. Emory & Cooper (1995:11), in describing the essence and importance of descriptive research, point out that, "…the very essence of description is to name the properties of things: You may do more, but you cannot do less and still have description. The more adequate the description, the greater is the likelihood that the units derived from the description will be useful in subsequent theory building".
- **Illustrative case studies:** Where the research attempts to illustrate new and possibly innovative practices adopted by particular companies.
- **Experimental case studies:** Where the research examines the difficulties in implementing new procedures and techniques in an organization and evaluating the benefits.
- **Explanatory case studies:** Where existing theory is used to understand and explain what is happening.

Yin (2003:20-27), emphasises the following five components of a research design, which are especially important for case studies, more specifically the research contained within the ambit of this thesis.

- **Study questions:** The case study strategy is most likely to be appropriate for 'how' and 'why' questions, which calls for the initial task being to clarify precisely the nature of the study questions.

- **Study propositions:** A study proposition directs the attention to something that should be examined within the scope of the study. For greater clarity, the proposition points to the, 'reason for the study'.
- **Unit of analysis:** Should the case study involve a specific person being studied, say a person with a rare medical problem, the individual being studied is the primary unit of analysis. The tentative definition of the unit of analysis is related to the way in which the initial research questions were formulated.
- **Linking data to propositions:** A number of ways are open to link data to propositions. An approach suggested by Yin is that of 'pattern matching,' whereby several pieces of information from the same case may be related to some theoretical proposition.
- **Criteria for interpreting findings:** If the different 'patterns' are sufficient contrasting, the findings can be interpreted in terms of comparing at least two rival propositions.

1.4.2 Methodological triangulation

The concept of 'mixed methodologies' (also known as methodological triangulation) representing a taxonomy of research approaches can be applied to a diverse range of research studies. Methodological triangulation refers to research where both quantitative and qualitative research approaches are used for data collection. This culminates in diverse data collection techniques which can be juxtaposed in the likes of questionnaires, interviews, surveys and field studies. This approach is in particular popular in research pertaining to business and management, making it highly appropriate to the research in this thesis.

1.5 THE DEMAND FOR A QUALITATIVE RESEARCH STRATEGY

While this author acknowledges that a number of strategies can be applied in similar research projects, the well-known concepts of objectivity, reliability etcetera, inherited from the empirical analytical paradigm, are proposed for the research undertaken in this thesis to ensure that a qualitative research strategy is followed. Quoting Thorndike & Hagen, these concepts are defined by Emory & Cooper (1995:156), as follows:

- **Practicality:** Practicality is concerned with a wide range of factors of economy, convenience, and interpretability.
- **Validity:** Validity refers to the extent to which a test measures what one actually wishes to measure. Yin (2003), identifies 3 subsets to the concept validity, namely: 'Construct validity', 'internal validity' and 'external validity'.
- **Reliability:** Reliability has to do with the accuracy and precision of a measurement procedure.

1.6 RESEARCH CONSTRAINTS

The following research constraints pertain to this research, which primarily point to the fact that Mozambique is a developing third world country with little or no formal academic infrastructures:

- Lack of locally available literature on the Mozambican Construction Engineering Industry.
- Lack of appropriate and up-to-date government documentation explaining the ruling principles pertaining to economic and business operating environments.
- Resistance to the disclosure of important and confidential information and poor participation from key government leaders and some private sector managers in fear of being labelled 'anti-government'.

1.7 THE THESIS STRUCTURE

This thesis has been structured in such a way as to ensure adherence to the following concepts:

- The concepts presented within the thesis must flow logically from one part to the next in order to maximise reader comprehension of the various topics presented.
- Given the diverse nature of the respective literature review interpretations, the order of presentation must be such that the reader is equipped with a deeper understanding of each review interpretation presented. This is to ensure that the evolutionary systems approach formulated within the ambit the thesis is understood, particular the sub-entities thereof, as it relates to the various philosophies and processes imbedded therein.

For the reasons listed above, the individual chapters of this thesis have been grouped together in four separate parts namely:

Part 1: Consists of abstract and the scope of the research. Furthermore, this part contains literature reviews pertaining to the ruling principles of The Systems Approach, the Biomatrix Systems Approach, and the ruling principles of the Viable Systems Model. These concepts are analysed, due to the fact that:

- The Systems Approach forms the basis of systemic reasoning, is perfectly rational, and remains verbal, analytic, as well as synthetic, holistic and dynamic. Furthermore, it accepts non-measurable elements, in its very nature deals with dynamic behaviours as its focus is not on the individual parts, but on the interrelationship between these parts (Ballé 1994:36). The observation can be made while the world changes – and continues to change at an accelerated peace – it does not mean that we should abandon the quest for fundamental concepts *'such as the system approach'* (my italics), that stood the test of time (Collins and Porras 1998: xiv).
- The 'Biomatrix Systems Approach' forming the basis of 'the enquiry' for this thesis, which Dostal (2004) defines as "…an approach to a problem, which takes a broad view, which tries to take all the aspects into account, which concentrates on interactions between the different parts of the problem".
- The Viable Systems Model will be used for diagnosing 'problems' of organization, hence the term 'viable systems diagnosing' particularly those arising in complex probabilistic 'systems' that comprise purposeful organised parts and are open to a changing environment.

This part will be contained within the ambit of Chapter 1 (Scope of the Research), Chapter 2 (The Systems Approach: A Holistic Perspective), Chapter 3 (The Biomatrix Systems Approach) and Chapter 4 (The Viable Systems Model).

Part 2: In this part, an environmental impact analysis will be conducted on the Construction Engineering Industries of Mozambique and South Africa. This environmental impact analysis will be conducted within the ambit of Chapter 5, which will include a comparative analysis pertaining to each country. The South

African Construction Engineering Industry will furthermore be mapped to the Mozambican Construction Engineering Industry. In addition, real-world complexities as they pertain to the Mozambican Construction Engineering Industry will be identified.

Part 3: In this part, an analysis will be conducted on the complex phenomena within Construction Engineering in Mozambique. The analysis will be based on the application of enquiry elements contained with the context of the Biomatrix Systems Approach (refer Chapter 3) and the Viable Systems Model (refer Chapter 4). This analysis will be conducted within the ambit of Chapter 6.

Part 4: Two chapters fall within the ambit of Part 4 namely Chapter 7 and Chapter 8. In Chapter 7, forming the crux of this thesis, the formulation of an evolutionary systems approach will take place. This evolutionary Systems Approach will be formulated from carefully selected elements from the Systems Approach (refer Chapter 2), the Viable Systems Model (refer Chapter 4), juxtaposed with the author's own contribution to culminate in a viable application to the solution of the research problem and associated research questions. This part will be reflected in Chapter 8, where the research will be concluded and key analogies drawn.

1.8 CHAPTER AND CONTENT ANALYSIS

The chapter and content analysis of this thesis, is the following:

PART 1

CHAPTER 1: SCOPE OF THE RESEARCH: This chapter provides a high level overview of the Construction Engineering Industry in Mozambique, and how the current economic and business environment as well as the governing legislation impacts on its sustainability and growth. Furthermore, the chapter provides for a holistic overview of the research contained within the ambit of the thesis. The research process is explained, which leads into the formulation of the research problem, the research question and associated investigative questions. The research design and methodology (case study research) is elaborated upon, the research

constraints listed and the thesis structure explained. The chapter is concluded with a high level chapter and content analysis, and key research objectives.

CHAPTER 2: THE SYSTEMS APPROACH: A HOLISTIC PERSPECTIVE: In this chapter, a holistic perspective will be provided of the 'systems approach', the concept which will form the crux of the research in this thesis. The chapter will be introduced with an historical overview of the evolution of the systems approach and the formulation of the General Systems Theory. The concepts of 'system' and 'system approach' will be elaborated upon, leading into an analysis of the concept of 'cybernetics' were 'management cybernetics' a 'hard' systems methodology and 'organisational cybernetics' a 'soft' systems methodology are differentiated. Due to the fact that the ultimate objective in this thesis is to formulate an evolutionary systems approach (a model) to mitigate not only the research problem, but provide an answer to the research question, the 'role of models' will be analysed in detail. Furthermore, to place the research in perspective of the overall research, a classification of systems falling within the context of the 'systems approach' will be elaborated upon.

CHAPTER 3: THE RULING PRINCIPLES OF THE BIOMATRIX SYSTEMS APPROACH: In this chapter the ruling principles of the Biomatrix Systems Approach will be analysed. To place the Biomatrix Systems Approach in perspective of the overall theme of this thesis, a comparative analysis will be drawn between the Biomatrix Model and the General Systems Model. The evolutionary development of the Biomatrix Model will be explained, the theoretical underpinning to the concept namely the 'systems paradigm' will be expanded upon. The core component of the Biomatrix, namely that it is 'a process based systems approach' is in particular appropriate to serve as an enquiry system, leads into an analysis of the generic elements of the theory. Furthermore, a distinction will be drawn between 'activity' and 'entity' systems. The chapter will be concluded with a contextual analysis of the approach, whereby key elements pertaining to 'teleons' and 'doublets' will be explained and the concept summarised to provide a holistic perspective and to place the Biomatrix Model in context of the overall research in this thesis.

CHAPTER 4: THE RULING PRINCIPLES OF THE VIABLE SYSTEMS MODEL: In this chapter, the ruling principles as it pertains to the Viable Systems Model will be analysed in detail. The major underlying principle to the Viable Systems Model, namely 'organisational cybernetics' will be analysed and a perspective provided of 'management cybernetics'. The five functional components of the Viable Systems Model will be analysed in more detail to provide insight into the operational capabilities of the model. Due to the fact that the Viable Systems Model forms a key component of the evolutionary systems approach to be formulated in this thesis, an extensive evaluation of not only the strengths but also the weaknesses will be provided. In the same realm, another key component of the evolutionary systems approach to be formulated namely the general systems paradigm will be critiqued to provide insight into the weaknesses of the paradigm.

PART 2

CHAPTER 5: THE MOZAMBICAN AND SOUTH AFRICAN CONSTRUCTION ENGINEERING INDUSTRY ENVIRONMENTS: A COMPARATIVE ANALYSIS: In this chapter, the Construction Engineering Industry in Mozambique and South Africa will be analysed in detail. Furthermore, the complex problems and the negative impact of the current business and economic environment involving the Mozambican engineering industry will be analysed. A benchmarking approach will be utilised to map and compare the operating environments of the Construction Engineering Industries of both countries. This chapter will serve as background to the analysis of complex phenomena in Chapter 6.

PART 3

CHAPTER 6: ANALYSIS OF COMPLEX PHENOMENA WITHIN THE CONSTRUCTION ENGINEERING INDUSTRY IN MOZAMBIQUE: The analysis will be based on the application of enquiry elements contained within the context of the Biomatrix Systems Approach (refer Chapter 3) and Viable Systems Model (refer Chapter 4)

PART 4

CHAPTER 7: FORMULATION OF THE EVOLUTIONARY SYSTEMS APPROACH: Against the background of complex phenomena identified within the Construction Engineering Industry in Mozambique, an evolutionary systems approach (a model) will be formulated to mitigate the research problem and to provide an answer to the research question. The basis of this approach will be the 'systems approach' as described within the ambit of Chapter 2.

CHAPTER 8: RESEARCH CONSOLIDATION AND ROLLOUT APPROACH TO SADC COUNTRIES: In this chapter the research will be concluded and summarised and final conclusions drawn. Furthermore, this chapter will contain a reflective overview of the thesis and a summary of conclusions drawn from the analysis of how the Mozambican economic and business environment impact on the sustainability and growth of Construction Engineering Industry can be mitigated using the formulated evolutionary systems approach. Recommendations will also be made to extend the same management strategy approach formulated in this thesis to other SADC countries, to ensure sustainability and growth.

1.9 KEY RESEARCH OBJECTIVES

The key objectives of the author with this thesis and by implication forming the basis of any research undertaken at doctoral level according to Easterby-Smith *et al.* (2002:11) is:

- To make a significant contribution (add value) to the existing body of knowledge from the perspective of the academic reader in particular as it pertains to the Construction Engineering Industry of Mozambique.

The primary *raison d'être* for this thesis is to analyse, benchmark and compare the economic and business management environments as it pertains to the construction engineering industry in Mozambique to a more developed country, namely South Africa an SADC member. Furthermore, through this comparative analysis, formulate an evolutionary management strategy (a model) to bring about a paradigm shift in the

management of the Construction Engineering Industry in Mozambique, to ensure its sustainability and growth. Moreover, this concept will be extrapolated to other SADC countries, to benefit the sub-continent as a whole.

1.10 CLOSURE

In this chapter a high level overview was provided of the Construction Engineering Industry in Mozambique, and how the current economic and business environment as well as the governing legislation impact on its sustainability and growth. The chapter furthermore provided a holistic overview of the research contained within the ambit of the thesis. The research problem was stated leading into the formulation of the research question and associated investigative questions. The research design and methodology was elaborated upon, the research constraints listed and the thesis structure explained. The chapter was concluded with a high level chapter and content analysis and key research objectives.

In Chapter 2 the primary theme of this thesis, namely 'the systems approach' will be elaborated upon in terms of:

- A historical perspective of the concept.
- The general systems theory.
- The concept 'system' (defined).
- The concept 'systems approach' (defined).
- The concept Cybernetics (defined).
- The role of models.
- Classification of the systems falling within the context of the systems approach.

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CHAPTER 2: THE SYSTEMS APPROACH: A HOLISTIC PERSPECTIVE

CHAPTER 2

THE SYSTEMS APPROACH: A HOLISTIC PERSPECTIVE

> *"…what is in the nature of systems is a continuing perception and deception, a continuing re-viewing of the world, of the whole system, and of its components. The essence of the systems approach, therefore, is confusion as well as enlightenment. The two are inseparable aspects of human living".*
>
> ***Churchman (1968)***

2.1 INTRODUCTION

The mitigation approach to address the unstructured complex phenomena threatening the sustainability and growth of the Construction Engineering Industry in Mozambique will be based on the Systems Approach, which calls for an in-depth understanding of the ruling principles of the concept. This observation against the background of the fact that the original parameters of the Systems Approach, which was first mooted by Von Bertalanffy in 1947, culminated in a plethora of 'derivative' systems thinking paradigms falling within the auspices of the approach. Furthermore, to determine to what extent an approach would facilitate paradigmatic change in the management of construction engineering in Mozambique and to ensure its sustainability and growth, would call for a new evolutionary approach to be formulated, while remaining within the broader parameters of the 'Systems Approach'. More specific to the theme of this thesis and in line with the proposed formulation of an evolutionary Systems Approach to mitigate the research problem, a 'derivative' systems thinking paradigm, namely the Biomatrix System Approach (expanded upon in Chapter 3) will be deployed to facilitate the enquiry process to establish the elements and nature of the complex phenomena present within the Construction Engineering Industry of Mozambique.

The aim of this chapter is to focus on the 'systems approach' *per se*, providing the reader with insight into the ruling principles that govern the approach. Each of the following selected elements represent a theme or field of study that will be expanded upon in order to provide a holistic understanding of the concept:

- **Historical development of the systems approach:** Providing insight into the evolutionary development of the concept.
- **General System Theory:** Whereby a general conceptual framework is provided of the Systems Approach.
- **The concept 'system' defined:** In this part, the various definitions attributed to the concept 'system' will be expanded upon.
- **The concept 'systems approach' defined:** In this part, the various definitions attributed to the concept 'systems approach' will be provided.
- **'Cybernetics' defined:** Providing insight into the two cybernetic streams pertaining to 'management' and 'organisational' cybernetics. Both these entities will be taken up in the formulation of the evolutionary systems approach to be formulated in this thesis.
- **The 'role of models':** The ultimate objective of this thesis is to formulate 'a model' to serve as a basis for the proposed evolutionary systems approach to not only mitigate the research problem, but also to provide an answer to the research question.
- **Classification of systems falling within the context of the systems approach:** Summarising the various concepts expanded upon above, the classification of systems falling within the context of the systems approach, provides a holistic perspective of the dynamic forces within the greater ambit of the systems approach.

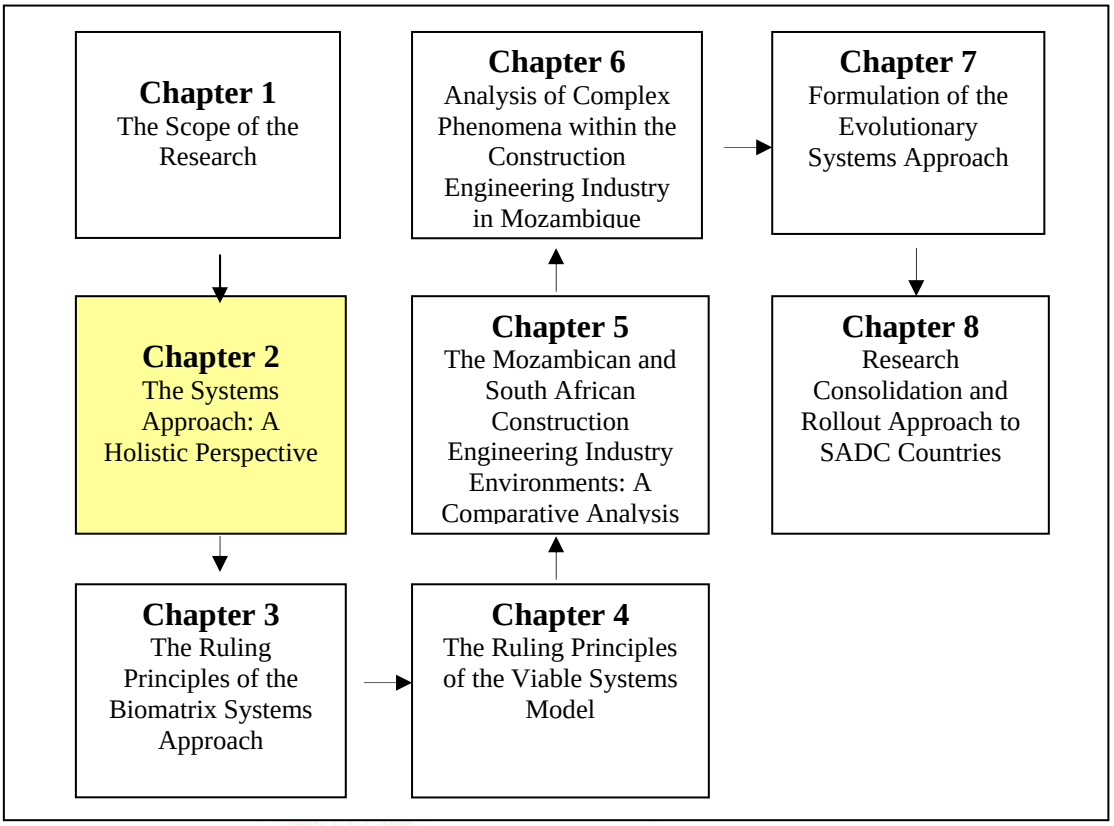

Figure 2.1: Chapters in context of the overall research

The analytical process followed thus far, is graphically depicted in Figure 2.1, which places the chapters in context with the overall thesis objectives, and furthermore indicates the relative positioning of this chapter.

2.2 HISTORICAL DEVELOPMENT OF THE SYSTEMS APPROACH

According to Von Bertalanffy (1973:xi), "… the systems theory is pre-eminently a mathematical field, offering partly novel and highly sophisticated techniques, closely linked with computer sciences, and essentially determined by the requirement to cope with a new sort of problem that has been appearing". Of the so called 'global theories', the one initially stated and defined by Bertalanffy in 1947, was termed the 'General Systems Theory'. This theory over time has been refined and modified to the extent of establishing the Society for General Systems Theory, the results of which was published in a General Systems Yearbook. Furthermore, Von Bertalanffy (1973:10) in the early 1920's, became puzzled about obvious lacunae in the research

and theory of biology. The then prevalent mechanistic approaches neglected or actively denied the phenomena of life itself. Bertalanffy advocated an organismic conception in biology, which emphasizes consideration of the organism as a 'whole' or 'system', and sees the main objective of biological sciences in the discovery of the principles of organization at its various levels.

Von Bertalanffy (1973:xviii), argues that the General Systems Theory is a scientific exploration of 'wholes' and 'wholeness', which were considered to be metaphysical notions transcending the boundaries of science. Novel conceptions, models and mathematical fields have developed to deal with them, such as dynamical system theory, cybernetics, automata theory, systems analysis by set, net, graph theory and others. The fact that modern technology and society have become so complex that traditional approaches were not sufficient, called for approaches of holism or systems, and generalist or interdisciplinary nature to be applied. As a result, the concept of the 'System Approach' became a requirement to mitigate complex interactive societal problems. Buckley (1967:6) is of the opinion that a revolutionary scientific perspective from the 'General Systems Research' movement and with a wealth of principles, ideas and insights that have already brought a higher degree of scientific order and understanding to many areas of biology, psychology and some physical sciences, modern systems research provide the basis of a framework more capable of doing justice to the complexities and dynamic properties of the socio-cultural system.

Von Bertalanffy (1973:9) is of the opinion that there were few preliminary works in the field of General Systems Theory. Notwithstanding this view, Köehler's physical *gestalten* (1924) aimed to achieve this objective but did not deal with the problem in full, restricting its treatment to *gestalten* in physics and biological and psychological phenomena. In a later publication (1927), Köhler raised the concept of a 'system theory', intended to elaborate upon the most general properties of inorganic compared to organic systems. To this extent, this demand was met by the 'theory of open systems'. Lotka's classic (1925) theory came closest to this objective with a general concept of systems (unlike Köhler's, restricted systems of physics). It was Köhler who was the first to give impulse towards the general systems theory in his

book entitled 'Die Physischen Gestalten in Ruhe im Stationären Zustand' (Von Bertalanffy, 1973:9) (Kramer & De Smith, 1977:3).

According to Von Bertalanffy (1973:13-15), Norbert Wiener's 'cybernetics' was mooted in 1948, resulting from the then recent developments of computer technology, information theory, and self-regulating machines. While it may be termed a coincidence, further fundamental 'Systems Approach' contributions appeared at about the same time, namely Shannon and Weaver's 'information theory,' which was formulated in 1949, and von Neumann and Morgenstern's 'game theory', which was formulated in 1947. Weiner carried the cybernetic, feedback and information concepts far beyond the fields of technology and generalised them for application within the context of the biological and social realms. Furthermore, cybernetics as the theory of control mechanisms in technology and nature and founded on the concepts of information and feedback, is but a part of a general theory of systems. According to Von Bertalanffy (1973:15) cybernetic systems are considered a special case, however important, of systems showing self-regulation.

Furthermore, Von Bertalanffy (1973:35) argues that while science tried to explain observable phenomena by reducing them to interplay of elementary units investigable independently of each other, conceptions appeared in contemporary science that were concerned with 'what is' somewhat vaguely termed 'wholeness' i.e. problems of organization, phenomena not resolvable into local events, dynamic interactions manifesting in the difference of behaviour of parts when isolated, or in a higher configuration in the likes of systems of various orders not understandable by investigation of their respective parts in isolation. Moreover, Von Bertalanffy (1973:36) is of the opinion that conceptions and problems of this nature have appeared in all branches of science, irrespective of whether inanimate things, living organisms, or social phenomena are the object of the study.

2.3 GENERAL SYSTEMS THEORY

The term 'General Systems Theory' was, according to Von Bertalanffy (1973:xvii) mooted by himself, deliberately, in a catholic sense. While one may limit the theory to the 'technical' meaning in the sense of mathematical theory, it would be

unadvisable in view of the fact that there are many 'system problems' requiring a 'theory', the latter which is not available in mathematical terms. According to Von Bertalanffy (1973:xviii) "…general system theory is a scientific exploration of the wholes and wholeness, which not so long ago were considered to be metaphysical notions transcending the boundaries of science". As a result, the 'General Systems Theory' is used broadly, similar to referring to the 'theory of evolution', which comprises everything between fossil digging, anatomy, and the mathematical theory of selection; or 'behaviour theory' extending from bird watching to sophisticated neurophysiological theories. The General Systems Theory was introduced prior to cybernetics, systems engineering and the emergence of related fields. In this context, Von Bertalanffy (1973:36) provides the following definition of the 'General Systems Theory':

> *"…General Systems Theory is a general science of 'wholeness' which up till now was considered a vague, hazy, and semi-metaphysical concept"*

According to Jackson (1991:48) citing Von Bertalanffy (1968), organisms should be studied as complex wholes. With the publication of Von Bertalanffy's work entitled '*The theory of Open Systems in Physics and Biology*' presented in Germany in 1950, Von Bertalanffy established, according to Jackson (1991:48) citing (Emery, 1969 and Lilienfeld, 1978), the Systems Theory as 'a scientific movement'. Jackson (1991:48-49) argues that Von Bertalanffy was important for establishing the notion of 'open systems', on a scientific basis. Furthermore, Jackson (1991:48-49) establishes Von Bertalanffy rightfully, as the 'father of the systems theory'.

Von Bertalanffy established in 1954 the 'Society for General Systems Theory' (Von Bertalanffy, 1973:13). This name was later changed to the 'Society of General Systems Research', which served as an affiliate of the American Association for the Advancement of Sciences. The aim of this association was the development of theoretical systems which were applicable to more than one traditional departments of knowledge, namely:

- To investigate the isomorphy of concepts, laws, and models in various fields, and to help in useful transfers from one field to another.

- To encourage development of adequate theoretical models in fields which lack them.
- To minimise duplication of theoretical effort in different fields.
- To promote the unity of science through improving communication among specialists.

According to Von Bertalanffy (1973:27) there is an array of systems models, more or less progressed and elaborate. Certain concepts, models and principles of 'general systems theory', such as hierarchic order, progressive differentiation, feedback, systems characteristics defined by set and graph theory and others, are applicable broadly to material, psychological and sociocultural systems. Others, such as open systems defined by the exchange of matter, are limited to certain subclasses. A practice in applied systems analysis shows that diverse systems models will have to be applied according to the nature of the case and operational criteria. Furthermore, Von Bertalanffy (1973:80) adds that General Systems Theory is not a catalogue of well known differential equations and their solutions, but raise new and well-defined problems which partly do not appear in physics, but are of basic importance in non-physical fields. As a result, General Systems Theory should be methodologically an important means of controlling and instigating the transfer of principles from one field to another. Within the same context, Haines (2000:5) citing Vickers (1972) defines the task of the general systems theory as follows:

> *"…the task of General Systems Theory is to find the most general conceptual framework in which a specific theory or a technological problem can be placed without losing the essential features of theory or the problem"*

According to Von Bertalanffy (1956:10) the main aims of the General System Theory can be summarised as follows:

- A general tendency towards integration in the various sciences, natural and social.
- Such integration seems to be centred in a general theory of systems.
- Such theory may be an important means for aiming at exact theory in the non physical fields of science.

- Developing unified principles running 'vertically' through the universe of the individual sciences. This theory brings us nearer to the goal of the unity of science.
- This can be lead to a much-needed integration in scientific education.

According to Flood (1990:121), the term 'General Systems Theory' disappeared from the name of the flagship organization of the systems movement over thirty years ago. Almost as soon as it was established, the 'Society for Advancement of General Systems Theory' became the 'Society for General Systems Research'. The term 'General' has now disappeared altogether, with the change of name in 1988 to the International Society for Systems Sciences. It was Boulding (1956:11) who established teleology of General Systems Theory, giving it a definition and an objective. Moreover, Boulding (1956:11) perceived a General Systems Theory as:

> *"…a body of systematic theoretical constructs discussing the general relationships of the empirical world. This, then, would be the quest of General Systems Theory".*

2.4 THE CONCEPT 'SYSTEM' DEFINED

The following exhortation of Beer (Beer, 1970:241) emphasizes the concept 'system' and its importance to science:

> *"…to speak of a system is to speak of the coherence of a number of entities called parts of that system. What constitutes a system? What identifies the collection of entities as being coherent? Surely this is an act of mental recognition".*

The Oxford English Dictionary (2002:849) provides a definition of a system as, "…a set of things working together as a mechanism or network". According to Capra (1996:27) the word 'system' descends from the Greek verb 'sunistanai' which originally meant 'to place together', hence the view that a system is a perceived whole whose elements 'hang together', because they continually affect each other over time and operate toward a common purpose. The term 'system' can be

associated with a plethora of interpretations depending on the field one wishes to apply the concept. The term is used in almost all sciences and everyday language, resulting in the term being associated with among other, system science, systems design, systems analysis, systems engineering, systems thinking and in terms of the theme of this thesis, 'systems approach'.

Churchman (1968:29) defines the concept system as, "…a set of parts co-ordinated to accomplish a set of goals", while Cleland & King (1975:15) are of the opinion that a 'system' may be defined as, "…an organized or complex whole: an assemblage or combination of things or parts forming a complex or unitary whole". Cleland & King (1972:77) provide an expanded definition of the concept 'system' which reads as follows:

> *"…A system, by its nature, is made up of interdependent elements. As such, actions which affect one element must affect others also. And actions of one element cause reactions on the part of others. The recognition of such interactions and interdependencies both within and without the organization is the essence of the systems viewpoint"*

Von Bertalanffy (1973:89) is of the opinion that it is generally agreed that a system can be defined as, "…a model of general nature, that is, a conceptual analogue of certain rather universal traits of observed entities". Aligned with this concept, Takahashi and Takahara (1995:7) are of the opinion that, "…every system in the reality is recognized only as a system model, and the structure of a system is equivalent to that of a system model". The above authors are furthermore of the opinion that if it is allowed to use the term 'structure' in defining a system, then the system can be defined as, "….a whole entity having its own structure". While Ackoff (1960:332) defines the concept of system as, "…any entity, conceptual or physical, which consists of interdependent parts", Jackson (2004:3) defines a 'system' as "…a complex whole the functioning of which depends on its parts and the interaction between those parts".

Flood and Jackson (1991:7) have a more general conception of 'system', namely in terms of complex networks. To this must be added content in the form of different

'applications'. This will provide the systemic metaphors which can be deployed as filters when looking at problem situations. The above authors call these 'systemic' because each one amounts to some kind of complex interactive network, whatever it be for example a 'system of functional units' or a 'system of social rules and practices'. Furthermore, Flood and Jackson (1991:7-8) consider five metaphors which capture, at a general level, the insights of almost all management and organization theory, namely:

- **A machine metaphor** or closed system view, which is typified by theories of bureaucracy (Weber) and scientific management (Taylor).
- **Organic metaphor** or open system view, which incorporates ideas drawn from studying complex phenomena from several levels of resolution. Survival and adaptability are other concepts that complement an 'open system' idea within the framework of the organic metaphor.
- **Neurocybernetic metaphor** or 'viable system' view, which emphasises active learning and control as opposed to the passive adaptability that characterises the 'open system" view.
- **Cultural metaphor** can be understood as the often unspoken but familiar way of thinking and acting that exist in all firms and enterprises.
- **Political metaphor,** which focuses on issues of interests, conflict and power, looking at relationships between individuals and groups as competitive and involving the pursuit of power.

According to Ackoff (1960:331-332), the term 'system' is used to cover a wide range of phenomena, some of which are conceptual constructs, and others are physical entities in the likes of philosophical systems, number systems, communication systems, control systems, educational systems and weapon systems. Ackoff and Emery (1972:18) provide a more consolidated definition of a 'system', namely "…as a set of interrelated elements, each of which is related directly or indirectly to every other elements, and no subset of which is unrelated to any other subset". In addition, Ackoff (1981:15) further expands on the concept and defines a 'system' as a set of two or more elements that satisfies the following three conditions:

- The behaviour of each element has an effect on the behaviour of the whole.
- The behaviour of the elements and their effects on the whole are interdependent.

- Subgroups of the elements are formed, each has an effect on the behaviour of the whole and none has an independent effect on it.

These conditions consolidate the concept that a system is a whole that cannot be divided into independent parts. This is supported by Athey (1982:12) who defines 'system' as, "…any set of components which could be seen as working together for the overall objective of the whole". Athey (1982:26) add that the basic types of systems are classified as static, dynamic, homeostatic or cybernetic depending on how much influence the environment has on the system, the degree of internal control the system has developed and whether the system goals are fixed or adaptive, namely:

- **Static Systems** are those systems which have fixed goals, and have no means of internal control to ensure that the system goals are met.
- **Dynamic systems** are those systems, which have no means internally to ensure that fixed system goals are met under highly variable environmental conditions.
- **Homeostatic systems** are those which respond to environmental changes, but have effective internal control devices to enable the system to meet its fixed system goals.
    - The environmental influence concerns how much effect the environmental conditions have on the functioning of the system. If the system is independent of the environment, it is commonly referred to as a 'closed system'.
    - The control which means how much internal capacity a system has for insuring the continual attainment of a system objective. This can range from a system having no internal feedback devices to systems which have very effective feedback loops.
    - The adaptability of goals which reflects whether the goals of the system are fixed or can be changed depending on the environmental condition and state of system learning.

Very similar definitions of 'system' are provided by Kauffman (1980:1), Simon (1956:63), Gerard (1956:155) and Hall and Fagen (1956:18), which culminates in the concept being defined as "…any entity, conceptual or physical, which consists of interdependent parts".

Dostal (2004:9-10) provides a number of definitions of a 'system' with clear tangent planes to one another. These definitions of the concept 'system' read as follows:

> *"…a system is a discernible whole, which is organised to function as a whole. It can be distinguished from its surrounding environment and is relatively independent from it"*
>
> *"…a system consists of interacting parts, which are organised around a purpose"*
>
> *"…a system is a set of organised relationships".*
>
> *"…a system is a whole in its own right; as well as being part of one or more larger wholes"*

Citing Vickers (1983), Dostal (2004:9) provides the following definition of a 'system' which the author considers one of the simplest descriptions of what a system is, and which reads as follows:

> *"…a system is anything that has a name"*

Kast & Rosenzweig (1974:101) expands the definition of system as being, "…an organized, unitary whole composed of two or more interdependent parts, components, or subsystems and delineated by identifiable boundaries from its environmental supra systems". Moreover, Kast & Rosenzweig (1974:101) citing Kenneth Boulding, provide a useful classification of 'system' which sets forth a hierarchy of levels as follows:

- The first level is that of static structure, commonly referred to as the level of 'frameworks'.
- The next level is that of the simple dynamic system with predetermined, necessary motions. This might be called the level of 'clockworks'.
- The control mechanism or cybernetic system, which might be called the level of 'thermostat'. The system is self regulating in maintaining equilibrium.

- The fourth level is that of the 'open system' or self maintaining structure. This is the level at which life begins to differentiate from non-life: It might be called the level of 'the cell'.
- The next level might be called the 'genetic-societal' level: It is typified by the plant, and it dominates the empirical world of the botanist.
- The 'animal system' level is characterized by increased mobility, teleological behaviour, and self-awareness.
- The 'human level', that is, of the individual human being considered as a system with self –awareness and the ability to utilize language and symbolism.
- The 'social system' or systems of human organization constitute the next level, with the consideration of the content and meaning of messages, the nature and dimensions of value systems, the transcription of images into historical record, the subtle symbolizations of art, music, and poetry, and the complex gamut of human emotion.
- 'Transcendental systems' complete the classification of levels. These are the ultimate and absolute and the inescapable unknowable, which also exhibit systematic structure and relationship.

Flood & Jackson (1991:4) provide a definition of 'system' within the ambit of mechanistic thinking and systems thinking, which reads as follow:

> *"…in mechanistic thinking, a 'system' is an aggregate of parts in which the whole 'is equal' of the sum of the parts…In 'systems thinking', a 'system' is a complex and highly interlinked network of parts exhibiting synergistic properties where the whole is greater than the sum of the parts".*

Furthermore, Flood and Jackson (1991:2) are of the opinion that within the context of the modern systems approach, the concept 'system' is used not to refer to things in the world but to a particular way of organising the thoughts about the world. Furthermore, the authors consider the notion of 'system' as an organising concept, before going on to look in detail at various systemic metaphors that may be used as a basis for structuring thinking about organizations and problem situations.

2.5 THE CONCEPT 'SYSTEM APPROACH' DEFINED

The Oxford Advanced Learner's Dictionary (2000:47) defines the concept 'approach' as:

> *"…the way of doing or thinking about something such as a problem or a task"*

For Churchman (1968:231), "…the Systems Approach begins when first you see the world through the eyes of another". Churchman, (1979:8) is of the opinion that on the broadest level, the Systems Approach belongs to a whole class of approaches to managing and planning human affairs with the intent that a living species conduct itself properly in this world. Furthermore, Churchman (1979:8) expands this concept into a definition of 'Systems Approach' which reads as follow:

> *"…the system approach is, therefore only one approach to the way in which humans should respond to reality; but it is a 'grand' approach, by which he means 'large', 'gigantic', or 'comprehensive'. It is one of the approaches based on the fundamental principle that all aspects of the human world should be tied together in one grand rational scheme, just as astronomers believe that the whole universe is tied together by a set of coherent laws".*

Cleland & King (1972:18) define Systems Approach as, "…more than a way of describing complexity; it is a prescribed method for studying and changing systems." Cleland & King (1972:79) citing Drucker (1967), who views the Systems Approach as, "….a host of formally unrelated activities and processes as all parts of a larger, integrated whole, is not something technological in itself. It is rather, a way of looking at the world and at ourselves". Fricks (1967) cited by Cleland & King (1972:79), emphasizes the common sense nature of the 'Systems Approach' in saying that it is, "…very little more than the application of common sense.

For after all, as an idea or concept, it merely requires that the total problem be identified and attacked in a systematic manner – unquestionably a desirable approach to any problem"

Athey (1982:5) is of the opinion that the 'Systems Approach' is offered as the best of the methods for problem-solving available. It addresses the total problem-solving cycle by including the following steps as part of this method, which includes both what is commonly thought as:

'S*ystem analysis'*, which includes the following steps*:*

- Formulate the problem.
- Gather and evaluate information.
- Develop potential solutions.
- Evaluate workable solutions.

'*Decision making'*, which includes the following steps:

- Decide on the best solution.
- Communicate the system solution.
- Implement the solution.
- Establish performance standards.

For authors Kast & Rosenzweig (1974:108-109), the Systems Approach has been utilized as a basis of organization for many advanced defence and space programs. Program management is geared to changing managerial requirements in research, development, procurement, and utilization. With the new complex programs such as ballistic missiles and advanced space programs, it became impossible to think of individual segments or parts of the program as separate entities, and it is necessary to move to a broader 'systems approach'. For a classification of systems falling within the context of the Systems Approach, see discussion contained within the ambit of Paragraph 2.8 of this chapter, in particular the graphical depiction thereof as reflected in Figure 2.3.

2.6 CYBERNETICS DEFINED

According to The Oxford English Dictionary, (2002:203), Cybernetics is defined as:

> *"….the science of communications and automatic control systems in both machines and living things"*

It was only in 1948 when Wiener's book '*Cybernetics'* was published, that contemporary ideas about control processes culminated in the definition of 'cybernetics' being formulated as, "…the science of control and communication in the animal and the machine." Wiener (1948:14) describes cybernetics as, "…a word invented to define a new field of science". It combines under one heading the study of what in human context is sometimes loosely described as 'thinking' and in engineering is known as 'control and communication'.

Jackson (1991:92) argues that the term Cybernetics originates from the Greek work *Kybernetes*, meaning, "…the art of steersmanship". For Checkland (1989:84) the meaning steersman forms the link between control mechanisms studied in natural systems opposed to engineered man made systems. Von Bertalanffy (1973:19) defines Cybernetics as "….a theory of control systems based on communication between systems and environment and within the system, and control of the system's function in regard to environment".

Jackson (1991:93) points to the fact that in the 1960s and early 1970s, two names stand out in management cybernetics, namely that of Stafford Beer and Jay Forester. Jackson (1991:93) adds that Beer was the first to apply cybernetics to management in one comprehensive fashion (in his book *Cybernetics and Management*), defining management as a science and profession and control. Moreover, Beer (1970:425) adds that cybernetics, which is defined as the science of control in the animal and the machine, *is precisely about organisation*, and for this is the medium through which control is exercised. Therefore cybernetics may also be defined, as it has been by certain Russian writers, as "the science of effective organisation".

Ashby (1956:1) is of the opinion that cybernetics is a theory of machines, but it treats not 'things', but ways of behaving. Furthermore, cybernetics deals with all forms of behaviour in so far as they are regular or determinant or reproducible. The materiality is irrelevant, and so is the holding or not of the ordinary laws of physics.

Athey (1974:30) defines cybernetic systems as those systems which are affected by environmental shifts but have means through feedback control to continue to meet system objectives. Furthermore, Athey (1974:30) adds that the systems objectives are not rigidly fixed but are adaptable to changing conditions and responsive to new understanding. These systems gain from experience and thus exhibit learning.

More specific to the theme of this thesis, Jackson (1991:102-104) distinguishes between two different cybernetic streams, namely that of '*management cybernetics*' and '*organizational cybernetics':*

- **Management Cybernetics:** Management cybernetics falling within the context of the "hard systems approach", which treats organisations as if they were actually like machines or organisms. The starting point for a management cybernetic model of the organisation is the input-transformation-output schema. This is used to describe the basic operational activities of the enterprise. The goal or purpose of the enterprise is in management cybernetics, invariably determined outside the system. Then, if the operations are to succeed in bringing about the goal, they must, because of inevitable disturbance, be regulated in some way. This regulation is effected by management. Management cybernetics attempts to equip managers with a number of tools that should enable them to regulate operations. As cybernetic tools represent an interrelated response to the characteristics of cybernetic systems, extreme complexity can be dealt with using the black box technique, self-regulation can be appropriately managed using negative feedback, and probabilism yields to the method of variety engineering. These elements will be further expanded upon in Paragraph 4.3, Chapter 4.
- **Organisational Cybernetics:** Organisational cybernetics, falling within the context of the 'soft systems approach' is a concept which, according to Jackson (1991:104), is primarily the brainchild of the revered Professor Stafford Beer. Organisational cybernetics is a strand of cybernetic work concerned with the

management and organisations that breaks somewhat with the mechanistic and organismic thinking that typifies management cybernetics, and is able to make full use of the concept of variety. Beer's version of organisational cybernetics seems to have emerged from management cybernetics as a result of two breakthroughs. First, in his book, *"The Heart of the Enterprise"*, Beer (1979) succeeds in building his 'Viable Systems Model' (further expanded upon in Chapter 4 of this thesis) in relation to the organisation from cybernetic first principles. This enables cybernetic laws to be fully understood without reference to the mechanical and biological manifestations in which they were first recognised. Second, more attention is given in organisational cybernetics to the role of the observer. Clemson (1984:20–21), makes a distinction between a first order cybernetics appropriate to organised complexity because it studies 'MEI' (**M**atter-**E**nergy-**I**nformation) and a second order cybernetics (organisational cybernetics) capable of tackling relativistic organised complexity because it studies as well, the observing system.

2.7 THE ROLE OF MODELS

The evolutionary Systems Approach to be formulated within the ambit of this thesis will manifest in the form of 'a model'. In this respect, Beer (1981:110) is of the opinion that "…some people think of a model as a mathematical equation, others think of it as a theory, still others as a hypothesis, and yet others as a physical thing. The last group looks the least sophisticated, and yet these people have understood best".

Takahashi and Takahara (1995:1), define Systems Theory as a theory about representations, i.e., 'models of systems' rather than systems themselves. The above authors provide the following general definition of a 'model', which reads as follow:

> *"Let A and B be two objects. If B is considered to copy the features of A, B is called a model of A. Then A is a prototype of B"*

Furthermore, Takahashi and Takahara (1995:1) are of the opinion that the term 'model' is deeply and essentially concerned with human thinking and activities, and

that in scientific field models are an indispensable concept for developing theories. Churchman (1968:61) adds that a model, for the scientist, is a way in which the human thought process can be amplified.

Beer (1970:100) adds that models of things may be more or less accurate, and thereby better or worse, able to predict the behaviour of what is modelled. Just because they are predictive, models are open to experimentation as a means of evaluating the likely performance of the thing modelled. Moreover, Beer (1970:101) is of the opinion that a model can not be equated to a scientific hypothesis due to the fact that the model does not postulate the casual mechanisms that underline events, it simply represents the pattern of the events themselves in advance, by extrapolation. Furthermore, Beer (1970:101) adds that a model is not like a scientific theory, due to the fact that a model has no explanatory content, it is simply a reflection of whatever is the case, which is explicitly made available for experimentation. It is this which distinguishes it from perception.

Takahashi and Takahara (1995:2-3) argue that the primary doctrine of systems science being "…a reality itself is so complex that we cannot directly analyse it and obtain effective information from it to improve present situations including problems. To attack the reality it is necessary not only to analyse precisely individual elements, but to recognise the situations in question as a whole entity and 'abstract' essential factors to be examined". Athey (1982:152) is of the same opinion, adding that for those systems problems which are highly complex, it may be a definitive advantage for the analyst to build a model of the system allowing to better understand the complex interrelationship of the system and through the model the analyst could generate specifically tailored information that he could not retrieve from any place else providing impetus to the approach in this thesis whereby an evolutionary Systems Approach will be formulated taking the form of a 'model'. Moreover, Athey (1982:152) adds that there are many different kinds and types of models, but basically they are all abstract representatives of actual systems or subsystems.

From the same perspective, Takahashi and Takahara (1995:3) are of the opinion that the main doctrine of systems science represents the factors of modelling, which

includes the four elements for it, namely a 'subject', 'aims', a 'prototype' and a 'model', where the aims for modelling are reflected in how the reality is recognised and abstracted. Furthermore, Takahashi and Takahara (1995:3) ague that systems theory is not a theory of 'systems' themselves that are objects with complexity whose properties one may want to examine, but a theory of 'system models' for such systems. The significance of system models, according to Takahashi and Takahara (1995:3), lies primarily in their roles played in systems science, where the role of system models can be considered, comparing with those of models in natural sciences.

Takahashi and Takahara (1995:11-16), describe four basic concepts to be understood in applying a Logical Approach to Systems Theory, commonly referred to as LAST, which provides a 'meta-framework' to describe and investigate explicitly both models and their structures, namely:

- **System model:** System models are objects of study in systems theory. LAST provides a formal framework for representing a system model to reflect systems recognition of a model builder. A system model is a whole entity whose elements lie in the innately complex interactions among elements, and which is recognised from a systems viewpoint.
- **Structure:** Since every system in reality is recognised only as a system model, the structure of a system is equivalent to that of a system model. If it is allowed to use the term 'structure' in defining a system, then a system can be defined as "…a whole entity having its own structure". A structure of a system model characterises the system model in the sense that the structure determines to which class of systems the system model pertains.
- **Morphism:** Is a conceptual basis for considering similarity between system models. Since morphism is both practical and conceptual significant as such in systems theory, one may need to develop some general morphism independent of such a particular representation so that it gives similarities between system models not only of the same kind of type, but of different types. Morphism is concerned with relationships between models or structures, while system models and structures specify relationships among elements.

- **Universality**. The mathematical definition of universality comes from category theory rather than logic. Universal properties can be found in many areas in mathematical theories. Especially in systems theory minimal realisation, which identifies a minimal structured system model satisfying a pre-structured data set, is considered to have the universal property. This categorical representation of the universality should be regarded as an abstraction that provides a unified framework to express the universality found everywhere.

Kast and Rosenzweig (1974:389) define the process of model building as the crux of model conceptualization. Models are developed to describe, explain, or predict pertinent phenomena in the real world. Starr (1971) cited by Kast and Rosenzweig (1974:389), define models as, 'the crux of rational management'. They provide a means for analysing and synthesizing complex situations or systems. Furthermore, Kast and Rosenzweig (1974:392) are of the opinion that the model itself is usually a representation of objects, events, processes, or systems. Manipulation of the model is used to test the impact, which proposed changes will have on the system as a whole. According to Cleland and King (1972:43), the various types of models have been classified into three general groups, namely:

- **An 'iconic' model:** Is a simple scale transformation of the real-world system. Some aspects of the system are omitted from iconic model. Iconic models and the real systems which they represent are therefore 'look-alikes'
- **An 'analogue' model:** In an analogue model, properties are transformed, i.e., one property is used to represent another. A graph is the simplest illustration of an analogue model.
- **A 'symbolic' model:** This model uses symbols to designate properties of the system under study.

Kast and Rosenzweig (1974:394) add that once the system has been described and numerical values have been assigned, the problem can be solved with whatever technique seems most appropriate. The model should be tested in the 'real world' in order to assess its viability. The cycle is repetitive until a satisfactory representation of the 'real world' situation is obtained as the modelling process suggests. The modelling process is graphically depicted in Figure 2.2.

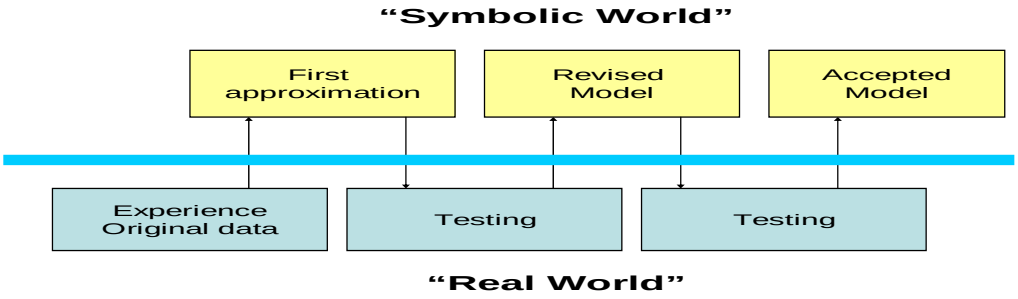

Figure 2.2 The modelling process (**Source:** Kast & Rosenzweig, 1974:394)

Cleland & King (1975:97) define the concept 'model' in a scientific sense as a system, which is used to predict the effect of changes on the performance of the system. According to Kast & Rosenzweig (1974:395), models can be broadly characterized as qualitative or quantitative. Many advantages accrue when quantification of models become possible. Translating models into mathematical symbols, forces the decision maker to identify explicitly pertinent variables and their relationships. In large complex systems, this testing process may involve many refinements and voluminous calculations. Mathematical models lend themselves to computerisation, a step which facilitates the model-building process. Cleland & King (1972:45) are of the opinion that a system model may be developed by integrating the functions and processes of various subsystems. The outputs from one subsystem are the inputs to another subsystem in such an overall systems model. According to Beer (1970:133) a model is predictive; it can be used to generate information, to facilitate experimentation, and to check hypotheses and potential solutions.

2.8 CLASSIFICATION OF SYSTEMS FALLING WITHIN THE CONTEXT OF THE SYSTEMS APPROACH

To provide the reader with a navigational roadmap to understanding the complexity of the Systems Approach, the components[1] of which are reflected in Figure 2.3, being adapted from Checkland (1989:95-97) for this purpose.

[1] Checkland (1989:96) refers to the 'components' of the Systems Approach as 'The shape of the systems movement'.

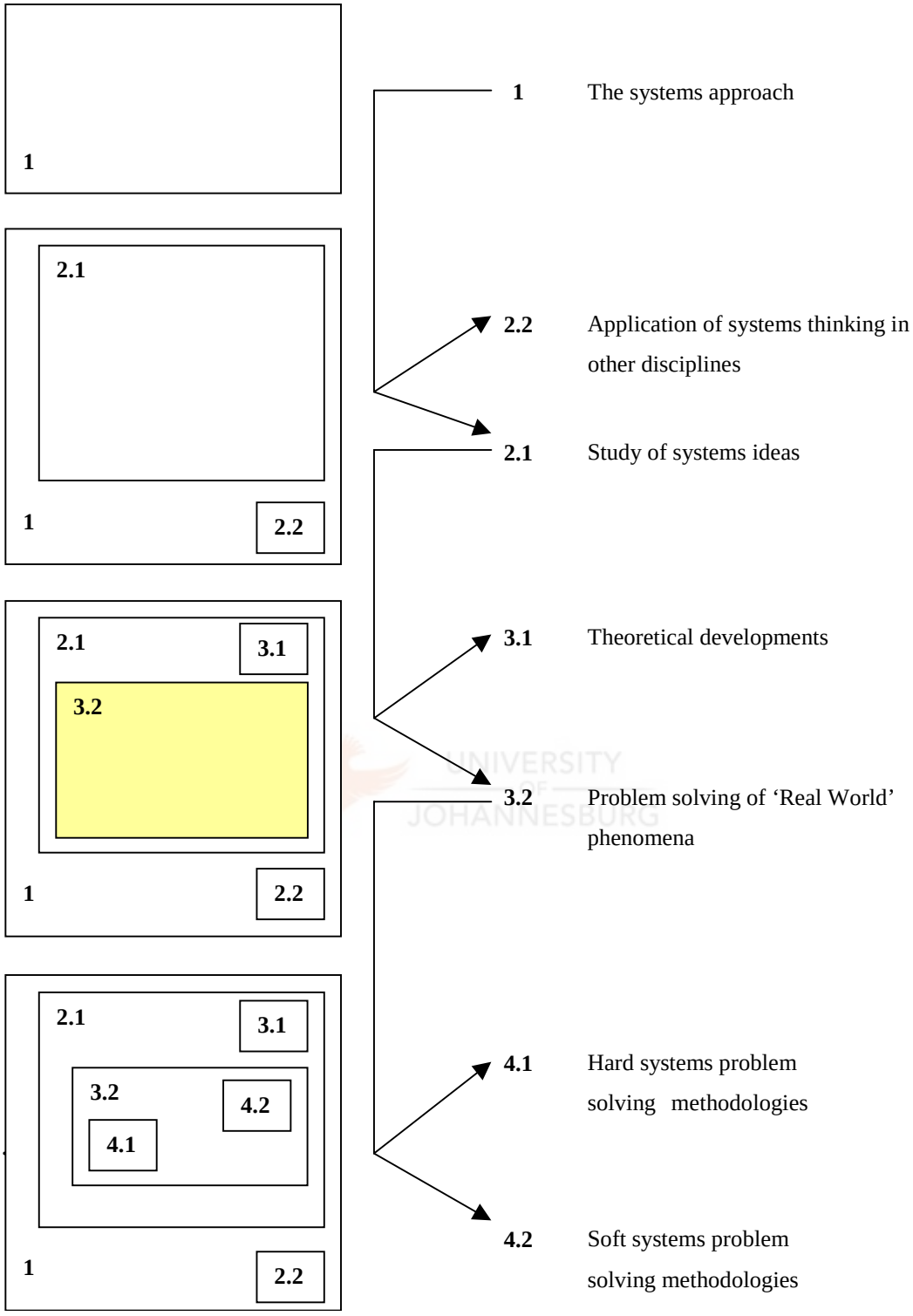

Figure 2.3: Classification of systems falling within the context of the 'Systems approach' (**Source:** Checkland, 1989:95-97)

It is acknowledged by the author of this thesis that the classification of systems within the context of the Systems Approach as depicted in Figure 2.3, is merely 'one of many' such classifications in existence today. The placing into different categories

according to which 'nature's systems' and 'human social systems' can be classified where the former relates to the 'naturosphere' and the later to the 'sociosphere' serves as an example of such a classification (In this respect, refer to Chapter 6, Paragraph 6.3). A more popular systems classification is provided by Jackson (1991:27-31). In terms of the classification by Jackson, system approaches are classified according to the assumptions they make where the terms, unitary, pluralist and coercive are used for describing the relationship between the various stakeholders with an interest in organisations, also referred to as 'the system of system methodologies'.

One dimension of the 'the system of system methodologies' deals with how complex the problem context is, while the second concerns the relations between stakeholders. This concept was first mooted by Jackson & Keys (1984:473), which was in essence a typology classification of the different assumptions made by methodologies (Mingers 1997:5). While the classification as depicted in Figure 2.3, was selected to demonstrate the 'classifications of systems' falling within the context of the 'Systems Approach', the focus in this thesis is centred on not only the Systems Approach per se, but also of systems falling within the ambit of the 'soft' system problem methodologies namely the 'Viable Systems Model' of Stafford Beer, (further expanded upon within the ambit of Chapter 4) and the Biomatrix Systems Approach, (further expanded upon within the ambit of Chapter 3).

Analysing Figure 2.3, the Systems Approach (shown as Frame 1) and forming the basis of this research, is presented as an all incumbent 'overall' problem solving methodology consisting of a multitude of different approaches to address complex phenomena. These different approaches led in the first instance to the 'application of systems thinking in other disciplines', (shown as Frame 2.2), of which the 1970's system revolution in geography serves as an example. In the second instance, the 'study of systems ideas' (shown as Frame 2.1), which are split into two distinct fields namely:

- Theoretical developments (shown as Frame 3.1), of which the 'General Systems Theory' serves as an example.

- Problem solving of real world phenomena (shown as Frame 3.2). It is this 'problem solving of real world phenomena', which gave rise to the very essence of the research contained within the ambit of this thesis.

The hard systems approach (shown as frame 4.1) is made up amongst others of the following problem solving methodologies:

- Systems Engineering
- Systems analysis.
- Operational research.
- Management cybernetics.
- Systems Dynamics.

The soft systems approach (shown as Frame 4.2), is made up of amongst others the following problem solving methodologies:

- The Biomatrix Systems Approach (further expanded upon in Chapter 3).
- Organisational cybernetics (as reflected whitin the context of the Viable System Model, further expanded upon in Chapter 4).
- Churchman's Social Systems Design.
- Mitroff and Mason's Strategic Assumption Surfacing and Testing Methodology.
- Ackoff's Social Systems Sciences.
- Checkland's Soft Systems Methodology.

2.9 CLOSURE

In this chapter, a holistic perspective was provided of the 'Systems Approach', the concept which will form the crux of the research in this thesis. Furthermore the reader was provided with an historical overview of the evolution of the Systems Approach, and the formulation of the General Systems Theory. The concepts 'system' and 'system approach' where elaborated upon, which lead to an analysis of the concept of 'cybernetics' were the differences between 'management cybernetics' a 'hard' systems methodology and 'organisational cybernetics' a 'soft' systems methodology were highlighted.

The ultimate objective of this thesis is to formulate an evolutionary Systems Approach (a model), to mitigate not only the research problem, but provide an answer to the research question. Against this background, the role of models were analysed in detail. To place the research in perspective of the overall research, a classification of systems falling within the context of the 'Systems Approach' were provided. In Chapter 3, the first of the enquiry systems which will be used in this research, namely the Biomatrix system, will be analysed in more detail.

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CHAPTER 3: THE RULING PRINCIPLES OF THE BIOMATRIX SYSTEMS APPROACH

CHAPTER 3

THE RULING PRINCIPLES OF THE BIOMATRIX SYSTEMS APPROACH

> *"…How can we solve the perplexing societal problems of poverty, unemployment, illiteracy, lack of education, political conflict, human rights, violations, environmental degradation, population explosion, crime, health disasters, urban decay, transport congestions, and unsustainable development amongst others? How can we design policies that will be comprehensively enough to address these problems? How must our institutions and organisations be organised to tackle issues of such magnitude?"*
>
> ***Dostal (2004)***

3.1 INTRODUCTION

In this chapter, the complexities of the Biomatrix Systems Approach are analysed, providing the reader with the required insight into the ruling principles that govern the approach. The key principles associated with each of the system aspects and their relevance in organizational management, change and transformation are analysed in more detail. Due to the fact that the theory incorporates and is integrated with the natural and social sciences, it provides for a meta-paradigm within which issues of sustainable development can be explored. Utilising these principles that fall within the ambit of Biomatrix Systems Approach, perplexing systemic problems as it pertains to the unstructured complex phenomena which threaten the sustainability of the Construction Engineering Industry in Mozambique can be identified. Furthermore, the Biomatrix systems approach falling within the ambit of 'soft systems' problem solving methodology, juxtaposed with the Viable Systems Model, would serve as the overall enquiry system in this thesis.

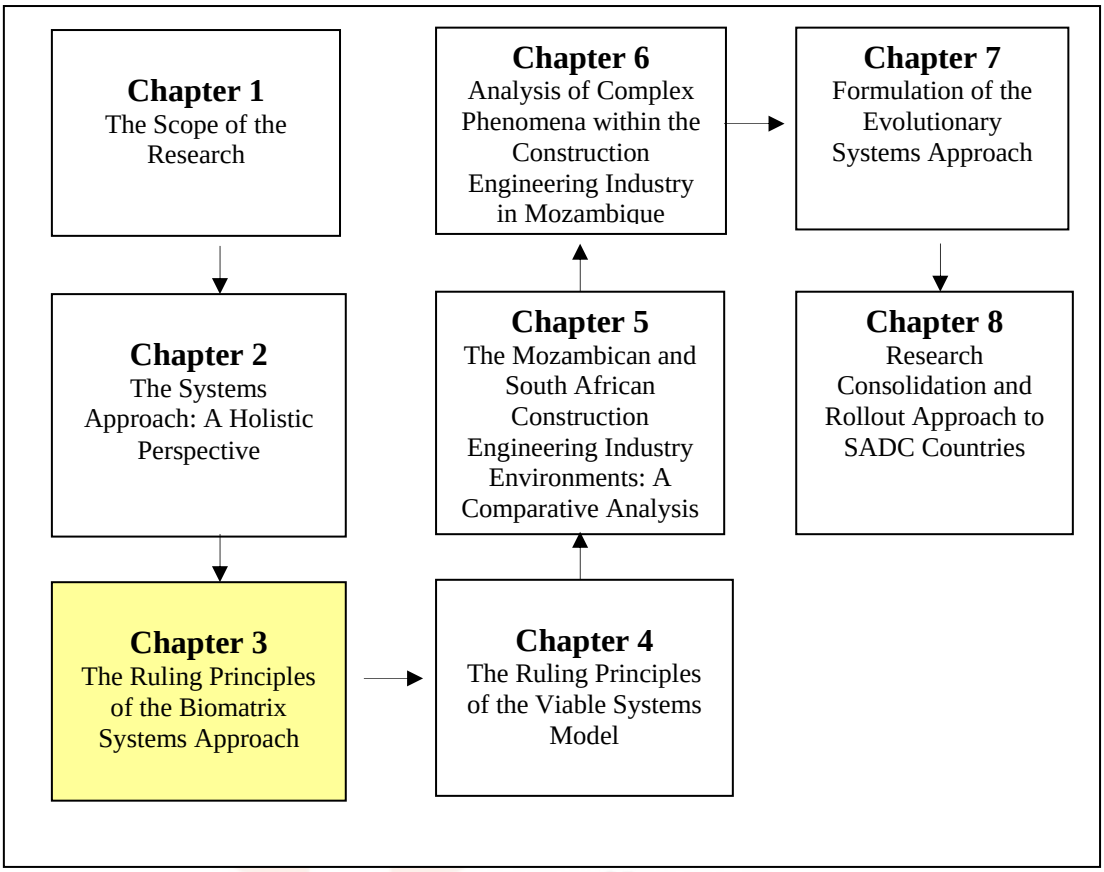

Figure 3.1: Chapters in context of the overall research

The analytical process followed thus far, is graphically depicted in Figure 3.1, which places the chapters in context with the overall thesis objectives, and furthermore indicates the relative positioning of this chapter.

3.2 BACKGROUND

According to Dostal (2004:380), the Biomatrix Systems Approach uses the generic principles and some of the practical approaches which fall within the ambit of 'soft systems methodologies' namely the Systems Dynamics Approach and the Ideal Design Approach. The Systems Dynamics Model describes the inherent dynamics of a system, depicting how change spreads through the system as it is configured. According to Dostal (2004:18), its application to social systems was pioneered by Forrester (1969) and popularised through the famous 'Club of Rome' study, with

Coyle (1977), Gomez and Probst (1987), Senge (1990), Vester (1990) and Wolstenholme (1994) as proponents of the approach.

An Ideal Systems Design represents a new state of the system, describing the system as an ideal vision, as it does not yet exist and, showing the possibility of how the system could function in the future, provided that it institutes the required changes. According to Dostal (2004:18), an 'ideal design,' represents a new logic of system functioning, having as the most important proponents of the design school Ackoff (1981), Ackoff, Finnel and Gharajedaghi (1984), Banathy (1994), Checkland (1981), Checkland and Scholes (1990), Nadler (1981), Nadler and Hibino (1990) and Warfield (1990) amongst others.

The Biomatrix System Approach present, according to Dostal (2004:380), some theoretical and practical contributions to 'systems dynamics' and 'ideal systems design', which include amongst others, the following:

- A generic systems dynamic, which is applicable to all systems. It introduces levels and dimensions into systems dynamics, as well as a generic flow of inward and outward directed change though the systems hierarchy.
- The concept of telentropy, which identifies problems arising from a mismatch between the conceptual and physical realities of a system.
- A practical method of problem analysis, namely that of casting the multi-dimensional and multi-levelled web of the Biomatrix to identify problem co-factors.
- A practical and systemic brainstorming methodology to generate ideas for the design.
- A framework for creating a coherent ideal design, namely the 'seven systems aspects' which are expanded upon in Paragraph 3.6. These serve as a framework for integrating the brainstorming output into a coherent design.
- The concepts of the 'clockwise' and 'anti-clockwise' forces of change, which propel a system towards its ideal and current futures respectively, as well as highlighting that the actual change within a system is the emergence of the interaction of these two types of change.
- The role of the generic systems dynamics within the Biomatrix in providing a framework for the analysis of problems within the existing system hierarchy, as

well as for directing the flow of desired change within the systems hierarchy. In line with the theme of this thesis, the Biomatrix Systems Approach also makes theoretical and practical contributions to the implementation of change within an organisation, namely:

- The generic principles associated with the 'seven systems perspectives' (Refer Paragraph 3.6) provide practical guidelines for an ideal design.
- The clockwise change provides the sequence for implementing an ideal design within the organisation.
- The counter clockwise change provides guidelines regarding the management of resistance to change as a result of the momentum inherent in the current system.

Dostal (2004:5-6), emphasises that there is a subtle, yet fundamental distinction in how most systems thinkers depict the universe and how the Biomatrix theory perceives it, while they share the same core concepts. There is nevertheless, a distinct difference in emphasis due to the fact that, while General Systems Theory emphasises the interaction between systems and their parts, whereby these interactions can form process chains and feedback loops, the Biomatrix theory emphasises the emergence of systems from interaction across levels. It (the Biomatrix) sees the strands of activity systems becoming dense in parts of the web, giving rise to 'entity systems,' distinguishing different webs within the Biomatrix, which interact with each other, giving rise to a multidimensional functioning of each system, thus, promoting the concept of 'web-think'. To place the Biomatrix Model in perspective as part and parcel of the 'systems approach', it would be appropriate to highlight the differences between the Biomatrix Model and the General Systems Model.

3.2.1 Difference between the Biomatrix Model and the General Systems Model

The main difference between the Biomatrix Model and the General Systems Model is that the Biomatrix focus on process rather than structure, namely that the Biomatrix Model 'sees things' as being primary composed of process from which structure emerges through the regular, patterned interaction of processes. In this distinction between process and structure, the Biomatrix Model according to Dostal

(2004), builds on the work of systems thinkers such as Bateson (1972, 1980), Capra (1982), Keeney (1983) and Maturana & Varela (1980, 1992). It is also important to note, that although the Biomatrix Model develops some of the general systems concepts further (e.g. teleons and doublets), its main contribution lies in the way it has organised the commonly used systems concepts into a coherent framework. The analogy can be drawn that one could therefore regard the Biomatrix Model as a 'systemic pattern of general systems concepts', which is in particular suitable as an enquiry framework as utilised within the framework of this thesis.

The following according to Dostal (2004), are some of the key assumptions of the Biomatrix Model, which are not exclusive to the Biomatrix Model, as they also pertain to other systems approaches:

- The essence of life is process or action.
- Structure is a manifestation of emergence from process.
- Processes, comprising the web of life, are purposeful.
- Life is hierarchically organised.
- Processes set into motion at one level continue through various other levels in the hierarchy of life.

3.3 THE EVOLUTIONARY DEVELOPMENT OF THE BIOMATRIX MODEL

The Biomatrix Model was first mooted by Járos with work pertaining to the generic organisation of physiological processes in human beings and higher animals (Járos, *et al.,* 1980). The concept was thereafter subsequently extended and generalised by (Járos and Cloete, 1987). An interdisciplinary team made up of Járos (focusing on general model development and its application) Cloete (focusing on model formalisation and development), Dostal (focusing on the development and application of the model to institutional organisation), Edwards (focusing on development of the model in the field of psychology) and Muller (focusing on principles of harmony inspired by music) added to the overall body of knowledge pertaining to the Biomatrix Model.

The Biomatrix Model has been applied in the fields of 'psychology' (Edwards and Járos, 1994a and 1994b), 'education' (Dostal and Járos, 1996), 'healthcare, business science and governance' (Dostal and Járos 1994a and 1994b). Against this background and mapping the theme of this thesis to facilitate the creation of a framework for an evolutionary systems approach problem solving methodology, the Biomatrix Model application will be primarily based on the work of Dostal, who focussed her work on the Biomatrix System in the area of business science.

3.4 THEORETICAL CONTEXT OF THE BIOMATRIX MODEL

The Biomatrix Model is grounded in the 'systems paradigm' (Laszlo & Laszlo, 1997). More specific to the theme of this thesis, the Biomatrix Model has its roots in the paradigm of the 'General Systems Theory' (Boulding, 1956; Mesarovic, 1964; Von Bertalanffy, 1968; Laszlo, 1972a and 1972b; Weinberg, 1975), and has furthermore an affinity with the purposeful systems of Ackoff (Ackoff & Emery, 1972).

Viewing the Biomatrix System from the perspective of a classification of systems falling within the context of the 'systems approach' (Checkland, 1989:95-97) (refer Paragraph 2.8, Chapter 2), elements of soft systems methodologies are evident in the Biomatrix Model (Dash, 1994; Lane, 1994; Lane & Jackson, 1995). Further support for the fact that the Biomatrix Model leans towards the soft systems paradigm as advocated by Checkland and Haynes (1994), the fact that the model serves as a conceptual map in order to facilitate looking at a problem from different perspectives, as opposed to serving as a quantitative model for analysis and design of systems, making it highly appropriate as an enquiry mechanism as applied within the ambit of this thesis.

The Biomatrix theory represents an integration of various concepts and approaches of the systems paradigm into one coherent meta-systems theory, namely the Biomatrix theory (Dostal, 2004:xv). The Biomatrix theory according to Dostal (2004:4-5), adds some new theoretical insights. Some of the most important contributions include the following:

- The distinction between different kinds of systems, namely between activity and entity systems.
- The underlying process nature of all systems.
- The continuity of activity systems though space as well as time.
- The concept of 'tapping'.
- The concept of Biomatrix and its sub-webs of the naturosphere, psychosociosphere and technosphere and their different ways of functioning.
- The flow of telentropy through the Biomatrix.
- The description of systems in terms of 'seven systems' perspectives (Refer Paragraph 3.6) and the differentiation between clockwise and counter clockwise change within systems.
- The three-fold level of organization into self and outer and inner environment.
- The concept of the emerging middle.
- The field concept of 'MEI', namely that of (**M**atter-**E**nergy-**I**nformation) from inseparable fields.
- The provision of a generic systems dynamics across levels and dimensions.

3.5 THE BIOMATRIX THEORY AS A PROCESS BASED SYSTEMS APPROACH

Dostal (2004:22) attributes the concept of 'pattern of life' to the word Biomatrix, and concludes that, "…Biomatrix is derived from bios (life) and matrix (mould). This literally means pattern of life, or how life is organised". According to Dostal (2004:3-4), the Biomatrix Systems Approach is an integrated systems theory using concepts and theories developed by the most influential representatives of the systems paradigm, incorporating them into one coherent theoretical framework, as well as adding some unique concepts. Furthermore, Dostal (2004:xiii-xiv) argues that one of the most important contributions of Biomatrix theory is that it integrates the key concepts of the whole field of systems thinking into one coherent theory, providing some unique features, such as the distinction between different types of systems, generic organising principles of both natural and human systems and an understanding of the flow of change between and within systems. This broad application of the Biomatrix system, due to the fact that the primary focus of the system is centred on 'process'. Biomatrix theory is an appropriate world view for the

information age, as it facilitates flexibility in response to environmental change, as well as stability in spite of rapid change.

Elements of the 'process paradigm' were introduced into the systems theory by Checkland, in what he (Checkland) referred to as 'human activity systems' (Checkland, 1981). In more recent times, the process paradigm was philosophically argued by Whitehead (Whitehead, 1969; Whitehead, 1985). Smuts with his theory of holism viewed 'process' as the fundamental tendency towards the evolution of 'wholes' (Smuts. 1926), while Sabelli (1991a and 1991b) perceived the concept to be the 'union of opposites'. From the perspective of Jantsch (1979), 'process' is viewed from an evolutionary perspective, while Capra explained the notion that events constitute the primary reality underlying the manifestation of the material world (Capra, 1976).

The Biomatrix Model according to Cloete (1999:5) focuses on "…systems as organised processes (or events) rather than as interacting entities. In this regard it is considered to be grounded within a process paradigm". Furthermore, the Biomatrix model assumes that the 'flux of mei' (**M**atter-**E**nergy-**I**nformation) constitutes a field of physical and conceptual space. In addition, the model introduces the concept of 'thread-like' process systems within this field, which are considered to be analogous to the concept of 'field-lines' proposed in the field theories of physics as proposed by Einstein and Infeld (1966), and Gribbin, (1984).

3.6 GENERIC ELEMENTS OF THE BIOMATRIX THEORY

The seven systems aspects of the Biomatrix theory is described by Dostal (2004:45), using the following analogy: "…A dice is made up of six sides, whereby each side shows another value. One can look at the dice from each side, focussing on a specific value. If one side were missing, one would not have a dice. During play the dice needs to be thrown by hand onto a surface. Likewise, a system has 'six' inherent aspects, which together, describe the system. The 'seventh' aspect is the environment with which the system is in interaction. If one of the aspects were missing, one would not have a system". Dostal (2004:45-46) adds that within the Biomatrix theory, seven different generic elements can be identified being 'six internal aspects' and 'one

external aspect' (the environmental aspect), reflecting the different qualities of a system which, together make up the 'Biomatrix System':

- **The Environmental aspect:** Describe how the system interacts with its environment.
- **The Ethos aspect:** Represents the field of ideas that inform the nature and functioning of the systems (In the systems of nature, ethos refers to the laws of nature and in the human social systems ethos is referred to as organizational culture).
- **The Teleos (aim) aspect;** Refers to the specific outcome of a system, such as aim, goal, purpose, ideal, objective which the system strives to achieve.
- **The Process aspect:** Describes the flow of substance (**M**atter-**E**nergy-**I**nformation) that occurs within an activity system and its transformation, within a specific period of observation.
- **The Structure aspect:** Refers to the actual and conceptual shape or form of a system and/or to the pattern of interaction formed by its activity systems.
- **The Governance aspect:** Refers to the planning and decision-making, controlling and regulating activities of a system, which guide the functioning of the system. Governace has two aspects, namely a teleos setting and regulation.
- **The Substance (MEI) aspect:** Refers to the field of MEI (**M**atter-**E**nergy-**I**nformation), which comprises the system and forms the building blocks, components and resources of the system. (In the context of organizations, this refers to the human, material, financial, technological and knowledge resources of the organization).

The above elements will be expanded upon in Chapter 7, dealing with the formulation of a revolutionary approach to organisational change.

3.7 THE DISTINCTION BETWEEN ACTIVITY AND ENTITY SYSTEMS

The distinction between activity and entity systems within the ambit of the mega system of the Biomatrix, implies a qualitative difference between different types of systems, with each type of system manifesting in a different logical order e.g. society is of a different logical order than its construction engineering industry or its economic systems, as is the planet compared to its climate, soil or water systems. For

the purpose of this thesis, this distinction is of importance and calls for closer scrutiny.

3.7.1 Activity systems

"…An activity system is a purposeful process or flow of MEI (**M**atter-**E**nergy-**I**nformation) or substance, which is structured and regulated to achieve its aims" (Dostal 2004:27). The analogy can be drawn that an activity system represents an organised flow of substance through time and space, and although it shows a flow of substance, it also exhibits structure because the flow of substance occurs in a regulated and stable manner. Moreover, Dostal (2004:29) is of the opinion that most systems thinkers emphasise the 'temporal extension' when speaking about the activity aspect of an activity system, namely that 'something changes in the course of time'. The Biomatrix theory however also emphasises that an activity system also represents a spatial flow from one entity system to another. The (re) design of activity systems in terms of the Biomatrix is further expanded upon in Chapter 6, Paragraph 6.4.1.1.

Dostal (2004:34) is of the opinion that activity systems of an entity serve two generally different purposes, namely that of 'giving' (contributing activity systems) and 'taking' (tapping activity systems):

- Through its contributing activities, an entity relates to another entity by offering something of itself to that entity. It contributes to the development of entities in the outer and inner environment, where contributions directed at the inner environment are mostly concerned with the distribution of resources amongst the members of the system, hence inward directed activity systems are also referred to as 'distribute activities'.
- Any contribution offered to an entity system needs to be tapped by it, thus involving the 'tapping of activity systems'. The aim is to access and internalise contributions from entity systems within the outer and inner environments and from it.

3.7.2 Entity systems

"…Entity systems are living systems, while artefacts are largely non-living systems made by entities. Artefacts are the product of humanity, but also of other living entities" (Dostal, 2004:30). Furthermore, entity systems and artefacts are structures that are relatively independent, autonomous and complete, but there is nothing completely independent from anything else or completely autonomous regarding its organisation and self-governance. On the contrary, systems thinking emphasises interrelatedness and openness between systems. Dostal (2004:31) provides the following list that highlights the most important differentiating characteristics that set entity systems apart from 'artefacts' and from 'dependent wholes':

- An entity system has a relatively independent existence from its outer context.
- It has a core which is the seat of its ethos.
- Ethos is the field of organising principles that attract, organise and govern the activity systems, which comprise the entity system.
- Dostal (2004:31) citing Maturana & Varela (1980) is of the opinion that an entity is a whole in itself as a result of organisational closure which involves:
  - Self-governance and self-organisation.
  - Self-referral in its various activities.
  - Self-maintenance.
  - The balancing of interests between different activity systems within or between the interest connected to the inner and outer environment of the entity.

Expanding further on the above, Dostal (2004:32) is of the opinion that the listed characteristics are also qualities that tend to be associated with 'life'; thus, concluding that an entity system is a living system. As a result, the analogy can be drawn that 'entity systems' consist of three types of activity systems, namely 'outward directed' and 'inward directed' and 'self directed' systems, being the system's purpose which determines the distinction between the three types of activity systems, and not the flow of its 'mei', namely:

- **Outward directed activity system:** To connect the system to its outer environment and make contributions to it.

- **Inner-directed activity systems:** To contribute to the maintenance of the inner environment, so that the inner environment can, in turn, contribute to the various activity systems of the entity system and make it's functioning possible.
- **Self-directed activity system:** To maintain the integrity of the entity as a whole and to serve its own needs.

From the above, the analogy can further be drawn that the Biomatrix theory suggests the optimal development of an entity system which requires a balance between the three sets of activity systems, namely its inward, outward and self-directed activity systems. Should such a three-fold organisational structure of entities be applied to a social organisation, like a corporation, one derives a three-dimensional matrix. Matrix management which is a well known organisational model in business seems to be emerging as the organisational model of the information age in general and replaces the universally applicable organisational model of the traditional hierarchy. Dostal (2004:82) adds that the generic threefold organisational structure of entity systems gives rise to a three-dimensional activity matrix, which provides the most optimal interaction between the three types of activity systems, as well as optimising coordination between them and maximising connectivity with the environment. The concept of an activity matrix facilitates multi-functionality and multi-connectivity. The (re) design of Entity systems in terms of the Biomatrix is further expanded upon in Chapter 6, Paragraph 6.4.1.2.

3.8 THE BIOMATRIX SYSTEMS APPROACH

The 'Biomatrix Approach' refers to the process of applying the Biomatrix Model, and thus refers to a specific 'systems approach' with associated assumptions and concepts embodied within the ambit of the Biomatrix Model. The analogy can be drawn that it is not unlike, "…an explicit dividing line separating the everyday real world of the problem situation from the consciously organised 'systems thinking' about the real-world situation" (Tsouvalis & Checkland, 1996:37). In this respect however Fuenmayor (1991:422), argues that a systems approach is "… not another scientific approach which simply deals with a special 'region' of beings; rather, it is a meta-scientific approach. It is thus an 'approach' or 'perspective' whose standpoint is of an ontological and epistemological nature".

It is of importance for the reader to note that as the Biomatrix Model is not considered to be a 'structured method', a 'structured sequence of events to be followed', or a 'set of rules'. In contrast with other soft systems approaches, the Biomatrix System Approach is a 'process or activity' based systems theory. The concept of process refers to the observed change within a system, namely a change in the flow of the substance of the system. Within the context of the soft systems methodology, the Biomatrix Model proposes a universal framework for 'conceptual models' to be drawn from 'root definitions' (Checkland & Tsouvalis, 1997:158). Furthermore, the investigative power of the soft systems methodology, "…derives not from an ontological view of a systemic world, but the epistemological power of a set of systems concepts, which may structure thinking about the world" (Rose, 1997:252).

The model lends itself to be applied to 'specific problem situations' and can be developed relative to disciplines, needs and acquaintance with other related methods (Edwards, 1995). This maps to the concept of 'complementarism' as introduced within the context of critical systems thinking, which states that 'complete' evaluations of situations can be made through the 'critical' (Jackson, 1994) use of different systems methodologies and application to a particular situation (Watkins, 2003). The Biomatrix Model will "… provide an enriched understanding of the situation being investigated" (Gregory 1996:619). From the above, the analogy can be drawn that the model can serve as a basis for a deep and reflexive enquiry into systems thinking itself (Fuenmayor & Lopes-Garay, 1991; Fuenmayor, 1997)

3.8.1 The concept of teleons

A 'teleon' represents a process or activity system within the Biomatrix. However, not every activity or process is necessarily a teleon. For example, a random process activity would not be called a teleon. Rather, a teleon displays goal oriented behaviour which is persistent in time, showing a relatively stable action pattern. More specifically, a teleon is defined as a purposeful, structured and governed process unit within the Biomatrix, which connects 'doublets'. The term 'tele-on' is derived from the Greek words 'teleos', which means aim or goal, and 'on' denoting the integrated unit that exists between its different aspects.

The six systems aspects (ethos, teleos, process, structure, substance, and governance) are intimately interlinked to co-produce the teleon. This interrelationship is contextualised with the following (rather lengthy) verbatim explanation by Dostal (1997:40) which reads as follows: "…Even if the main emphasis of the teleon is on process, like that of the river being in flow, the teleon is nevertheless more than just another word for process or activity. It is a system in its own right. As a system, it displays all six system aspects, namely teleos, which determine the intended outcomes of the processes of the teleon. The way the processes of the teleon are organised represents its structural aspect, while the regulation as well as teleos setting refers to the governance of a teleon. These aspects are influenced by an ethos which is derived from the doublet from which the teleon emanates. To function optimally, the teleonic functioning also needs to reflect the ethos of the doublet at which the teleon is directed".

There are systems thinkers who use the term 'activity systems' (Banaty, 1991 and 1992; Checkland, 1981, Checkland & Scholes, 1990) and 'functions' (Gharajedaghi, 1986) in a similar way as the Biomatrix Model uses 'teleons'. Moreover, these thinkers also highlight the multi-functionality of some systems. Within the Biomatrix, this idea was further developed into the concept of 'doublet', which is expanded upon in Paragraph 3.8.2 of this chapter.

The Biomatrix Model distinguishes between different types of teleons, depending on the level in the Biomatrix at which the teleons are directed, namely at the outer level (exoteleons), the inner level (endoteoloens) or the same level (centoteleons). Each of these three categories may be further distinguished in terms of 'give' and 'take', whereby teleons either contribute an activity towards a doublet at one of the three levels or take (i.e.'tap') contributions offered to the doublet.

Exoteleons are teleons whose purpose is judged by the observer looking at a specific part of the Biomatrix as being directed toward the outer level of the Biomatrix. The exoteleons are responsible for contributions of one doublet toward another doublet at the outer level in the hierarchy of the Biomatrix. Endoteleons are teleons whose purpose is judged by the observer looking at a specific part of the Biomatrix as being directed toward the inner hierarchical level. The function of endoteleons is to ensure

optimum working of the lower levels of the Biomatrix. Furthermore, they also serve the self-maintenance and survival of the system as a whole.

Centroteleons are teleons which are judged by the observer as being directed towards the doublet itself. They typically exert a governing influence and balance exo and endo functioning. Centroteleons describe the processes within a system which are associated with the self-organisation (Bateson, 1972, 1980), self-reflexiveness (Capra, 1982) and autopoisis (Maturana & Varela, 1992) of a system.

Contributing teleons are those teleons whose outcome makes a contribution to a doublet. By means of their activities, the exoteleons contribute to the emergence of doublets at the outer level. By means of its endoteleonic activities, a doublet offers resources to its inner level for the purpose of its maintenance, growth and development by means of centroteleonic activities a doublet serves itself. Tapping teleons access resources from the outer and inner levels of the system.

3.8.2 The concept of doublets

The term ‘doublet’(which refers to things, entities or beings) was first used by Craib (1927) to denote closely related charge pairs encountered in nerves and muscles during activity. This term points to the two-faced nature of a unit, but at the same time, imply a close interrelation between its poles. Jaros & Cloete (1987) chose the term ‘doublet’ to emphasise its dual outward and inward focus in the systems hierarchy as well as its ‘field’ nature and define the concept as follows: “…A doublet is a discernible whole or entity within the Biomatrix, which is comprised of bundles of teleons”. More specifically, a doublet emerges from the interaction of bundles of exo, endo and centro teleons, whose interactions from a stable enough pattern in space and time to give the doublet the appearance of a structure. From the above, the analogy can be drawn that a doublet is,“…a whole in the sense of a coherent group of actions which can materialise and be seen as a whole or a complete entity”.

Most systems thinkers refer to systems as discernible and indivisible wholes, which have a reasonable independent existence and identity (a name) attached to them, which distinguish one type of a whole from another. These wholes have been given

different names by different systems thinkers, namely that of 'holon' (Koestler, 1978a, 1978b), 'centers' (Laszlo, 1972b), and 'org' (Koestler, 1978a). The Biomatrix Model refers to such wholes as 'doublets'. The definition of doublet can against the above background be expanded into the analogy that, "…a doublet is a discernible whole or entity within the Biomatrix, which is comprised of bundles of teleons. More specifically, doublets emerge from the interaction of bundles of exo, endo and centro teleons whose interaction from a stable enough pattern in space and time to give the doublet the appearance of a structure. Moreover, the General Systems Model typically regard observable wholes as being delineated by an observable boundary, while the Biomatrix model regards a whole as represented by a doublet merely as the 'centrobody' from which the doublet spreads like a field outward and inward towards other doublets in the inner and outer environment. This field emerges around a core or attractor (Gleick, 1987), with the ethos of the system which may act as such an attractor (Wheatley, 1992). Like the teleon, the doublet exhibits all six systems aspects, namely ethos, teleos, process, structure, substance (MEI) and governance.

Although all doublets are observable wholes, not every whole is a doublet. To be classified as a doublet, an entity has to comply with the following characteristics:

- It can lead a relatively independent existence from its outer context. It is autonomous, whereby autonomy refers to what Maturana & Varela (1992) refer to as 'organisational closure'.
- It has a core in which the ethos resides and which attracts and govern teleon.
- It is self-governing.
- It is self-referring in its various activities.
- It is self maintaining
- It has endo, exo, and cento teleons and displays a balance between its exo, and endo teleons by means of its centroteleons.

The observer of the Biomatrix can focus on either teleons or doublets, while keeping in mind that the underlying reality of both systems is the same, namely 'process or activity'. Although the doublet and teleon perspectives focus on different aspects of a system, they are nevertheless interrelated, whereby the teleonic perspective leads to the doublet perspective and *vice versa*.

3.9 THE BIOMATRIX SYSTEMS APPROACH IN SUMMARY

The Biomatrix Model was conceptualised by Jaros & Cloete (1987, 1990, 1993) and it belongs to the group of theories comprising the general systems paradigm. The Biomatrix Model distinguishes itself from other approaches within the systems field by emphasising 'process' as the primary unit of analysis. It regards process as the underlying reality of life and structure as emerging from the interaction of the processes in time and in space. The most important characteristics of the Biomatrix Model are as follow:

- The Biomatrix Model distinguishes two types of systems, namely 'process or activity systems', called 'teleons' and 'observable wholes' or 'entity systems' called 'doublets'.
- The Biomatrix Model regards doublets as emerging from the interaction of teleons, thereby emphasising the process nature of all life.
- The Biomatrix Model encourages a shift in perception and thinking between process and structure, yet emphasising the equal relevance of both perspectives as well as emphasising process as being the underlying nature of structure.
- The teleon and doublet perspective emphasises the temporal and spatial perspectives respectively, analogous to the wave/particle nature of light in physics.
- Unlike most general systems models, which identify a system according to its observable boundary, the Biomatrix Model regards this observable whole as merely being the 'centrobody' of the doublet, from which the doublet spreads 'field-like' towards its outer and inner environment.
- The Biomatrix Model identifies generic patterns of organisation, namely that teleons interact either with the outer or with the inner level. They are called exoteleons and endoteleons respectively. Teleons rather make a contribution or they link-up with the contributions of other teleons from the outer or inner environment. The latter are referred to as 'tapping' of teleons.
- The Biomatrix Model emphasises that teleons continue though the hierarchy of life.
- The Biomatrix Model stipulates that a transformation in substance takes place in the teleon at each level in the hierarchy.

- The Biomatrix Model suggests that there are centroteleons (i.e. teleons directed at the self) which act in a self-referring and governing role and coordinate the exoteleons and endoteleons.
- The Biomatrix Model proposes that the interaction between endo, exo and centroteleons gives rise to a matrix structure as the organisational model of the doublet.
- In suggesting that generic patterns underline the organisation of the Biomatrix at all hierarchical levels. Furthermore, the Biomatrix Model provides a metaframework for interdisciplinary debate and interdisciplinary systems analysis and design.

3.10 CLOSURE

In this chapter, the ruling principles of the Biomatrix Systems Approach were analysed. To set the scene, a comparative analysis was drawn between the Biomatrix Model and General Systems Models. The evolutionary development of the Biomatrix Model was expanded upon and the theoretical underpinning of the concept being the 'systems paradigm' explained. The core component of the Biomatrix, namely the fact that it is 'a process based systems approach', leads into an analysis of the generic elements of the theory. Furthermore, a distinction was drawn between 'activity' and 'entity' systems. The chapter is concluded with a contextual analysis of the approach whereby key elements pertaining to 'teleons' and 'doublets' were explained and the concept summarised to provide a holistic overview to place the Biomatrix Model in context of the overall research in this thesis.

In Chapter 4, the second of the enquiry systems which will be used in this research, namely the Viable Systems Model, will be analysed in more detail.

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CHAPTER 4: THE RULING PRINCIPLES OF THE VIABLE SYSTEMS MODEL

CHAPTER 4

THE RULING PRINCIPLES OF THE VIABLE SYSTEMS MODEL

> *"…Stafford Beer is undoubtedly among the world's most provocative, creative, and profound thinkers on the subject of management, and he records his thinking with a flair that is unmatched. His writing is as much art as it is science. He is the most viable system I know."*
>
> ***Ackoff (1983)***

4.1 INTRODUCTION

In this chapter, the Viable Systems Model falling within the ambit of Organizational Cybernetics (a soft systems methodology) which is concerned with general patterns, laws and principles of behaviour that characterize complex, dynamic, probabilistic, integral and open systems will be analysed in more detail. Due to the fact that Beer's Viable Systems Model focuses on organization rather than structure, assuming its evolutionary nature, it can be used for diagnosing problems of organisation, particularly those arising in complex probabilistic systems that comprise purposeful organised parts and are open to a changing environment (Flood & Jackson, 1991:88). The model represents a powerful tool to be used to diagnose the faults in existing organizational systems. This is in line with the theme of this thesis, in terms of which a framework for an evolutionary systems approach will be formulated to mitigate unstructured complex management paradigms threatening the sustainability and growth of the Construction Engineering Industry in Mozambique.

Organisational cybernetics is, according to Jackson (2004:108), about ensuring that an organization is viable and in a position to reach goals (efficacy) and about doing so without waste of resources (efficiency). It (Organisational cybernetics) does not bother itself about whether the goals which are being pursued are the right ones in the sense that they are goals that one actually wants to achieve (effectiveness).

Moreover, the Viable Systems Model seeks to provide knowledge, based upon cybernetic principles, that supports regulation in the social domain. Its aim is to increase the ability to 'steer' organizations and other social systems as envisaged with the proposed evolutionary Systems Approach in this thesis. Jackson (2004:108) adds that it is true that there are those who wish to 'capture' the Viable Systems Model for other paradigms, but they need to ask whether it really is an appropriate tool with which to pursue interpretative and emancipatory ends, and what is lost in the process.

The Viable Systems Model draws strength from its structuralist epistemology. It has been able to integrate some profound insights into a usable management tool that carries enormous explanatory power because it rests upon the science of cybernetics.

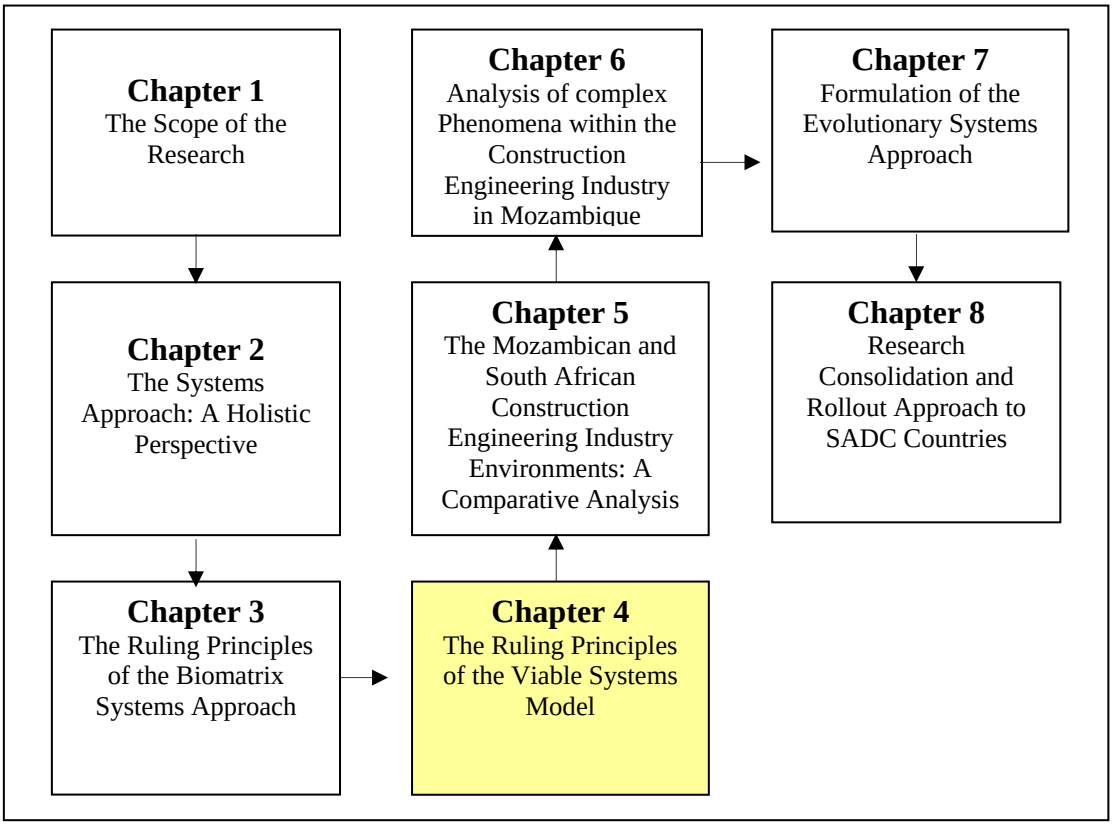

Figure 4.1: Chapters in context of the overall research

The analytical process followed thus far, is graphically depicted in Figure 4.1, which places the chapters in context with the overall thesis objectives, and furthermore

indicates the relative positioning of this chapter.

The attention of the reader is drawn to the fact that the analyses of the ruling principles of the Viable Systems Model in certain instances have been reproduced verbatim from Watkins (1999) (with permission) as the analysis contained therein could not be improved upon.

4.2 BACKGROUND

The term 'self-organisation' is used from different perspectives within the ambit of systems literature (Von Bertalanffy, 1968; Jantsch, 1979; Goertzel, 1992), and depending on its application, may actually refer both to 'intrinsic' governance and to 'emergent' organisation. From this the analogy can be drawn that the ability of a system to organise itself does not necessarily distinguish the 'mechanisms' of organisation being used. Consequently, it may either be as a result of emergent properties e.g. the ability of a group to organise itself or may be as a result of an 'internal' decider.

In terms of the 'Living Systems Theory', which is associated with a cybernetics viewpoint, whereby systems (e.g. humans, organisations etc.) can maintain regularity despite irregularity in the system's environment. 'Regularity' is achieved by comparing current or future states with internally represented desired states and converting any differences into actions that will keep differences small. The role played by different categories of information in the organisation of systems as perceived within the context of 'The Living Systems Theory', is according to Banathy (1996:112), "…the assignment of functions to components in order that critical processes may be carried out in an appropriate manner".

From the above the analogy can be drawn that cybernetic-based concepts of organised complexity, regulation, transformation, equilibrium, information exchange and feedback and control are central to not only the organisation and viability of systems in the viable systems model (Jackson, 2000), but can also be applied to the Construction Engineering Industry in Mozambique, being the primary focus of this thesis.

4.3 A PERSPECTIVE ON MANAGEMENT CYBERNETICS

While 'management cybernetics' (a hard systems approach) do not form part of the core of the thought process to address the research problem, the building blocks thereof however calls for clarity to place 'organisational cybernetics' (a soft systems approach) in perspective of the overall research. Clemson (1984:44) is of the opinion that there are three laws representative of cybernetics and of particular interest to management. These laws and their associated corollaries are:

- **Self organising systems**: Complex systems organise themselves; the characteristic structural and behavioural patterns in a complex system are primarily a result of the interactions among the systems parts. Every self-organising system has regions of stability separated by thresholds of instability.
- **Feedback:** The output of a complex system is dominated by the feedback and, within wide limits, the input is irrelevant. All outputs that are important to the system will have associated feedback loops.
- **The law of requisite variety**: Given a system and some regulator of that system, the amount of regulation attainable is absolutely limited by the variety of the regulator. Most of the regulation of very complex systems is achieved through the interaction of the parts, i.e. one part acts to regulate some other part.

The building blocks of 'management cybernetics' which calls for closer scrutiny, the following:

- The Black Box Technique
- Variety Engineering
- Negative Feedback

4.3.1 The black box technique

Exceedingly complex systems according to Cleland & King (1972:46-47), which are so complicated that they cannot be described in any precise manner or detail are commonly known in cybernetic terms as 'black boxes'. The complexity of such systems according to Schoderbeck et al. (1985) cited by Jackson (1991:95) is the combined outcome of the interaction of four main determinants namely:

- The number of elements comprising the system.
- The interactions among these elements.
- The attributes of the special elements of the system.
- The degree of organisation in the system.

While significantly dated against the background of 21st Century Information Technology models, it is interesting to note that Steerman (1988:24), considered certain computer models as being 'black boxes', due to the fact that these devices operate in completely mysterious ways. The way 'not' to proceed in approaching an exceedingly complex system – 'a black box' – according to Ashby (1956b:11), is by analysis. Instead of analysis, the black box technique of input manipulation and output classification should preferably be employed. According to Jackson (1991:96), faced with a black box, a manager does not have to enter it to learn something about it. Instead, the system is investigated by collection of a long protocol, drawn out in time showing the sequence of input and output states. The manager can then manipulate the input to try to find regularities in the output. Initially, if nothing is known about the black box, random variations of input will be as good as any. As regularities become established, a more directed program of research can be conducted.

Caution regarding the use of this technique is provided by Ashby (1956a) and Beer (1979) cited by Jackson (1991:96). According to Ashby, there are problems with the black box technique, e.g. when a particular experiment changes a system to such an extend that it cannot be returned to its original state for further experimentation. Beer (1979) adds that it is very important not to jump to conclusions about the behaviour of a system, without observing it for a sufficient length of time

4.3.2 Variety engineering

Executive management are faced on an ongoing basis with complex phenomena, which are invariable unstructured and unexpected, resulting in the use of probabilistic systems. In this respect, Ashby (1956a:110) for instance provides some understanding of such difficulties and ways in which they should be dealt with from a cybernetic point of view using 'variety engineering'. According to Ashby

(1956a:110), variety of a system is defined as "…the number of possible states it is capable of exhibiting". It is therefore, a measure of complexity.

The problem for management, as Ashby's 'Law of Requisite Variety" has it, is that only 'variety can destroy variety', thus in order to control a system, as much variety available is needed as the system itself exhibits. When faced with massive variety, the variety must either be reduced (variety reduction) or increased (variety amplification), a process which according to Beer (1981:41) is known as 'variety engineering'. From this follows the analogy that since the variety equation initially seems to place executive management at a disadvantage, it will require all the skills available to balance varieties and (following the law of requisite variety) to achieve control.

Beer (1981:230-231) provides a comprehensive table, which highlights the techniques that executive management can employ to reduce external variety of both kinds (operational and environmental) and amplify their own variety. Jackson (1991:100-102), is of the opinion that managers have to learn how to use variety reducers, filtering out the vast complexity of operational and environmental variety and capturing only that of relevance to them (managers) and the organisation. Also, they (managers) have to learn how to use variety amplifiers, amplifying their own variety vis-à-vis the operations and the organisation's variety vis-à-vis its environment.

Furthermore, Beer (1981a:230-231) is of the opinion that managers can reduce external variety of both kinds, namely 'operational' and 'environmental', and amplifying their own variety. In reducing external variety managers can according to Jackson (1991:101-102), employ the following methods:

- Structural method which deals with divisionalisation, functionalisation and massive delegation.
- Planning method which deals with setting priorities.
- Operational method which deals with management by exception.

In amplifying their own variety, management can employ the following methods:

- Structural method which deals with integrated teamwork.

- Augmentation method which deals with recruit experts, employ consultants.
- Informational method which deals with management information systems.

The following extract from Beer (1981a:41), provides an incumbent summary of the concept variety engineering:

> *"…The output variety must (at least) match the input variety for the system as a whole, and for the input arrangement and the output arrangement considered separately".*

By implication, this determines that control can be obtained only if the variety of the controller (and in this case of all the parts of the controller) is at least as great as the variety of the situation to be controlled.

4.3.3 Negative feedback

According to Jackson (1991:97), exceedingly complex probabilistic systems have to be controlled through self-regulation. To understand what such self-regulation cybernetic can provide, it is important to have a perception of the following two concepts:

- It is the existence of mechanisms bringing about self-regulation that gives a degree of stability to the environment of organisations.
- Due to the fact that managers lack 'requisite variety' they should understand the nature of self-regulation they wish to induce in the organisation they manage.

The work of Wiener (1948) cited by Jackson (1991:97), has established that the way to ensure self-regulation is through the negative feedback mechanism. The feedback control system is characterised by its closed-loop structure. It operates by the continuous feedback of information about the output of the system. This output is then compared with some predetermined goal, and if the system is not achieving its goals, then the margin of error (the negative feedback) becomes the basis for adjustments to the system designed to bring it closer to realising the goal. Churchman (1983:175) defines negative feedback as "...a situation in which

information coming to the manager arrives at the right time for him to take the appropriate course of action".

Four distinctive elements are required for negative feedback to function optimally, namely:

- A desired goal, which is conveyed to the comparator from ouside the system.
- A sensor (a means of sensing the current state of the system).
- A comparator, which compares the current state and the desired outcome.
- An activator (a decision-making element that responds to any discrepancies discovered by the comparator in such a way as to bring the system back towards its goal).

This kind of control system is extremely effective, since any movement away from the goal, automatically sets in motion changes aimed at bringing the system back onto course.

4.4 ORGANIZATIONAL CYBERNETICS

Cybernetics is, according to Norbert Wiener (1948:14-16) "…a word invented to define a new field in science. It combines under one heading the study of what in human context is sometimes loosely described as thinking and in engineering is known as control and communication. In other words, cybernetics attempts to find the common elements in the functioning of automatic machines and of the human nervous system and to develop a theory which will cover the entire field of control and communication in machines and in living organisms".

According to Clemson (1984:19), Norbert Wiener who is generally accorded the title of the 'father of cybernetics', defined the concept as "…the science of effective communication and control in man and in the machine". Wiener took the word cybernetics from the Greek word for steersman or governor. Clemson (1984:19), add that this definition has never helped him (Clemson) and that he prefers Beer's definition of the concept which reads "…cybernetics is the science of effective organization", and which have the following characteristics:

- **Complex:** They have more relevant detail than the given observer can possibly cope with.
- **Dynamic:** They are changing in their behaviour or structure or both.
- **Probabilistic:** There are important elements whose behaviour is at least partly random.
- **Integral:** They act in some important sense as a unit.
- **Open:** They are embedded in an environment which affects them and which they affect.

Clemson (1984:19) expands upon the cybernetic definition of Beer with the following: "…cybernetics is concerned with the general patterns, laws and principles of behaviour that characterize complex, dynamic, probabilistic, integral, and open systems".

Jackson (1991:102) is of the opinion that 'management cybernetics' represents little improvement over hard systems thinking and is subject to the same criticisms, while 'organizational cybernetics' are however, based on a rather different philosophical orientation and is able to exploit fully the potential power inherent in cybernetic building blocks. According to Jackson (1991:95), extreme complexity can be dealt with using the black box technique, while self-regulation can be appropriately managed using the negative feedback, and probabilism can be dealt using the method of variety engineering. Jackson (1991:103) adds that Beer has been 'pushing' 'organizational cybernetics' (though he does not use this term) for some years and has worked hard at defining its relationship with hard systems thinking. Jackson (1991: 104) is of the opinion that Beer's version of organisational cybernetics seems to have emerged from management cybernetics as a result of two intellectual breakthroughs. First, in the Heart of Enterprise, Beer (1979) succeeds in building his Viable Systems Model in relation to the organisation from cybernetic first principles. This enables cybernetic laws to be fully understood without reference to the mechanical and biological manifestations in which they were first recognised. Second, more attention is given in organisational cybernetics to the role of the observer.

According to Clemson (1984:20), cybernetics and General Systems Theory are concerned with systems, usually involving both deterministic and random elements, which are resistant to the methods of both sciences. Cybernetics has also emphasised the relationship between information and matter/energy, i.e. information negative entropy, thereby linking all three basic aspects of reality.

Clemson (1984:21) expand on this concept saying that second order cybernetics is concerned with the nature of the observer as the observer interacts with a system being observed, having the activity of observing, in general, some influence on the observed system (this might be termed a generalised 'Heisenberg effect'). Furthermore, Clemson (1984:21) is of the opinion that the nature of the observer partially determines what the resulting observation will be. Thus, Clemson (1984:21) argue that the second order cybernetics can be termed "…the cybernetics of observing systems", linking up the three basic aspects of reality, namely **M**atter, **E**nergy and **I**nformation with the observer, or the observing system.

Jackson (1991: 104) is of the opinion that the Viable Systems Model encapsulates all of the most important features of organizational cybernetics which pertains to the second order cybernetics. Flood & Jackson (2002: 89) add that the principles that underpin this approach are all cybernetic in nature, and when organisations do not perform well, it is assumed that cybernetic principles are being violated.

4.5 BEER'S VIABLE SYSTEMS MODEL

According to Clemson (1984:98), the work of Beer encapsulated in *The Brain of the Firm* and *The Heart of Enterprise,* represents the culmination of over twenty years of managerial experience and research into organizations. Clemson (1984:98) argue that the basic problems Beer was concerned with were problems associated with the twentieth century, involving new degrees of:

- **Complexity**: More people, organizations, technology, problems, opportunities, information, etc, than ever before.
- **Rate of change**: All sorts of things are changing at an unprecedented rate.
- **Interdependency**: Organizations, social systems and personal lives are inter-mixed and inter-dependent to the extent that one can hardly do anything

without a complex ripple effect that influences scores of other people, things and organizations.

Clemson (1984:98-99) adds that all this means that survival requires an increasing amount of learning and change on the part of individuals and organizations, being the 'bottle neck', the rate at which one can change oneself to adapt to new circumstances. Moreover, Clemson (1984:99) is of the opinion that the nature of the problem Beer set out to solve evolves around the following critical questions:

- How can organizations be created that continue to meet the needs of their clients?
- How can organizations learn and adapt rapidly?
- How can one create an effective 'nervous system' for the organization that is capable of maintaining it, learning, and adapting?
- How to create a 'brain for the organization' that will improve its effectiveness?

According to Jackson (1991:105), for Beer a system is 'viable' if it is capable of responding to environmental changes even if those changes could not have been foreseen at the time the system was designed. In order to become or remain viable, the system has to achieve requisite variety with the complex environment within which it is faced, and it must be able to respond appropriately to the various threats and opportunities presented by its environment.

Beer (1981a:77-85) adds that the traditional company organization chart is totally unsatisfactory as a model of a real organization, providing as an alternative, his Viable Systems Model which he (Beer) considers a more useful and usable model. Furthermore, Clemson (1984:141) adds that the Viable Systems Model is Stafford Beer's design for effective formal organizations. This model, since it is explicitly based upon the principles of cybernetics, facilitates consideration of what is and is not possible within formal organisations and provides guidance in creating efficient structures. Clemson (1984:142) adds that the Viable Systems Model specifies five broad functions that must be carried out in any organisation that manages to both maintain internal stability and adapt to a changing environment. Flood & Jackson (2002: 90) support the view of Clemson declaring that the Viable Systems Model is

an arrangement of five functional elements (System One to System Five) that are interconnected through complex information and control loops.

Clemson (1984:137) adds insight into the compilation of the five functional elements of the Viable Systems Model as follow:

- **System One:** Is concerned with the collection of operational units.
- **System Two:** Is about the co-ordination function.
- **System Three:** Is concerned with the 'internal' and 'now'.
- **System Four:** Is about the external and future.
- **System Five**: Is to maintain the proper balance between System Three and System Four.

An in depth analysis of the five functional elements of the Viable Systems Model returns the following:

- **System One:** According to Jackson (1991:106), System One consists of the various parts of an organisation, directly concerned with its implementation, carrying out the tasks that the organisation is supposed to be doing. Flood & Jackson (2002:90) add that the following key aspects pertain to System One:
  - System One parts are directly concerned with 'implementation'.
  - Each part is autonomous in its own right.
  - Each part must exhibit all the features of a viable system itself.
  - Each part connects to its local environment and so absorbs much of the overall environment variety.

- **System Two:** According to Jackson (1991:108), System Two has the 'coordination' function. Under normal circumstances, compatible instructions from higher management should ensure that the various parts of System One of an organization act in harmony, but in an emergency, each part of System One will try to act in its own best interests based on only local information. Moreover, System Two consists of the control centres of the parts of System One linked to a corporate regulatory centre, which receives information about the cautions of the various subsidiaries and is able to prevent dangerous oscillations arising in the system created by all the subsidiaries. Flood &

Jackson (2002:90) provide the following key aspects pertaining to System Two:

- Co-ordinates the parts that make up System One in a harmonious manner.
- Dampens uncontrolled oscillations between the parts.

- **System Three:** According to Clemson (1984:134), System Three must maintain the internal homeostasis and must ensure that the various operational units are in fact producing what they are supposed to be producing. Clemson (1984:135) adds that System Three is charged with several tasks, namely:
  - Must ensure that its organization as an entity, produces the outputs that larger organisation requires of it.
  - Must ensure that its internal operational elements each produce the outputs that it is assigned to produce.
  - Must ensure that internal operational elements are able to secure the resources that they need to function.
  - Should be concerned that the workings of its internal operational elements are co-ordinated and do not generate 'vicious cycle' effects.
  - Must be concerned about the possibility of synergistic relationships among its operational units. This function involves assistance from System Four, but it pre-eminently involves maintaining a perspective that is logically superior to that of any of the operational elements. System Three must be concerned with the nature of the organisational unit as an entity and with the systemic, holistic properties that it has that none of the parts have.

Furthermore, Flood & Jackson (2002:92) add that the following key aspects pertaining to System Three:

- A control function that ultimately maintains internal stability.
- Interprets policy decisions of higher management.
- Allocates resources to the parts of System One.
- Ensures effective implementation of policy.
- Carries out 'audits' using the System Three auditing channel. 'Audit' is defined by Flood & Jackson (2002: 104) as, "…the general label Beer

attaches to audit and control functions designed to ensure that internal homeostasis is maintained".

- **System Four:** According to Jackson (1991:111) System Four is the point in the organisation where internal and external information can be brought together. As such, activities like corporate planning, market research, operational research, research and development, and public relations should be located there. Jackson (1991:111) adds that Beer propose that System Four become the 'operations room' of the enterprise, a real 'environment of decision', in which all senior meetings are held. Clemson (1984:133) expand these notions adding that System Four has three main 'jobs', namely:
  - The 'first job' is to create an explicit model of the organisation; what does this organisation do and how does it do it?
  - The 'second job' is to model the organisation's environment. Every organisation has an environment that is enormously complex and that is filled with things that potentially affect it in critical ways.
  - The 'third job' for System Four is to deal with the future. Given that the organisation has a model of itself and a model of its problematical environment, then it has a base upon which it can begin to build its desired future.

Flood & Jackson (2002:92) provide the following key aspects pertaining to System Four:

- An intelligence gathering/reporting function that captures all relevant information about a system's total environment.
- Provides a model of the organisation's environment.
- Distributes environmental information upwards or downwards according to its degree of importance.
- Brings together internal and external information in an 'operations room' an environment for decision.
- Rapidly transmits urgent information from Systems One, Two and Three to System Five.

- **The System Five:** According to Clemson (1984:137) System Five has as its primary function the maintenance of a creative tension between Systems Three and System Four. Jackson (1991:111) adds that System Five is responsible for the direction of the whole enterprise, ensuring that the organisation adapts to the external environment while maintaining an appropriate degree of internal stability.

  Flood & Jackson (2002:92) add that the following key aspects pertain to System Five:

  - Is responsible for policy.
  - Responds to significant signals that pass through the various 'filters' of Systems One, Two, Three and Four.
  - Arbitrates between the sometimes antagonistic internal and external demands on the organisation as represented respectively by Systems Three and Four.
  - Represents the essential qualities of the whole system to any wider system of which it is a part.

Clemson (1984:141-142) adds that the Viable Systems Model is Stafford Beer's design for 'effective formal organisations'. This model, since it is explicitly based upon the principles of cybernetics, facilitates consideration of what is and is not possible within formal organisations and provides guidance in creating efficient structures.

4.6 CONSTRUCTION OF THE VIABLE SYSTEMS MODEL

The highly complex elements making up the construction of the Viable Systems Model, are analysed in more detail in Appendix A

.

4.7 STRENGTHS AND WEAKNESSES OF THE VIABLE SYSTEMS MODEL

The Viable Systems Model has, according to Jackson (1991: 117) been found to be applicable to small organisations (Espejo 1979; Jackson & Alabi, 1986), large firms

(Beer, 1979), training programs (Britton & McCallion, 1985), industries (Baker, Elias & Griggs, 1977), local government (Beer, 1974) and national government (Beer, 1981a). Furthermore, Jackson (2004:106) adds that organizational cybernetics, as embodied in the Viable Systems Model, offers a model of great generality that can be applied to all types of systems and organizations, and to systems at different levels in the same enterprise. Moreover Jackson (2004:107) adds that Viable Systems Model offers a scientific justification for empowerment and democracy in organizations. The parts must be granted autonomy in order for them to absorb some of the massive environmental variety that would otherwise overwhelm higher management levels.

Jackson (1991:117) comments as follows on the attributes of the Viable Systems Model also serving as a powerful motivation to serve as the basis for the evolutionary systems approach to be formulated within the ambit of this thesis:

- The Viable Systems Model is capable of dealing with organisations whose parts are both vertically and horizontally interdependent. The notion of recursion enables the Viable Systems Model to cope with the vertical interdependence displayed in say, a multinational company that itself consists of divisions embracing companies, which embrace departments and so on. Jackson (1991: 118) adds that the applicability of the Viable Systems Model at different system levels acts as a great variety reducer for managers and management scientists. The idea of 'recursion' is not unique to Beer's writings, but only in the Viable Systems Model, is it incorporated into a 'usable management tool'.
- The model demands that attention be paid to the sources of command and control in the system. In the Viable Systems Model, the source of control is spread throughout the architecture of the system, allowing the self-organising tendencies present in all complex systems to be employed productively. Problems are corrected as closely as possible to the point where they occur.
- The model offers a particularly suitable starting point for the design of information systems in organisations, as has been convincingly argued by Espejo (1979), Espejo & Watt (1978) and Schumann (1990).
- The organisation is represented as being in close interrelationship with its environment, both influencing it, and being influenced by it. The organisation

does not simply react to its environment, but can proactively attempt to change the environment in ways that will benefit the organisation.

- The Viable Systems Model can be used very effectively as a diagnostic tool to make specific recommendations for improving the performance of organisations. A system of concern can be compared to the model to check that its structure and processes support an underlying organisation capable of ensuring survival and effectiveness.
- The model provides powerful cybernetic arguments for granting maximum autonomy to the parts of an organisation and for the democratic definition of purposes. According to Jackson (1991:119), Beer advocates decentralisation of control because of the implications of the law of requisite variety. These parts must be granted autonomously so that they can absorb some of the massive environmental variety that would otherwise overwhelm higher management levels.
- Clemson (1984:162) adds that the most important function of the Viable Systems Model is to facilitate maintenance of the continuous balance between autonomy of the parts and integration of the whole.

To provide a balanced perspective of the Viable Systems Model, the following criticism a levelled against the concept by Jackson (2004:108). The first states that although it may be the intention of the Viable Systems Model to promote decentralization and autonomy, it actually offers a powerful and extremely efficient means of increasing control and consolidating position. The second attacks the concept of 'good management' as proposed by the Viable Systems Model. Organizational cybernetics implies that good management is management that establishes requisite variety between itself and the operation managed, and between the organization as a whole and its environment.

According to Flood & Jackson (2002:110), a critique of Beer's Viable Systems Model is carried out making use of the meta-paradigmatic net which was developed for the purpose of critiquing methodologies:

- The cybernetic model is held by some to give an impoverished, or subset, picture of the organisation. It emphasises organisational structure and communication and control processes, but neglects qualities brought by the

human actors who make up organisations. As a result, it has little to say about the social processes that go on in organisations, e.g. organisational culture, politics or power struggles in enterprises.

- Connected to the first criticism it is often argued that the Viable Systems Model neglects the purposeful role of individuals in organisations. Flood & Jackson (2002:110) citing Ulrich (1986) indicts the model for being a 'tool' rather than a 'social system design', for emphasising 'purposiveness' instead of 'purposefulness' and for encouraging 'intrinsic control' but not 'intrinsic motivation'.
- It is sometimes said that the cybernetic model emphasises stability at the expense of change.
- It has been suggested that cybernetics encourages organisations to function on a set of a *priori* goals, without regard to the field of relationships in which they find themselves, and that this can be dangerous in the long term as organisations might spoil their environments.
- The cybernetic model is often accused of adherence to mechanical and biological analogies which are misplaced when applied to social contexts. However, cybernetics itself is stronger in articulating the complexity metaphors of machine, organism and brain than the participant metaphors of culture and politics.
- One of the main cybernetic principles that underlie the work of Beer is the 'law of requisite variety', that only variety can destroy variety. The Viable Systems Model can be seen as a grand design for a variety engineering organisation. Yet variety has been criticised as a poor measure inappropriate for scientific work, and as unexceptional when applied to the management of social organisations, but it is possibly, the only type of measure appropriate to the science of organisation.
- The Viable Systems Model is difficult to apply in practice, particularly because of the resistance it is likely to provoke within an organisation. As long as the Viable Systems Model is perceived as simply a more efficient control device, resistance to implementation will obviously be strong.

Notwithstanding, Flood & Jackson (2002:113) add that the Viable Systems Model survives most of the attacks made upon it, but there are two major unresolved

difficulties: The purposeful role of human beings within Viable Systems Model design has not been sufficiently well explored, but since the Viable Systems Model does not dictate a management style, this is a task to be done rather than a task that cannot be done. Second, the neurocybernetic perspective is only one way of conceiving any organisation, and this is adequately dealt with the logic of the concept of Total Systems Intervention when offered a process of thinking about organisational situations in terms of many metaphors.

In defence, Beer (1970: 256) offers the following perspective concerning the Viable Systems Model, arguing that "…viable systems have the ability to make a response to a stimulus which was not included in the list of anticipated stimuli when the system was designed. They can learn from repeated experience what is the optimal response to that stimulus. Viable systems grow. They renew themselves – by, for example, self reproduction. They are robust against internal breakdown and error. Above all they continuously adapt to a changing environment, and by this means survive quite possibly in conditions which had not been entirely foreseen by their designer".

4.8 THE GENERAL SYSTEMS PARADIGM EVALUATED

Having analysed the 'Systems Approach' (Chapter 2), the Biomatrix Model (Chapter 3) and the 'Viable Systems Model' (Chapter 4), it would be appropriate for the purpose of completeness, to draw the attention of the reader to the following points of criticism levelled at the general systems paradigm:

> *"The general systems paradigm has been criticised for using selective evidence from various scientific disciplines, as well as for applying analogies of phenomena across different fields of knowledge, in its construction of concepts that claim to be applicable across disciplines* (Lilienfeld, 1978).

> *"Systems thinking involve the paradox of attempting to be holistic vis-á-vis our inability to grasp totality* (Woodhill, 1993).

> *"Systems thinking achieve its all-encompassing universality by its abstractness and by ignoring the concrete, specific and substantive* (Lilienfeld, 1978).

> *"Systems thinkers are imprecise, ambiguous and often unclear in their use of concepts* (Lilienfeld, 1978; Robbins & Olivia, 1982).

> *"To date, the general systems paradigm does not "offer a conceptual space in which to visualise systemic ideas or any kind of conceptual map of how these ideas (i.e. various systems concepts) might relate to one another* (McNeil, 1993).

> *"The criticism has been lodged that although the general systems paradigm aims to develop a common vocabulary to unify disciplines, different disciplines have their own intrinsic and fundamental conceptions of systems and their functioning. These may even be in conflict with each other. At the same time, many applications of systems thinking within a specific discipline are not adding new insights to the discipline, but merely represent a replacement of vocabulary* (Lilienfeld, 1978).

4.9 CLOSURE

In this chapter, the ruling principles as it pertains to the Viable Systems Model were analysed in more detail. The major underlying principle to the Viable Systems Model, namely 'organizational cybernetics' was analysed while a perspective on 'management cybernetics' was provided for the purpose of clarity. The five functional components of the Viable Systems Model was analysed in detail to provide insight into the operational capability of the model. These functional components for the purpose of completeness has been expanded upon in Appendix A. The Viable Systems Model for the purpose of this thesis forms a key component of the evolutionary systems approach to Construction Engineering in Mozambique. As a result, it was considered appropriate by this author to provide an extensive evaluation of not only the strengths of the model, but also of its weaknesses. In the

same realm, another key component of the to be formulated evolutionary systems approach namely the general systems paradigm is critiqued to provide insight into the weaknesses of the concept in general.

In Chapter 5, a comparative perspective will be provided of the Mozambican and South African Construction Engineering Industries.

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CHAPTER 5

THE MOZAMBICAN AND SOUTH AFRICAN CONSTRUCTION ENGINEERING INDUSTRY ENVIRONMENTS: A COMPARATIVE ANALYSIS

> *"…Good governance and sustainable development are indivisible. That is the lesson of all our efforts and experiences from Africa to Latin America. Without good governance, without the rule of law, predictable administration, legitimate power and responsive regulation, no amount of funding, no amount of charity will set us on the path to prosperity"*
>
> ***Kofi Annan (2004)***[1]

5.1 INTRODUCTION

According to Hodgson, Hughes and Gasa (2003), in developing countries, the strategic aim of construction industry development is the creation of an enabling environment, in which sustainable domestic capacity is expanded upon to meet national demand, national economic and social objectives, improved efficiency and competitiveness and improved value to clients and society. The ultimate goal is the delivery of infrastructures and a built environment that underpin economic competitiveness and social development.

In this Chapter, the focus will be centred on a comparative perspective of the Mozambican and South African construction engineering industry operating environments. The complex problems and the negative impact of the current business and economic environment involving the Mozambican construction industry will be highlighted which includes key elements impacting upon the industry in terms of its negative operating environment. The holistic perspective of the status quo in this chapter will serve as background information to the analysis of complex phenomena

1 Speech of the United Nation's General Secretary. UNECA-Africa Governance Report: Addis Ababa, October 2004

to be analysed in Chapter 6 and to which the systems approach (Refer Chapter2) will be applied.

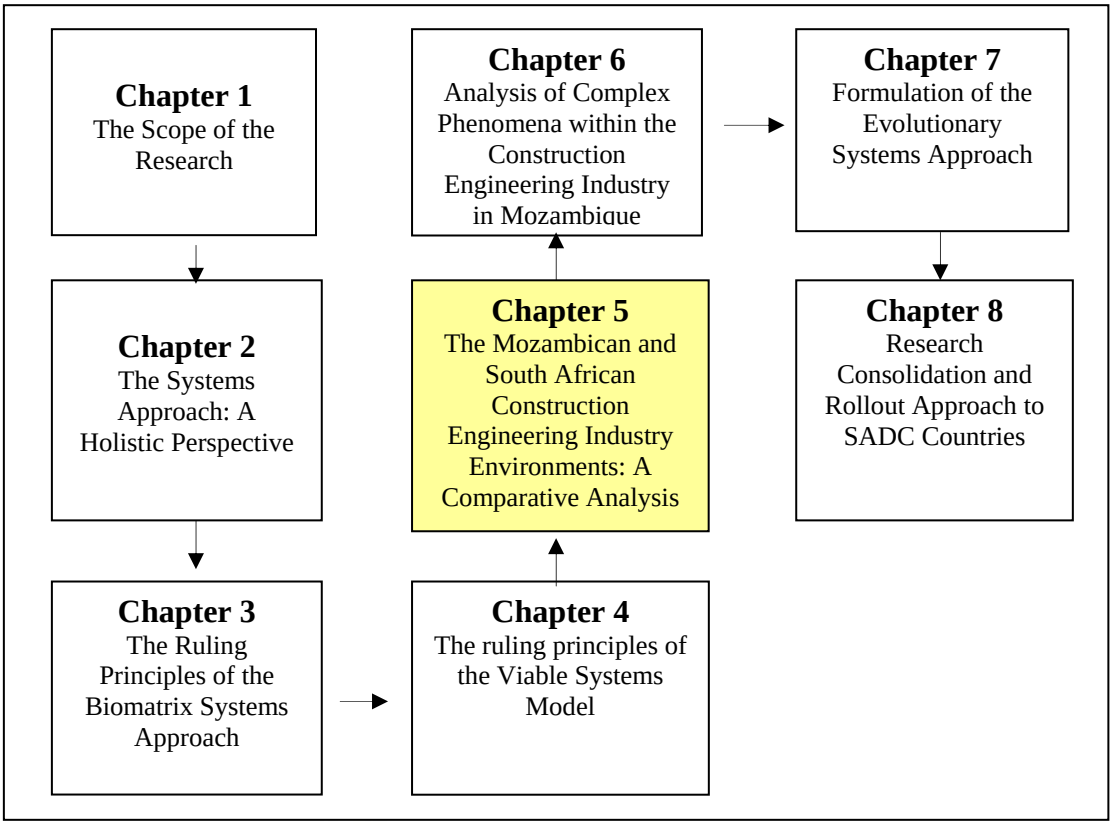

Figure 5.1: Chapters in context of the overall research

The analytical process followed thus far, is graphically depicted in Figure 5.1, which places the chapters in context with the overall thesis objectives, and furthermore indicates the relative positioning of this chapter.

5.2 BACKGROUND

According to United Nations – Habitat (2005) the population of Mozambique was estimated as approximately 18 million in 2002, with about 52 percent women and 48 percent men. 42 percent of the population is under 15 years of age, and only 3,6 percent is 65 or over (World Bank, 2004). The Centro de Promoção ao Investimento-CPI (1999) adds that Mozambique has the cheapest and most direct access to the sea for hinterland countries, namely Swaziland, Zimbabwe, and Zambia, while serving as principal harbours for these countries. Mozambique has a total area of 799,380

km² of land available for agriculture, with abundant forest resources capable to produce 500,000 m³ of high quality wood per annum. The Mozambican ocean produces 490,000 tons of fish and 14,000 tons of prawns per year, with a 2,800 km of coast drawing high quality tourism. Mineral resources include natural gas, coal, gold, tantalite, diatomite and others, making Mozambique a very attractive country with opportunities for investments and business opportunities.

Mozambique is considered one of the world's poorest and least developed countries, although recent surveys indicate a gradual improvement in this status. According to United Nations estimates, in 1998 the Human Development Index was 0,28 and it was ranked 166 out of 174 countries, while in 2001 the Human Development Index was 0,378, showing a significant increase, albeit from a very low base. This improvement reflects, in part, a reduction in the adult illiteracy rate from 60,5 percent in 1997 to 56,7 percent in 2001. Statistics from the United Nations & International Chamber of Commerce (2001) indicate that the purchasing power of the lower-middle and upper classes which is 2 to 3 percent of the population is comparable to that of the middle class in South Africa. The annual economic growth of more than 7% that the country is being enjoying since 1995 is steadily increasing the purchasing power.

USA-Trade (2004) statistics show that Mozambique's macroeconomic reforms in attracting large investment projects have resulted in an average GDP growth rate of 8 percent from 1992 to 2003, being the highest in Africa over this time period. GDP growth in 2003 was approximately 7 percent, and the government expects the economy to continue to expand at a rate between 7 and 10 percent over the next few years. The inflation for 2003 was 13 percent. Since a one time devaluation of approximately 40 percent in the middle of 2001, the Metical (national currency), has remained very stable against the dollar. The exchange rate, particularly over the past year has been relatively stable, and divergence between the official and parallel rate is small. Mozambique's trade balance however, remains unfavorable.

Against this background, Hanlon (2002) cite an article published by the United Nations (2002) - Office for Coordination of Humanitarian Affairs Integrated Regional Information Network, which argues that "…ordinary Mozambicans have to

see any real changes in their lives, despite official World Bank figures". Hanlon (2002) adds that this is confirmed by a public opinion survey which showed people not being of the opinion that their standards of living are improving. Furthermore, a survey of 13.790 households undertaken by the National Statistics Institute of Mozambique between October 2000 and May 2001, where people were asked to compare their situation with what it had been a year earlier, 35 percent expressed the opinion that they were in much the same situation as a year previously, while 38 percent said that they were worse off. Ratilal (2001), a former governor of the Central Bank of Mozambique is of the opinion that the declared living standard success has not yet produced tangible results for the majority of the population. Ratilal (2001) adds that rising unemployment and extremely high levels of absolute poverty are producing among others aspects, adverse social effects and rising crime.

US-Trade (2004) statistics reflect that imports for 2002 were $ 1.837 million, while exports were only $ 1.187 million. Direct donor aid accounted for 60 percent of the country's 2002 GDP and helped to cover government budgetary shortfalls. Direct foreign investment also covered a significant share of the shortfall, especially for the capital intensive MOZAL aluminum smelter and the recently inaugurated SASOL gas pipeline that transfers natural gas from Mozambique to Secunda, South Africa.

Business confidence, as reflected in the Association of Business Associations CTA/KPMG Quarterly Index (2004), seems to have experienced a series of upheavals during 2000, with business confidence declining. Uncertainty caused by the political impasse following the December 1999 general elections, widespread destruction due to the floods, and investor's intolerance for trends in neighboring Zimbabwe, clearly contributed in the short-term degradation of business confidence. US-Trade (2004) reflects that excellent macroeconomic policies and high-level commitment to attracting business mask the bureaucracy that remains at times unresponsive to the needs of corporations, especially for small-to-medium sized enterprises.

Opinions raised in the US–Dept. of Commerce - Country Commercial Guide Mozambique (2004) reflect that corruption is a serious problem in Mozambique. Bribe-seeking activities by officials throughout the government is an everyday

occurrence. Senior officials often have a conflict of interest between their public roles and their private business interests. The independent media actively reports alleged cases of misconduct and misuse of public funds by government officials, pointing out that political pressure is preventing the judiciary branch from investigating and prosecuting acts of misconduct by government officials. The government launched a new Anti-Corruption Unit operating under the auspices of the Office of the Attorney General, which is charged with investigating and prosecuting corruption-related offenses.

The Mozambican government has been accelerating the implementation of market based economic policies, including structural reforms in favour of private enterprises. Moreover, the government is eager to encourage foreign direct investment, which is governed by the Mozambican Investment Law nr. 3/93 (1993), with amendments by Decrees 12/93 (1993) and 37/95 (1995) which were subsequently replaced by Decrees 16/2002 (2002). Mozambique's traditional industries are disappearing, as they are no longer competitive as a result of an obsolescence of technologies, difficulties in importing material and subsidiary equipments and a lack of strategic planning 'vis–a-vis' global markets. In addition, the opening of the economy to Mozambique's neighbour South Africa, with its superior competitive advantage, contributed to the decline of the traditional industries in Mozambique.

5.3 FACTORS IMPACTING UPON THE MOZAMBICAN CONSTRUCTION ENGINEERING INDUSTRY

The factors which impact adversely upon the Mozambican Construction Industry are briefly elaborated upon below to create a composite understanding of the complexity of the various elements, and to show how tangent planes between these elements are juxtaposed to add to the adversity of the situation. The factors being referred to pertain to:

- Mozambican Legislation.
- Land ownership.
- Labour law.
- The judicial system.

- The fiscal system and taxation.
- The Municipal system.
- The housing policy.
- The financial system.
- Corruption.

5.3.1 Mozambican Legislation

Mozambique continues to be a country where it is difficult to do business and where in general, competitiveness is low. Research by this author has shown that the deficient business environment is not a consequence of a lack of political will, but basically the result of a complex process of change from a centralised economy to a market economy. This change is impacted upon by the recent colonial history and its politics of segregation, the recent civil war, and by the intrinsic characteristics of an extremely poor country. The lack of self confidence and capacity of Mozambican policymakers allows for the development of economic policies that do not address the realities of Mozambican business life. Furthermore, it is recognised that many changes that were suggested by the private sector were only partially implemented either because they were not understood properly by the Government or that the political risk of their adoption proved to be too high.

At The 8th Annual Conference of the Private Sector (2004), it was concluded that the main constraints in producing adequate legislation in Mozambique pertains to the fact that:

- Policymakers have little clarity about, and limited knowledge of the operation of market economies, which necessitates amongst others training on a sustained basis.
- There is an absence of self-confidence and capacity in Mozambican society which is needed to both balance the dominance and to encourage bold strategies for accelerating economic growth and ending absolute poverty (Woods, 2006).
- The Government continues to favour direct interventions by the state in the economy as opposed to acting as a facilitator in the provision of services to the citizens.

- There is a prevalent tendency to legislate 'everything' and a belief that the legislation must be complex in order to be good. This overly-complex legislation invariable leads to corruption in the government departments which increases transactional costs and creates uncertainties. The weaknesses of the legislative system also result in the exaggerated application of fines and penalties to both companies and individuals.
- At national level, the private sector is weak, with limited competences and very little capitalization.

The transparency of the regulatory system will be boosted by the promulgation of a new commercial code. According to the US-Dep. of Commerce 2004-Country Commercial Guide Mozambique, current regulation governing business are antiquated and may be viewed as contradictory. Bureaucracy associated with all aspects of doing business in Mozambique remains a serious problem. Investors must comply with a myriad of permits, approvals, and clearances that take a significant amount of time and effort to obtain prior to investment approval. The World Bank Report entitled "Doing Business in 2004" (2004), identifies Mozambique as one of the most difficult countries to establish a business and adds that entrepreneurs can expect to go through 14 different steps to launch a business over a period of 153 days on average.

5.3.2 Land Ownership

Land tenure is a subject of intense debate and at present relies on a lease system without private ownership. While private ownership including industrial property rights is protected by law, private ownership for land is not recognised. The Ministry of Public Works and Housing is responsible for drafting the Regulations for urban land and national housing policy, and for the control of the quality of building and infrastructure works as well as regulating of the construction engineering industry.

According to the United Nations-Habitat (2005), the haste and lack of consultation in the formulation of the regulations for urban land and national housing policy in 2004 was caused due to pressure from the World Bank, who found that there is insufficient security of land for large investors. Few companies have been successful in

overcoming the plethora of obstacles to invest in Mozambique. Furthermore, the United Nations-Habitat (2005) found that the consultants to the Ministry of Environment who have prepared Mozambique's policy for land use and planning did not consult with stakeholders. This was made through a participatory process at provincial, regional and national levels. Amongst other elements, the draft includes the following:

- Recognises existing occupiers and communities of land as the most important element in any intervention of ordering or planning of land use and natural or built resources.
- Promotes the concept of territorial planning as a means of achieving sustainable use of natural resources
- Defines the type of plans, the responsible bodies and means for approval, alteration, revision and suspension. It also establishes a public right to information, participation and objection.

According to the Constituição da Republica de Moçambique (Artigo no.109), all land ownership vests in the state. Land cannot be sold or passed onto a third party, nor may it be mortgaged nor pledged. The underpinning reasoning for this being that the use and benefit from land for creation of wealth and social well being is the right of all Mozambicans. According to the Constituição da Republica de Moçambique (Artigo no.111), the state recognises and protects the rights to land acquired through inheritance or occupation, except in legally defined reserves or areas where land has been legally transferred to another person or body. According to Mozambican Law no. 10/95 (Council of Minister's Resolution), the national land policy was made to reflect Mozambique's entry into the market economy, with the objective of promoting post-war reconstruction. Key principles of the policy are to ensure the rights of the Mozambican people over the land and other natural resources, and to promote investment in sustainable and equitable use of these resources.

5.3.3 Labour Law

According to the US-Dep. of Commerce 2004: Country Commercial Guide Mozambique, the estimated work force in Mozambique is 9,2 million. In 2004 the Government increased the country's statutory minimum wage by 13 percent. The

minimum wage for industry, services, and the civil service rose by 14 percent, while for agricultural works it rose by 15 percent. Labour unions created during the socialist years are gaining strength and asserting greater independence from the ruling party Frelimo (the political party in power). With respect to the revision of the labour law in 2004/2005, labour unions are exerting pressure on the Government to maintain a high degree of worker protection in the labour law.

In terms of the US–Trade Report (2004), the labour laws in Mozambique are problematic for investors and employers. The government recognises that current labour legislation is not conciliable with private sector growth. Attempts at reforming the laws however, will place Frelimo in conflict with historical supporters in organised labour, an aspect which the government would prefer to avoid. This results in a situation where most privately owned business interests are being ignored, adversely impacting in particular the Construction Engineering Industry.

The 8th Annual Conference of the Private Sector (2004) reflected that only 521,000 people are employed in Mozambique by the formal public and private sectors, which translates to about 6% of the total employable population of 9,2 million people. Current labour laws have been strongly criticized by entrepreneurs as they promote policies that protect the very few that are employed and do not encourage the creation of new jobs. The issues raised by the private sector regarding the labour laws include the following:

- The inflexibility of the law regarding the employment and dismissal of workers does not promote investments in labour-intensive industries in the likes of construction engineering.
- The cost of dismissing workers does not encourage innovation in companies as it becomes too expensive to employ new and more qualified people.
- The excess of paid vacations and other benefits result in Mozambican labour being very expensive and unproductive.
- The ever-increasing national minimum wage and its impact on companies' general payroll do not promote the creation of additional jobs.
- The administrative difficulties related to the employment of qualified construction engineering foreign workers reduce the competitiveness of the

country, and prevent many qualified foreigners from investing in small and medium companies and generating new job opportunities.

According to the US-Trade Report (2004), although under revision, the labour laws are extremely biased and remain an impediment for foreign investment. Business operations are further impacted upon by labour inspectors that are notoriously corrupt, by the human capacity that is weak particularly the availability of skilled labour, and the increasing HIV/AIDS threat which erodes the labour base.

5.3.4 The Judicial System

In terms of the US-Dep. of Commerce 2004: Country Commercial Guide Mozambique, the Mozambican judicial system is generally regarded as corrupt, inefficient, and subject to political pressures. Municipal, district and provincial courts exist but lack training and resources. The Supreme Court is the highest court of appeal, and consists of seven members appointed by the President and approved by Parliament. The expeditious and transparent operation of the judiciary is fundamental to investor confidence and litigation resolution. The US-Trade Report (2004), confirms that Mozambique has an expensive, slow, and unreliable judicial system. Most disputes among Mozambican parties are settled privately or go unresolved. The business community is still so small that a damaged reputation from a commercial dispute or accusation of illegal activity can seriously impact on a business venture. For disputes involving international and national companies, the law closely follows the UNCITRAL-United Nations Commission of International Trade Law model.

5.3.5 The Fiscal System and Taxation

The US-Trade Report (2004) reflects that fiscal reform was instituted in an uncoordinated way without adequate planning and participation from key role players. A number of studies in this respect show that the high level of taxes adopted, and the complexity involved in the fiscal administrative process defeated the initial objectives of tax base enlargement through the attraction of more taxpayers to the system. With regard to customs system reform, significant improvements with regard

to procedures as well as coordination of the customs fiscal authorities with the private sector were confirmed.

The 8th Annual Conference of the Private Sector (2004) returned that, conceptually the Government and the Private sector present different viewpoints, since the Government intends to control and maximise revenues, while the private sector aims for efficiency, productivity and competitiveness. Furthermore, the 8th Annual Conference of the Private Sector (2004) refers to the fact that the country's fiscal policy does not stimulate investment, productivity, creation of employment or development of the private sector.

A new taxation system has been introduced in order to meet the deficit in the governmental budget, and as a result high taxes are being collected from private companies and individuals. The fiscal directive that requires construction engineering companies to pay anticipated taxes based on their previous year's invoicing serves as an example of one of the new taxation laws. This dispensation does not create a stable environment for entrepreneurs and business investors. Business leaders and entrepreneurs are desperate in their efforts to keep their organisations operating, in most cases 'without losses' but also 'without profits', with the sole objective to maintain market presence, waiting for better business opportunities. The situation however is not sustainable for the already established companies. To start a new business venture in Mozambique involves unpredictable risks and extraordinary efforts to overcome the myriad of obstacles imposed by legislation, adversely impacted upon by general corruption (an accepted norm) and red tape that is debilitating and well established.

5.3.6 The Municipal System

Mozambican Law 2/97 (Article 6), replaced by Law 22/97 pertaining to the Municipal Framework Law, municipalities are given the responsibility for urbanization, housing and licensing construction in accordance with their capacity, and in conjunction with other state bodies. Municipalities are also given the authority to exercise powers given to them under the Land Law and Regulations. According to the Mozambican Law 11/97 (Articles 24 and 27), the Municipal Finance Law gives

municipalities the power to prepare and approve general and detailed land use plans, urban development programs and land development schemes, in collaboration with relevant central government bodies. Enforcement of such plans is subject to ratification by the government. According to Law 11/97 (Articles 54-61), municipalities can also collect taxes on urban land and buildings, including unused land that has been provisionally allocated.

5.3.7 The Housing Policy

Concerning the housing policy, the United Nations-Habitat Report (2005) reflects that there is no officially approved housing or urban policy in Mozambique. In 1990, the first national housing policy was formulated and subsequently approved by the Assembly of the Republic, but was never adopted. A new housing policy is currently being prepared by the Ministry of Public Works and Housing, but unfortunately little consultation by the ministry with other organizations has occurred. To date, there has been little coordination of policies between the Ministry of Environment and the Ministry of Public Works and Housing. Mozambican towns and cities follow the infrastructural trends developed during the colonial period. During that period, permanent housing and infrastructure was largely denied to the Africans, who subsequently housed themselves in unplanned and un-serviced settlements on the outskirts of colonial towns. Today, towns and cities typically include a central area, formally laid out during the colonial period for settler population and provided with some public services. Surrounding these areas is a mix of unplanned occupation and areas laid out since independence with plots for owner-built housing.

There are no statistics on the demand for housing, although it is clear that access to housing is a major problem in urban areas. This is especially true in the Maputo and Matola areas, where there is high demand for urban land. This is due to the private sector housing development which is aimed at the top end of market. Government housing initiatives have been limited to the Housing Promotion Fund, while NGO's involvements are limited to re-housing victims of the 2000 floods. Furthermore, there is no government policy or system that seeks to provide housing finance for the greater majority of the population, whose incomes are too low to be considered for a

bank loan, resulting that many low and middle income families building their own homes.

5.3.7.1 Housing Services

According to United Nations-Habitat Report (2005), the National Water Policy recognises that urban residents suffer from deficient water supply and sanitation services. The observation is also made that peri-urban residents without piped water supply pay more for their water than more affluent residents with better water supply. While the policy states that one of its prime objectives is the provision of basic water supply to low income groups, and emphasises women's participation in management, it is heavily influenced by the structural adjustment and cost recovery policies of the World Bank. The policy dictates that water should be viewed as having both social and economic value. The price of water should therefore reflect its economic value and geared towards cost recovery. The policy paved the way for privatisation of the management of operation of water supply services, and concessions for water supply in seven major urban centres.

Electrification in urban and peri-urban areas is driven by demand, and the national electricity company extends supply on request, provided that the owner can pay for the cost. In general, people are not evicted for not paying utility bills. Instead, supply is discontinued.

5.3.8 The Financial System

The financial system of Mozambique reflects recent policies undertaken by the Government and the Bank of Mozambique (Central Bank). According to the US-Trade Report (2004), liberalisation of interest rates was approved in 1994 and between 1996 and 1997 financial institutions began to privatise. The merger of two national banks, the Banco Internacional de Moçambique and the Banco Comercial de Moçambique was completed in 2001. The re-privatisation of Banco Austral to ABSA, the purchase of BNP Nedbank by African Banking Corporation, the closing of Credicoop, and more recently, the merger of Banco Comercial e Industrial de Moçambique and Banco de Fomento have streamlined and created major changes for

the banking sector. Banco Internacional de Moçambique dominates the Mozambican banking system controlling 48 percent of the loan market and 52 percent of the deposit market.

Commercial banks in Mozambique are best suited for short-term loans, trade related finance, and free-based services. Medium-term loans are available, but demand high collateral requirements and are subject to very high interest rates for the commercial sector. Long term and mortgage-based lending is not generally available. Venture capital financing is uncommon having a particular impact on the Construction Engineering Industry. Leasing is an area of growing commercial bank interest. For foreign companies it is more beneficial to obtain offshore financing for their Mozambican operations, making the Mozambican companies less competitive. The range of services offered by domestic banks is limited, and innovation is not a hallmark of the sector.

Concerning credit policies, several banks are active in providing credit for housing. Requirements for guarantees and the very high interest rates (between 20 to 30 percent) have restricted access to the wealthy.

5.3.9 The Impact of Corruption on the Mozambican Construction Industry

Mozambique seems to fit the pattern of having been a paragon of integrity in the late 1970's (Gastrow & Mosse, 2002). A study by the South African Institute of Security Studies clearly shows that "…Mozambique is very close to becoming a criminalised state". The legal system has collapsed and court rulings are available to the highest bidder. Furthermore, Gastrow & Mosse (2002) add that money laundering is common, and Mozambique has become an important drug warehousing and transit centre, with large sums of cash involved.

An extensive survey by Austral Consultoria e Projectos, Lda (2004) was executed to highlight the control of corruption in Mozambique. The study was based on three parallel surveys, directed at households, enterprises and public officials, where 2447 Households, 486 Enterprises and 992 Public Officials were interviewed throughout Mozambique.

According to Austral Consultoria e Projectos, Lda (2004), the study concluded that according to the indicators produced by the World Bank Institute on the control of corruption, and taking the Southern African region as a reference, Mozambique is situated among the worst countries in terms of controlling corruption with only Angola and Zimbabwe presenting worse scores (See Figure 5.2).

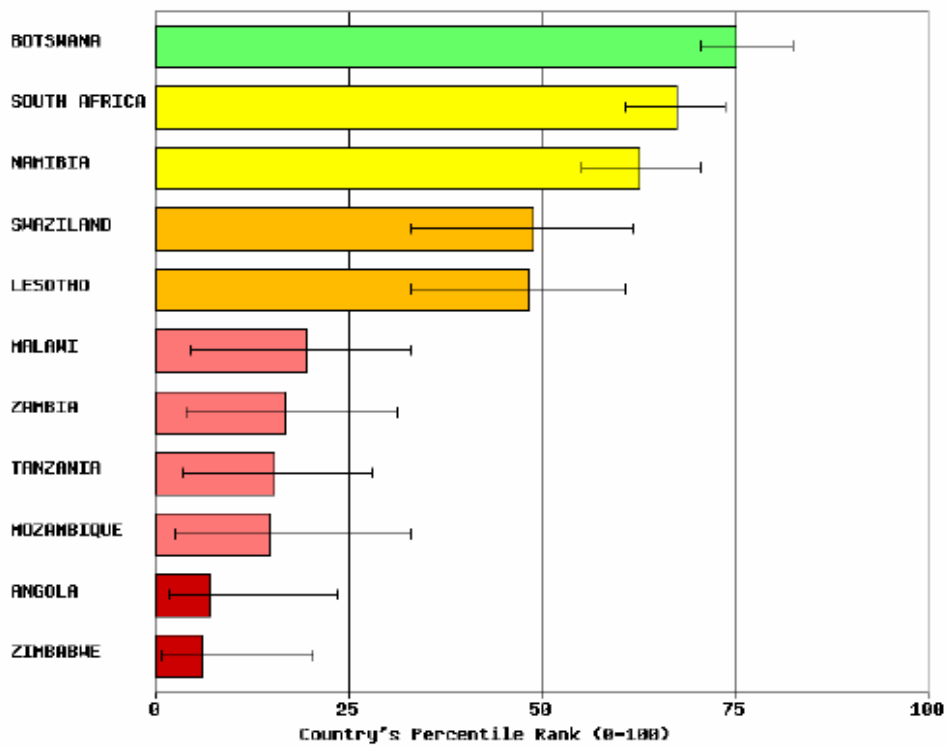

Figure 5.2: Control of Corruption in Southern Africa.
Source: Austral Consultoria e Projectos Limitada (2004)

According to the survey by Austral Consultoria e Projectos Lda (2004) on Mozambique, the country was evaluated in terms of the following criteria:

- Voice and accountability.
- Political stability.
- Government effectiveness.
- Regulatory quality.
- Rule of law.
- Control of corruption.

Corruption was found to be one element on which Mozambique underpinned the most. For a graphical depiction of the relative positioning of the criteria, see Figure

5.3. Taking into consideration the dynamics at work over the last couple of years in Mozambique, the control of corruption is the only factor that did not show an improvement.

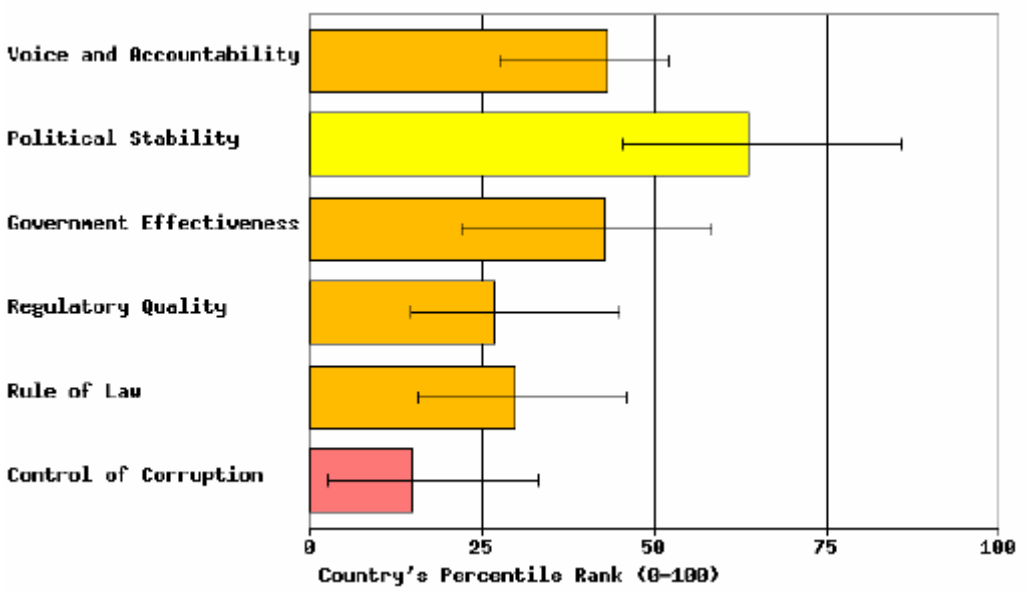

Figure 5.3: The key elements pertaining to corruption.
Source: Austral Consultoria e Projectos Limitada (2004)

As part of the survey conducted by the Austral Consultoria e Projectos Lda (2004) twelve elements were identified (Unemployment, cost of living, inflation, water, food, roads, crime, public corruption, medical assistance, drugs, sanitation and housing) across three sectors of population namely households, enterprises and officials.

The survey returned a surprising result which reflects that amongst business and government officials, the perception was contradictory to the actual prevailing situation. Figure 5.4 shows that households and government officials view unemployment as the highest factor which impact on them, while enterprises reflect 'crime' as the highest figure. This surprising result points to the fact that in sub-Saharan Africa, the concept of 'corruption' is considered an accepted practice and part and parcel of everyday life. The importance of this survey cannot be overstated, and Appendix B contains a verbatim abbreviated translation by the author of this thesis from the original Portuguese report by Austral Consultoria e Projectos, Lda entitled 'Pesquisa Nacional sobre Governação e Corrupção, (2004)'.

The twelve elements which impact Mozambique most adversely (The smaller the number, the worst the problem)	Groups Surveyed		
	Households	Enterprises	Officials
Unemployment	1	2	1
Cost of living	2	3	2
Inflation	3	7	4
Water	4	8	8
Food	5		9
Roads	6	4	
Crime	7	1	3
Public corruption	8	5	10
Medical assistance	9	9	
Drugs	10		5
Sanitation		6	6
Housing		10	7

Figure 5.4: The ten most serious problems pertaining to the Mozambican society

Source: Austral Consultoria e Projectos, Lda (2004)

5.3.10 Mozambican Construction Engineering Industry: Largest Projects

In terms of mega projects, the Mozambican construction industry continues to grow. The rehabilitation and expansion of the national road and rail network is continuing with significant donor funding from the World Bank and other organizations. The rehabilitation of port and airport facilities also figures prominently on government and donor agendas. Construction of rural health and education facilities offers possibilities for additional contracts. In terms of the International Trade Administration, US – Dept. of Commerce (2006) – Country Commercial Guide Mozambique, the following important construction projects are currently being implemented in Mozambique, namely:

- The major commercial ports are at Maputo, Beira, and Nacala. Long-term operating concessions in port and railway services will involve significant expansion and equipment upgrades. The Maputo Port Development Corridor recently assumed operation of the port of Maputo on a 15-year management

concession agreement (extendable for another 10 years), and is undertaking significant infrastructure upgrades.

- The Beira port has undergone significant upgrades over the past decade. Beira is Zimbabwe's main port of entry to the world market. Political turmoil in Zimbabwe has slowed traffic through the port, with exports declining by approximately 40% since 2001. Reconstruction and management of the Sena line, which links Beira with the city of Tete, was given by the Mozambican government to the firms RITES and IRCON in 2004. The World Bank is providing $104.5 million in soft loans, with RITES and IRCON investing an additional $35 million, to restore this line. Reconstruction will require three and a half years. Given the current inoperative state of the entire length of the line, significant purchases of equipment, rails, signals, and rolling stock will be a necessary part of the process

- Two American companies, Edlow Resources Ltd and Railroad Development Corp., are shareholders in the Nacala Corridor Development consortium, which manages the port of Nacala and the railway line to Malawi. The Overseas Private Investment Corporation is funding the consortium with $30 million to improve both the port and the railway line. Development of the Nacala rail corridor, particularly to connect the line to the massive coalmine in Moatize, should lead to significant investment in port and railway equipment and rolling stock.

- Considerable oil and gas exploration possibilities exist in the provinces of Gaza, Inhambane, Sofala, Zambézia, Nampula, Cabo Delgado, and related offshore areas. The government opened bidding in July 2005 for the exploration of several offshore blocks in an area known geologically as the Rovuma Basin, named for the Rovuma river that forms Mozambique's northern boundary with Tanzania. On January 31 the government announced that it was reviewing bids from seven companies, including one American company. A winner is to be selected during 2006.

- In the South, the Pande gas field is a proven world-class natural gas deposit, with reserves of over 3.5 trillion cubic feet. SASOL South Africa completed the construction of a natural gas pipeline from the Pande and Temané gas fields to its synfuel plant in Secunda, South Africa in 2004. In early 2005 SASOL routed some of this gas back to Mozambique through a newly built gas pipeline running from South Africa to Maputo, paralleling the highway from the border.

- Mozambique has commercially important deposits of coal, high quality coking coal, iron ore, titanium ore, apatite, graphite, marble, bentonite, bauxite, kaolin, copper, gold, and tantalum ores. Two of the largest investment projects in development are mining and processing ventures of "heavy sands" deposits, essentially mineral deposits brought down by rivers and built up into sandy bluffs.

- The Moma Heavy Sands and Corridor Sands projects together will require more than $1 billion in investment in the next few years. Lack of electricity at the moment is a key constraint on the Corridor Sands project, and may delay its development for several years while a source of power is found.

- Companhia Vale do Rio Doce, a large Brazilian coal company, won rights to the world-class Moatize coal field in Tete province in late 2004. There may be possibilities for the provision of coal mining equipment for its operations. Companhia Vale do Rio Doce also is considering constructing a coal-fired power station, perhaps 1,600 megawatt in size. The building of this station would offer additional opportunities in Mozambique's construction sector.

- Mozambique has considerable hydropower potential. The Mozambican government is actively seeking investors to build a northern powerhouse at the Cahora Bassa dam (the southern bank powerhouse is in operation) and to construct a second dam lower down the Zambezi at Mepanda Uncua.

- Construction of the bridge over Zambezi River in Caia, at the centre of the country. A $ 90 million project.

5.4 BENCHMARKING PRACTICES IN THE CONSTRUCTION ENGINEERING INDUSTRY

According to Knuf (2001:58-71) and Smith (1997:40-46), "…benchmarking is an important continuous improvement tool that enables companies to enhance their performance by identifying, adapting and implementing the best practice identified within a participating group of companies".

A group of 24 companies in the Chilean Construction Engineering Industry has participated in a National Benchmarking Study that also provides a reference to international benchmarks (Alarcon *et al.* 2001). The National Benchmarking System was developed by the Corporation for Technical Development of the Chilean Chamber of Construction, with the support of the program for Excellence in Production Management of the 'Pontificial Universidad Catolica de Chile'. By comparing key performance indicators, the Corporation for Technical Development hopes to identify best practices and generate short term improvement opportunities for participating companies (Proyecto FDI, 2001). However, using performance indicators to measure the 'gap' between 'individual company performance' and the 'industry leader' will generally not enable the root cause of the difference to be determined. The analogy can be drawn that to identify the management practices that underpin these performance differences, it is necessary to complement a 'quantitative benchmarking system' with a 'qualitative benchmarking system' based on a structured industry questionnaire. Qualitative benchmarking provides information on different management dimensions to help identify best practices and explain observed performance differences.

According to Have *et al*. (2003), 'benchmarking is the systematic comparison of organizational processes and performances in order to create new standards and/or improve processes'. Four basic types of benchmarking can be identified:

- **Internal:** Benchmarking within an organization.
- **Competitive:** Benchmarking operations and performance with direct competitors.
- **Functional:** Benchmarking similar processes within the broader range of industry.

- **Generic:** Comparing operations between unrelated industries.

Any type of industry can benefit from benchmarking. Benchmarking can provide new insights into strengths and weaknesses of an organization, illustrate possible improvements, create objective norms, and assist in the formulation of new guidelines and fresh ideas. Benchmarking according to Have *et al.* (2003), entails the following (sometimes overlapping) steps:

- Determining the scope of the project.
- Choosing the benchmark partner(s).
- Determining measures, units, indicators and data collection method.
- Collecting data.
- Analysing the discrepancies – get facts behind the numbers.
- Presenting the analysis and discuss implications in terms of new goals.
- Making an action plan and/or procedures.
- Monitoring progress in ongoing benchmark.

The process of benchmarking as proposed by Have *et al* (2003) is schematically depicted in Figure 5.5

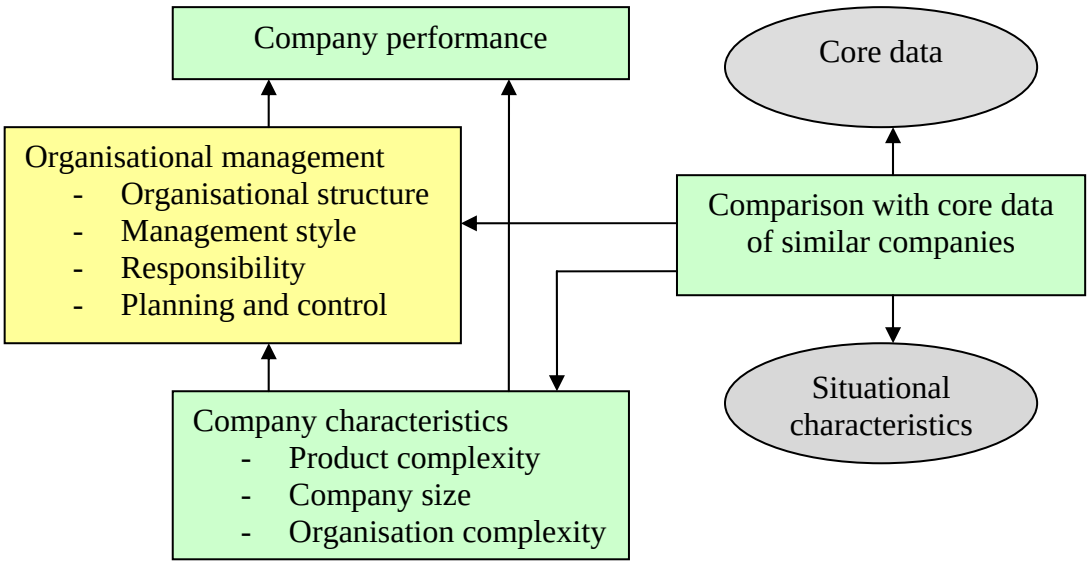

Figure 5.5: The process of benchmarking (**Source:** Adapted from Have *et al.*, 2003)

By applying explanatory factors, benchmarking can not only provide comparative data that can trigger the need for improvement, but also highlight new improvement opportunities and solutions to problems (Have *et al*., 2003).

A country's economic growth and business sustainability depends largely on the human resource quality, the technological level and its general legislation. Benchmarking the impact of legislation on the sustainability and growth of the industry, can help to develop new standards against which performance can be assessed. Furthermore, benchmarking can improve the policy and legislation formulation, avoiding impact on the construction industry caused by adverse limitations of legislation.

According to Spendolini (1992), data analysis for benchmarking can be conducted using the following approach:

- Summarise and interpret data.
- Analyse the gap between the processes being analised (legislation) and the partner's equivalent processes (legislation).
- Project where future gaps will be.
- Analyse things that were not on the agenda.
- Develop key findings into new operational goals.

Analysing the benchmark performance gap can be done as a 'snapshot' or as a 'trend' over a period of time. To close the benchmark gap, the non complying performer must take strategic actions in addition to operational process improvements. More often than not, these strategic actions include restructuring, reengineering or redesigning the concepts and legislation. The qualitative observations may provide the breakthrough thinking that will be required in order to 'leap-frog' the current process and develop an improved process (Spendolini, 1992).

As a continuous process improvement technique, benchmarking requires the same change management frameworks which are typical of organisational improvements. It also employs a proven methodology to achieve meaningful results from benchmarking assessment, as reflected in Figure 5.6, adapted by this author to map

to the theme of this thesis. Appendix F reflects this process applied to the Construction Engineering Industries of South Africa and Mozambique.

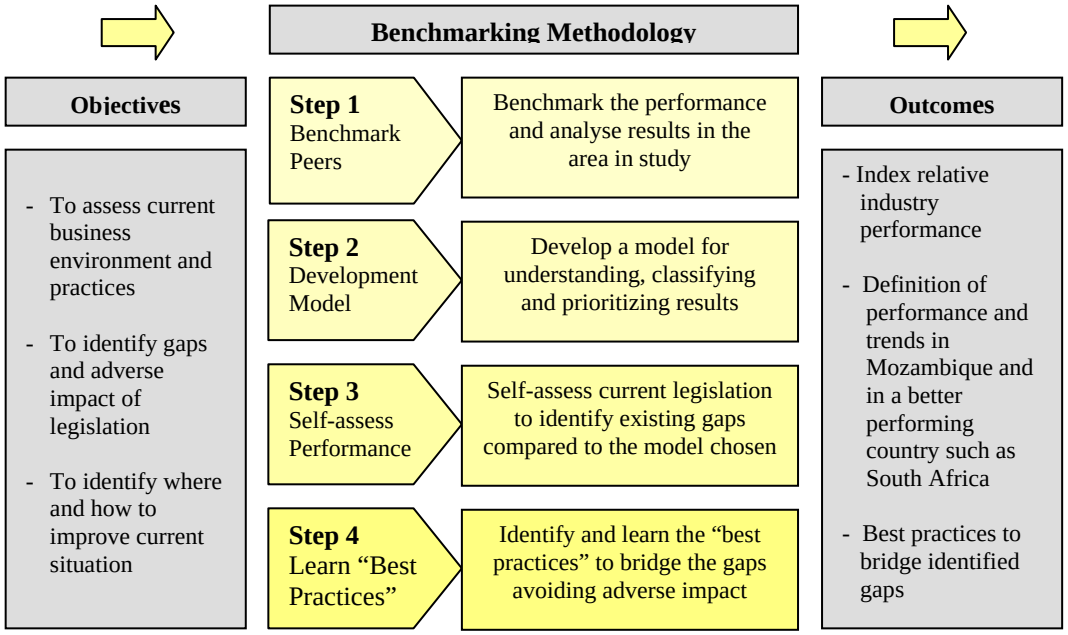

Figure 5.6: Benchmarking methodology **(Source:** Adapted from On Marc Consulting, 2004)

The Knowledge Assessment Methodology is a benchmarking tool developed by The World Bank Institute, which serves as quick graphical approach to compare countries policies and institutions. The methodology is used as a framework to determine how the economy and economic legislation compare with the country used as a reference. Benchmarking can be used in the context of performance management and in the investment decision-making process. Benchmarking is as much a 'qualitative' as it is 'quantitative' exercise to assess and determine 'gaps' in performance. Benchmarking results provide a 'snapshot' of the gap and competitiveness of an asset and effectiveness of the organization responsible for its operation.

According to Tomasko (2002), common difficulties businesses have with the concept 'benchmarking' pertain to the fact that:

- Benchmarking is by nature a 'rear-view mirror' approach. Before a practice can be selected for benchmarking it has to have been put in place and proven its worth. Considerable time may pass before one can consider to adopt a particular practice. A practice which was appropriate for a particular point in time in the past may be less useful in the present.

- Companies to be benchmarked against are frequently chosen on the basis of past financial performance. While past success is not always the best predictor of current or future performance, such companies invariable could suffer a performance decline even though they seemed to be performing well in terms of the benchmark.
- Benchmarking often attempts to isolate and extract individual management practices from the broad array of practices a company are using. This extraction processes often misses the interdependencies and preconditions one practice sets for another. This extraction process more often than not misses the cultural context that enables a particular practice to be effective in one company, but useless in a business with a different history and culture.
- Companies sometimes try to take short-cuts to address their underlying problems, by hoping to find (symptoms) relief through force-fitting 'proven' best practices (benchmarks) on to their organisations. Organisations have to be treated as organic 'wholes' and the implications of change in one aspect of how the company operates must be considered in relation to how everything else functions.
- For many companies the future is a 'moving target'. The biggest danger from focusing too heavily on best practices of the past is the risk of missing clues about what will be most needed in the future.

The improvements which can be made to the status quo of an organisation invariably culminate in benefits to be gleaned from the exercise. In this respect, the Benchmarking National Research Policies Conference held in Athens from 17-18 January 2003 upheld the following opinion:

> *"…The presentation and discussions in this conference, however, have reinforced the necessity of linking benchmarking exercises to policymaking. This is not a recently perceived need. Benchmarking, in the guise of the collection and comparison of strategic intelligence (otherwise known as spying or the covert method of coordination), has swayed decision-making at the highest levels since time immemorial."*

5.5 THE SOUTH AFRICAN CONSTRUCTION ENGINEERING INDUSTRY SERVING AS A BENCHMARK FOR MOZAMBIQUE

It is important to note that according to the Construction Industry Development Board (2003), South Africa, as a developing country is fortunate to have a strategically developed Construction Engineering Industry. The expansion of South African business into global markets, including sophisticated engineering and construction services, highlights the inherent potential of the country as well as that of its Construction Engineering Industry.

According to Rogerson (1998), the South African Construction Industry is a potential critical actor in post-apartheid reconstruction. The reasons include tangent planes with other sectors, its growth-generating characteristics and its potential for adopting labour-intensive techniques for a wide range of products. The release in 1998 of the South African Government's Green Paper on the construction sector has focused attention on the creation of an enabling environment for the growth of the industry, the organization and working of the construction economy, including the sector's roles in national reconstruction. Rogerson (1998) adds that the building construction sector is also fundamental to housing delivery in urban reconstruction and in the economic empowerment of historically disadvantaged communities. In many aspects therefore, the construction sector is at the cutting edge of post-apartheid economic and social development.

The building construction sector can play a meaningful role in addressing the current unemployment crisis in South Africa. According to Rogerson (1998), the overall industry employs about 450,000 people, a figure which was in decline as a result of economic recession and high interest rates and now in an upswing. Furthermore, the growing presence of foreign migrant workers in the South African construction sector contributes to this trend. Internationally, the Construction Engineering Industry is characterized by a pattern of segmented labour markets, casual forms of employment and by the extensive use of subcontracted work, all of which pave the way for migratory workers. The South African construction sector does not attract migrants from as wide a range of source countries as in the case of other sectors. Only four countries are the major suppliers of migrant workers, namely

Mozambique, Zimbabwe, Swaziland and Botswana, with Mozambique the dominant supplier of migrant labour to South Africa.

According to South Africa's former Minister of Public Works, Radebe (1999), the White Paper of 1999 is a refined result of a broad public policy making process and represents a significant milestone in the development of the South African Construction Engineering Industry. Furthermore, it provides an enabling framework within which the Construction Engineering Industry can play a more strategic role in social development and economic growth.

Radebe (1999), in referring to the 1999 White Paper, is of the opinion that: *"…The construction industry, comprising both the building and civil engineering sections – performs an indispensable role in the economy of South Africa and increasingly of the region as a whole. The construction industry provides the infrastructure which is fundamental to the ongoing development of our country; its activities affect everyone's lives in one way or the other. Right at the top of the list of Government development priorities is the provision of infrastructure in undeveloped areas, designed to bring relief to people living there in the form of jobs, linkages to markets, assets that promote economic business development in an integrated and coherent fashion. Jobs, expanding business opportunities and the potential for increased investment for small, medium and emerging contractors and individuals are but some of the benefits that will flow from an expanded and motivated industry"*.

The White Paper published in 1999 has as it core the concept of 'construction engineering change'. It is about the actions needed to stimulate change, to promote increased participation of the emerging sector, improved labour relations and sustainable employment. Furthermore, it is about appropriate human resource development and improved industry and client performance. In addition, it is about establishing the institutional arrangements best suited to create a climate in which the industry can readily adapt to the accelerating changes impelled by globalisation.

Moreover, the White Paper (1999), dictates that the Department of Public Works in South Africa is responsible for the championing of a range of initiatives, and has to co-ordinate the development of a comprehensive Construction Engineering Industry

development policy as part of its contribution to the national project of reconstruction, growth and development. Furthermore, the White Paper (1999) dictates that the Construction Engineering Industry comprising both building and civil engineering sections, performs an indispensable role not only in the economy of South Africa, but increasingly in the African region as a whole. Expanding business opportunities, the potential for increased investment for small, medium emerging contractors and individuals, represent some of the benefits that will flow from an expanded and motivated industry.

The South African Construction Engineering Industry, which comprises both the building (residential and non-residential) and civil engineering sectors, provides the physical infrastructure which is fundamental to the country's development and its activities affect the lives of all South Africans. Construction Engineering contributes about 35% to gross domestic fixed investment, and current projections of future infrastructure requirements indicate that its contribution to gross domestic fixed investment could double within the next 5 to 10 years. Furthermore, the Construction Engineering Industry offers significant job and business opportunities to those formerly marginalized from economic activity.

5.5.1 The South African Construction Legislation

South Africa established the Construction Industry Development Board (CIDB) in April 2001 as a result of an act of parliament (CIDB Act 38 of 2000). This followed a three-year process of broad stakeholder engagement under the auspices of a constituted task team, mandated by the Minister of Public Works. The work of the team culminated in a draft government policy which contributed to the finalisation of the government's White Paper entitled "Creating and Enabling Environment for Reconstruction, Growth and Development in the Construction Industry". The White Paper formed the basis for the Construction Industry Development Board Act of 2000.

According to Sigcau (2000), *"….The CIDB must be a catalyst for change. It must ensure sustainable growth, regional and global competitiveness and the continuous inclusion of historically marginalized sectors of our society. It must promote*

investment and value for money to clients. In the South African context, and indeed in the context of our region, the industry's development must be geared to rolling back the enormous legacy of an inadequate infrastructure, its inequitable distribution, and the underdevelopment of locally based physical and human resources…."

The South African Construction Engineering Industry operates in a complex and generally project-specific environment. It is heavily dependent on labour and each new project faces different challenges in terms of size and scope, location and the range of skills and materials required (White Paper, 1999).

The industry is mobile, and every project involves the assembly of a new combination of role players and resources, which includes clients, a spectrum of professional disciplines, contractors and subcontractors, skilled and unskilled workers, plants and equipment. The analogy can be drawn that nothing in the industry is static. Industry instability is compounded by the fact that construction engineering is a competitive and high risk business for both client and contractor.

Critically and significant for industry growth and development in South Africa, is the growing and relatively stable environment forming the foundation for sustainable growth and job creation, enhanced employment stability, investment in human-resource development and the availability of plant and equipment necessary to maintain or improve productivity, quality and international competitiveness.

5.5.2 South African Social and Economic Policy Framework: Impact on the Construction Engineering Industry

According to the White Paper (1999), the policy framework development of the Construction Engineering Industry in South Africa must respond to the following broad social and economic imperatives:

- Sustainable economic growth and productivity of the sector.
- Rapid and efficient delivery of quality assets to the public.
- Sustainable employment creation.
- Affirmative action.

- The active promotion of Small and Micro-Enterprises.
- Stabilised and enabling labour relations within the framework of labour regulation.
- A human-resource development strategy which is holistic, sustainable and accessible.
- Competitiveness and the opening up of South African markets to regional and international business.
- The development of public-sector capacity to manage the delivery process.
- Government's role in promoting an enabling environment for industry development, and greater private-sector participation in the delivery process.

5.5.3 South African Construction Engineering Capacity

In terms of the White Paper (1999), the South African Government believes that emerging construction-related Small and Micro-Enterprises can contribute significantly to the realisation of key economic and redistribution of wealth objectives for a number of reasons:

- They can be powerful generators of income and employment opportunities since they generally use less capital investment per unit of output than larger enterprises.
- Small and Micro-Enterprises can be more competitive than large firms on certain types of small, disparate and geographically dispersed projects as they generally have relatively lower overheads.
- The relatively low entry barriers in terms of skills (technical and managerial) and capital requirements make Small and Micro-Enterprises contracting an important entry point for historically disadvantaged persons into the construction industry.
- Given the above, Small and Micro-Enterprises can lay the foundation to de-racialise the construction industry if they provide a platform for future medium-sized and large-scale firms owned and controlled by historically disadvantaged persons.

The Department of Public Works conducted a status quo review of the South African Construction Engineering Industry, and the findings of this study undertaken by the CSIR (2002) include, inter alia, the following:

- Difficulties experienced by the Government in spending their construction budgets are due largely to capacity constraints caused by the loss of knowledgeable personnel, excessive mobility of senior staff and inadequate succession planning. Furthermore, numerous recent policy changes, such as decentralisation of budgets to provinces and local authorities and inadequate protection of capital budgets, as well as inadequately defined work processes and procedures to deal with these changes, have resulted in operational difficulties at Government level.
- Clients are in general satisfied with the quality of the final construction product, but are often dissatisfied with the quality of the level of service of the built environment professionals. Furthermore, surveys show that clients expect the level of service of professionals to deteriorate further due to the loss capacity of the professional sector to other sectors of the economy and to international markets. This loss of professionals can be attributed to a general unattractiveness of the industry caused by long-term decline in real demand for construction goods and services.
- The decline in demand for construction goods and services has resulted in increased competitive pressure for work and a decline in fees earned by professionals. This competitive pressure has caused professionals to cut professional development activities such as knowledge transfer and mentoring of young professionals. Furthermore, the trend of clients accepting the lowest cost tenders is encouraging a situation where quality assurance procedures and site supervision are inadequate, culminating in a further overall decline in quality.
- Similarly, contractors are facing increased competition due to the long term decline in demand, and many contractors have responded by shedding labour. The larger contractors have also responded by moving into international markets. Small local contractors in particular, are furthermore subject to volatilities due to the geographic distribution of construction and the peak workloads that characterise construction projects, which has further reduced their ability to build capacity.

- Emerging contractors are subject to the same market forces described above for small contractors. However in addition, while emerging contractor development policies were intended for black economic empowerment, small government contractors have in fact been used as job creation opportunities. This has resulted in an overcrowding of this market, and increased financial failures of emerging contractors.

5.5.4 Access to Finance for the Construction Engineering Industry in South Africa

Budgetary constraints in several countries have, according to CIB-World Building Congress (2001), led governments to seek alternative methods of financing infrastructure provision. Public Private Partnerships have received widespread attention in several countries in recent years, and these Public Private Partnerships initiatives have enabled the public sector to utilize private sector finance and expertise for provision of public infrastructures. South Africa like many other countries is faced with the problem of infrastructure backlogs and budget constraints. The South African government, through its Department of Finance recognized the need to cooperate with the private sector in order to address this problem.

Moreover, and according to the White Paper (1999), the South African National Urban Reconstruction and Housing Agency, provide working capital guarantees on projects run by Small and Medium Enterprises, Non Governmental Organisations, community trusts, and non-profit and private-sector developers. The National Urban Reconstruction and Housing Agency will serve as a precedent for using public-sector guarantees to enable the previously marginalized to become active in the construction sector. A prerequisite for improved access to finance, is the regularisation of the market to reduce the uncertainty which dictates the investment decisions of financial institutions. To encourage the banks to establish specific loan-assistance programmes for emerging businesses, the following programmes are being tested within the framework of the Emerging Contractor Development Programme:

- A database of emerging contractors has been created in six major centres. The database includes details of the capacity and performance of the enterprises, and is regularly updated. Such information can be used by financial institutions

for the initial screening of loan applicants. It is also being used to encourage major material suppliers to open lines of credit for such firms. This database needs to be expanded as the programme is rolled out, and will eventually be incorporated in the national register of contractors.

- Access to the loan-guarantee fund established by Khula Enterprise Finance Ltd, for emerging construction business is being promoted.

In addition, mechanisms are being explored to enable Small and Medium Enterprises to cede contract payments to financial institutions until their loans are repaid.

5.5.4.1 Payment and Surety Arrangements

The White Paper (1999) states that sureties or performance guarantees for certain low-risk public sector construction engineering contracts are being waived. However, these facilities will be accorded to enterprises with demonstrable capacity to perform. Registration and accreditation procedures, as well as performance monitoring, will minimise and limit risk in such cases.

Since emerging contractors are particularly vulnerable to cash flow problems. This sector will benefit from measures to streamline payment procedures that are being promoted by the inter-ministerial Task Team on Construction Industry Development.

5.5.5 Overcoming Regulatory Impediments to Industry Performance in South Africa

According to the White Paper (1999), this endeavour to remove regulatory impediments and to streamline the regulatory environment will require close interaction with the industry and Government. A review of the regulatory environment dictates that it should:

- Be fair and equitable to all role-players.
- Be transparent.
- Be simple, easy to understand and apply.
- Retain acceptable and appropriate standards.
- Be standardised as far as possible.

- Encourage initiative and be responsive to change.
- Change existing controls only when necessary.
- Be compatible with international best practices.
- Facilitate employment and growth of SMEs.
- Promote growth and competitiveness in the industry.
- Promote training in the industry.
- Unite industry rather than promote fragmentation.
- Encourage partnerships.
- Be flexible enough to accommodate all categories of work and contractors.
- Ensure adequate accountability.

In promoting an appropriate degree of regulation, the South African Government is also seeking to create an environment, which defines a level of standards suitable to the industry. In this endeavour, the Goverment will seek to define standards that are appropriate to specific sectors of the construction economy, even to the extent of defining different standards for different sectors of the market. Notwithstanding in defining these standards, the South African Government will be guided through its interaction with industry to ensure that the long-term growth and development of the industry will be promoted.

5.6 CLOSURE

In this chapter, a literature review was conducted on the Mozambican and South African construction industries. A high level background was provided on the Mozambican economic environment, to provide insight into the economic impact this has on the viability of the construction industry. The biggest construction projects in Mozambique were listed to serve as reference to the size of the industry as a whole. The South African construction industry environment and social and economic policy framework was expanded upon, which included a perspective on industry capacity and access to finance in South Africa. A list was provided on aspects to mitigate impediments from a regulatory perspective.

A perspective of the concept of ‘benchmarking’ was provided whereafter the South African Construction Engineering Industry was benchmarked to that of

Mozambique. The holistic perspective provided on the construction engineering status quo in Mozambique will serve as background information to the analysis on complex phenomena in the industry to be analysed in detail within the context of Chapter 6.

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CHAPTER 6

ANALYSIS OF COMPLEX PHENOMENA WITHIN THE CONSTRUCTION ENGINEERING INDUSTRY IN MOZAMBIQUE

6.1 INTRODUCTION

Enquiry into the complex phenomena pertaining to the Construction Engineering Industry in Mozambique will in this chapter be executed using the Biomatrix Model, the latter which was comprehensively analysed within the context of Chapter 3 of this thesis. The classification of systems as proposed in Paragraph 2.8, Chapter 2 incorporates and adapts concepts derived from Miller (1978), Schoeman (1982)(1985), Boulding (1978), Gharagedaghi (1986), Jordaan and Jordaan (1984) and Young (1976). These concepts are encapsulated within the context of the Biomatrix Systems enquiry mechanism which will serve as a system intervention and enquiry approach for the analysis of complex phenomena within the Construction Engineering Industry in Mozambique.

The concept of 'current future' and 'ideal future' will be analysed in more detail to provide context to the very nature of the proposed enquiry. In addition, insight will be provided on the perpetuating forces which pertain to the transformation of 'a current' to 'an ideal future'.

The Biomatrix as a framework for systems enquiry and design will be elaborated upon, specifically as it pertains to the 'sociosphere'. The processes of 'telentropy' and 'telentropy tracing' the latter pertaining to actual performance of the system in physical reality in order for the system to move closer towards its ideals, will be explained in detail.

The crux of the chapter will be embodied in a process to be designed for the enquiry into the complexities associated with the Construction Engineering Industry in Mozambique, in terms of which:

- A system type will be selected to determine the design method.
- A problem analysis will be conducted through the process of telentropy tracing.
- Problem co-factors will be identified.
- Brainstorming output will be integrated into a coherent ideal design.

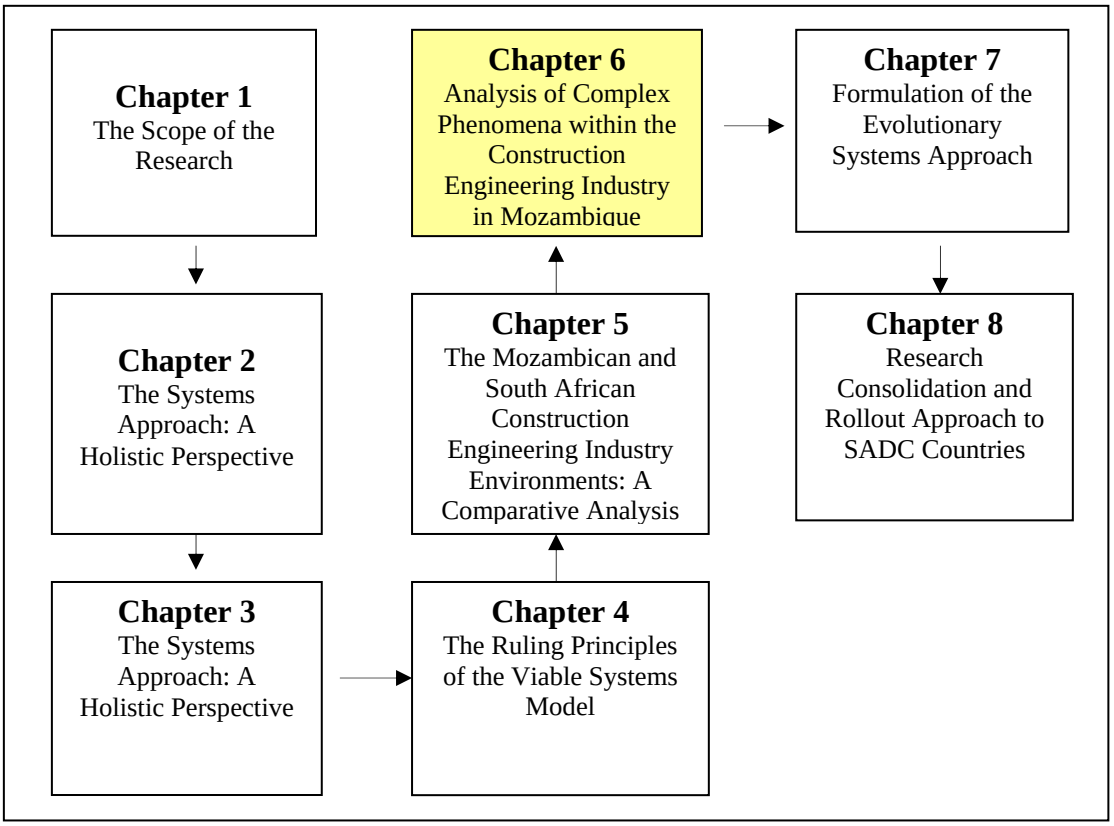

Figure 6.1: Chapters in context of the overall research

The analytical process followed thus far, is graphically depicted in Figure 6.1, which places the chapters in context with the overall thesis objectives, and furthermore indicates the relative positioning of this chapter.

6.2 CURRENT VERSUS IDEAL FUTURE

Two broad system type changes can be identified namely, 'change occurring as a result of the inherent dynamics of a system' and 'change brought about as a result of intended actions'. Projected into the future, the former is referred to as the 'current future' and the latter as the 'ideal future'. In terms of the Biomatrix Model, this is referred to as 'clockwise' and 'anti-clockwise' change respectively (refer Chapter 3,

Paragraph 3.2). It is of importance to note that actual change is always the outcome of both processes, and therefore not predictable. Against this background, the concepts 'current future', 'ideal future' and the role of current and ideal future in systems change, calls for closer scrutiny.

6.2.1 The current future

Futures research, according to Dostal (2004: 132), represents the discipline that looks most closely at changes in a system over time. Systems thinkers have contributed significantly to a better understanding of the future of a system, as in the instance of the famous study for the Club of Rome entitled "The limits to growth" as described by Meadows *et al*. (1974). Current future analysis assumes that the future will be an extension of the past, because systems have inherent dynamics that drives it to behave as in the past. The inherent dynamics is the result of the various parts of the system behaving as it usually did in the past. The ethos (values, ideologies), teleos (purpose, goals and functions), processes (actions), structures (action patterns and organizational structures), the MEI (**M**atter-**E**nergy-**I**nformation) and governance (policies, norms, standards, regulatory processes) of the system continue as usual. It is of importance to note that these systems aspects form a 'system dynamic' in themselves (refer Paragraph 6.1 of this chapter), whereby structure gives rise to processes. This is being referred to as the anti-clockwise change process, whereby attempting to change an ethos, teleos or processes without allowing the organizational structure to change, will still perpetuate into old behaviour of the past.

Identifying aspects of the current dynamics and extrapolating them into the future is commonly referred to as 'exploratory forecasting'. Trend extrapolation is a method that assumes that the inherent momentum of the system will continue into the future and that the system will evolve accordingly. It answers the question 'what is likely to occur if the current system behavior continues?' According to Ackoff (1981) and Ackoff *et al* (1984) cited by Dostal (2004:131), the future assumed on the basis of this type of forecasting can also be referred to as the 'current future'. From this, the obvious analogy can be drawn that the 'current future' represents the systems logic of the past and present. As a system is embedded in and interacts with a larger system if the environment of the system is changing, the same systems behaviour is

likely to produce a different outcome in the future, creating the opportunity for forecasters to typically present a range of 'current future scenarios'.

More often than not, social systems reveal conflicting tendencies at any time. Furthermore some parts of a system work to conserve the status quo, while other parts may be engaged in actions to change the system. Over time and in interaction with a changing environment which may favour one stance over another, the continuation of the same systems behaviour will produce a completely different outcome. This serves as another reason why projections of the current future dynamics yield different 'current future scenarios', rather than one scenario. As in the various scenarios, these alternative futures however represent a range from less to more favourable scenarios.

6.2.2 The ideal future

The concept of the 'ideal future' for a system based on the assumption that the actors within the system can co-create the future into an entity which fundamentally differ from the present. Determining the ideal future for a system involves normative projections. It explores the question 'what could or what should be' and how would this influence the actors of a system and consequently the behaviour of the whole system in the future? It involves designing the ideal outcomes of a system, how the system should ideally behave, be structured and governed.

Having designed the ideal system, strategies have to be formulated that allow the current system to move closer towards that ideal, allowing the setting up of intermediate goals on the way to that end. Ackoff (1981) cited by Dostal (2004:131) adds that the process of projecting the various steps on the way from the desired end to the current situation is also referred to as 'backcasting', a process which is graphically depicted in Figure 6.2. Moreover, Ackoff (1981) cited by Dostal (2004:131) is of the opinion that an ideal future represents a fixed end, and that knowing one's destination, one can choose between different strategies or means to get there. If one strategy does not work, one can try another one. Having a fixed end allows the choice between different means, which according to Garajedaghi (1985) is referred to as 'equinafinality'. By comparison, the current future represents fixed

means (continuation of current behavior). In interaction with a changing environment, fixed means could produce a variety of ends, which is referred to by Garajedaghi (1985) as 'multi-finality'. These different outcomes represent the 'current future', and they are derived by forecasting the inherent dynamics of a system.

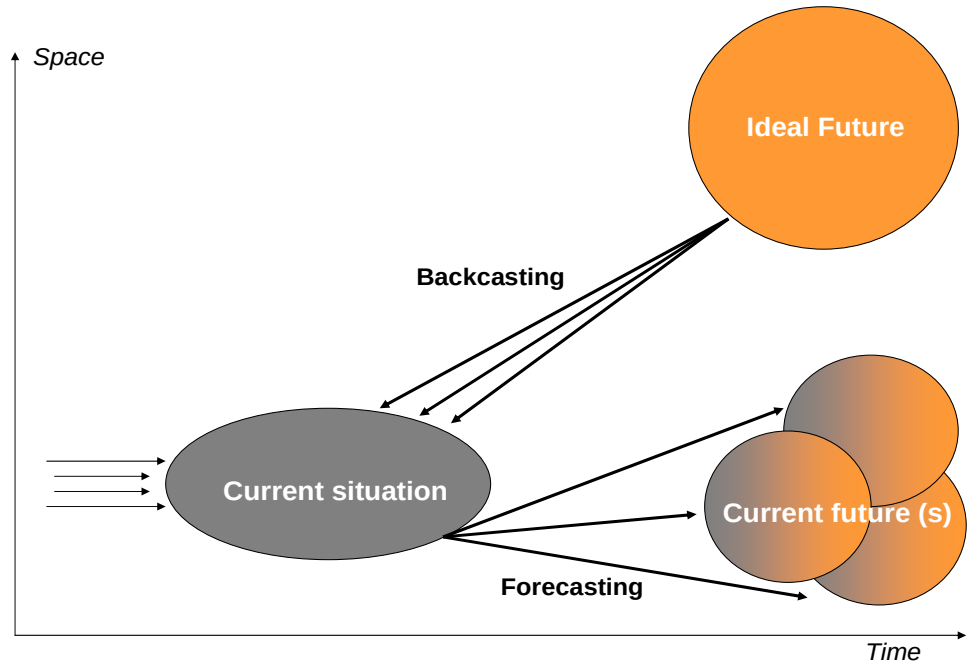

Figure 6.2: Forecasting current futures versus backcasting from the ideal future (**Source:** Dostal 2004: 131)

Should Figure 6.2 be mapped onto the Mozambican Construction Engineering Industry environment, the following analogies can be drawn:

- **The current future:** Is represented by an inherent dynamic, which propels it into a current future. In terms of this maxim, the inherent momentum of the Construction Engineering Industry in Mozambique, which is derived from past unstructured behaviour, will continue with this 'logic' into the future. Futures researchers have also observed that complex social/organisational problems representative of the Construction Engineering Industry in Mozambique, tend to become worse in the medium and long term. According to Dostal (2004:137) it is of the primordial importance to analyse the current future, because it can lead to an anticipation of change before problems happen, alert planners to the increasing magnitude of future problems, lead to an identification of the various co-factors that give rise to the problems associated

with the system, act as a motivator to change behaviour and organisation being a 'push factor' for change. Furthermore it creates an awareness that 'more of the same' type strategies and behaviours are not likely to produce desirable results, and that a new logic is required to produce a future, which does not follow the logic of the current situation and its current future.

- **The ideal future:** The ideal future represents a vision of the ideal that the system wants to achieve in the future. In the ideal future, the ends are 'fixed', while the means to achieve those ends are 'flexible'. Viewed from a systems perspective, the system 'knows' where it wants to be and what it wants to attain. Furthermore, it 'knows' its destination, its ideal end-state, and will endeavour to try different means to arrive there. From this, the analogy can be drawn that what is required within the context of the Construction Engineering Industry in Mozambique is to determine what the barriers are to attain its ideal future and to transform those barriers through a structured evolutionary Systems Approach to culminate in an 'ideal future'.

6.2.3 Perpetuating forces pertaining to the transformation of a current to an ideal future

The change agent who wishes to transform a 'current system' into an 'ideal system', needs take cognizance of the forces that perpetuate the current system. These perpetuating forces to the transformation of a 'current future' into an 'ideal future', are expanded upon below for ease of reference:

- **Understanding the current system for leverage:** Unless it is a complete new system, any implementation of a design has to be introduced into a currently functioning system. A thorough understanding of the current system allows the identification of those parts of a system where interventions are likely to produce desirable results. Senge (1990) calls this 'leverage', while Gomez & Probst (1987) and Vester (1990) speak of 'controllable' and 'active' variables. More often than not, effort and resources are wasted on strategic interventions aimed at passive variables, which produce only minor results. Should the dynamics of the system be ignored, unexpected or undesirable side effects may occur. Strategy transposes the current momentum of the system, using it as leverage towards achieving a more desirable state. To enforce strategies which

are not sustained by forces inherent in the current system or which oppose them are not likely to succeed in the long term.

- **Resistance and barriers to change:** Barriers may prevent the successful implementation of a change initiative calling for such barriers to be removed. Ackoff, Finnel & Gharajedaghi (1984) refer to this as 'obstruction analyses'.
- **Shared problem identification reduces conflict:** According to Cross (1984), solutions to problems should be found in the early stages of a systems change design and that an extensive phase of problem analysis is undesirable. While this holds true for homogenous systems with little conflict potential, Kraybill (1989/90) and Strümpfer (1994) are of the opinion that experience in divided societies shows that an intense phase of problem analysis creates understanding of divergent points of view, allowing emotions to surface and dissipate, aligning mindsets and building trust and fellowship, serving as prerequisites for starting a design process.
- **Undesirable and unintended side effects of intervention:** A thorough understanding of the current system allows the design of an intervention, which minimises, eliminate or transform undesirable and unintended effects.
- **Interaction 'evokes' cues for solutions:** Interaction with current problems can be used as a brainstorming method to generate ideas about an ideal system. Some of the more common problems relate to difficulties in creating solutions or distorting themselves from the current situation while others have an emotional investment in the problem and refuse to participate in an idealized debate.
- **Ideals differ qualitatively from problems:** Although an existing problem may contribute to the formulation of ideals, the ideal itself may describe a different state of the system involving properties that are not contained in the current system.
- **Without constraints by the current system the mind conceives new and creative ends and means:** The change agent can move outside the frame of reference of the current system and create a new system altogether. The involvement of different stakeholders with their different perceptions can assist the generation of innovative solutions. Mitroff & Mason (1981) and Osler & Strümpfer (1993) are of the opinion that in the absence of stakeholders, a stakeholder analysis is a useful method to use.

- **Idealised design creates alignment:** The involvement of stakeholders in the design process creates shared understanding and alignment. Most general system methods suggest that stakeholder interests are considered in a design and that conflicting interests are accommodated in a design in a win/win approach.
- **The creation of an internally consistent design:** One of the problems of most current public policy is that it 'fixes problems' in parts of the current system until the viability of the 'patched-up' whole becomes impaired. Design on the other hand allows the creation of an internally consistent, viable whole, requiring a comprehensive framework for systems inquiry, such as being proposed by the dimensions and hierarchical levels associated with the Biomatrix as applied within the ambit of this thesis.

6.3 THE BIOMATRIX AS A FRAMEWORK FOR SYSTEMS ENQUIRY AND DESIGN

Researchers of various disciplines, including general systems thinkers, have identified different categories according to which nature's systems and human social systems can be classified. The former is referred to in this study as the 'naturosphere', while the latter is referred to as the 'sociosphere'.

Dostal (1997:79) is of the opinion that due to the interrelationship of these two entities, any systems inquiry or design involving the Biomatrix Model needs to be placed in the context of both the 'naturosphere' and 'sociosphere'. A framework showing the spheres and dimensions inherent in the Biomatrix could assist in identifying all issues that should be taken into consideration in any systems intervention. The framework comprises eight 'kingdoms' of nature within the 'naturosphere' and four dimensions within the 'sociosphere', namely the ecological, cultural, techno-economic and political dimensions. The cultural dimension comprises of three subdimensions, namely the ethical, aesthectic and scientific dimension. As the research in this thesis pertains to complex phenomena within the context of the 'social world', the sociosphere and associated cultural, techno-economic, political and ecological dimensions call for closer scrutiny.

6.3.1 The Sociosphere

With respect to the generic activities of society, Leonard (1972) and Schoeman (1982, 1985) argue that anthropologists have observed that almost all societies have evolved from a generic set of institutions around similar activities based on similar needs and values. However, the expression and prioritizing of these activity systems vary considerably between societies and at different stages of societal evolution.

Schoeman (1985) is of the opinion that these universally observable institutions rest in religion, art, education, communication, language, economy, technology, law, social organization, politics and recreation. Gharajedaghi (1986) suggests five functionally different dimensions of society which arise from the pursuit of four values as identified by Greek philosophers, namely 'good', 'truth', 'beauty' and 'plenty', representing the 'ethical', 'scientific', 'aesthetic' and 'economic' functions. 'Power' associated with 'governance', represents the fifth function of society. Roux (1989) proposed a threefold societal order which comprises of culture, economics and politics. Boulding (1978) distinguishes three sub-systems of society, namely a threat, exchange and integrative system. These categories largely overlap with those of culture (integrative system), the economy (the exchange system), and politics (the threat system).

These different approaches to identify and classify societal activities, values and modes of interaction can, according to Dostal (1997:83) be juxtaposed into one framework for the sociosphere, namely a cultural dimension concerned with the pursuit of the non-material value of truth, beauty and good, which represent the scientific, aesthetic and ethical sub dimensions of a society's culture, a techno-economic dimension concerned with the pursuit of plenty and a political dimension which is concerned with the governance of society. Due to the inseparable interrelatedness of the naturosphere and sociosphere, the ecological dimension is one of the dimensions which needs to be taken into account in any systems inquire or intervention.

6.3.1.1 The cultural dimension

Dostal (1997:83) is of the opinion that culture within a society is concerned with the 'creation', 'expression' and 'dissemination' of values in society. These values represent the different aspects of culture and may be regarded as sub dimensions of the cultural dimension. According to Boulding (1978), the activities involved in the pursuit of these three values are largely cooperative, based on the identity with other people and common values. According to Gharajedaghi (1986), the following subdimensions are associated with the cultural dimension, namely:

- **The scientific subdimension:** The pursuit of 'truth' is embodied in science or world-view. Its purpose is the understanding of reality, of how the world functions. It is concerned with cause effect relationships and its basis of evaluation is 'true' versus 'false'. The main institution associated with the generation of knowledge is 'science', while the institution associated with the distribution of knowledge in society is 'education'.
- **The aesthetic subdimension:** The pursuit of 'beauty' represents the aesthetic function of a culture. Its purpose is to create beauty as well as encouraging inspiration of and aspiration towards ideals. Moreover, one could also add the purposes of creating quality of life and harmony in society. Achieving harmony may be especially challenging in the context of designing policy and of making decisions in situations of great complexity and conflict as in the instance of the complexity associated with Construction Engineering Industry in Mozambique.
- **The ethical subdimension:** The pursuit of 'good' represents the ethical-moral function of society. Its purpose, according to Gharajedaghi (1986) is the creation of peace of mind in individuals and peace between individuals through transcendence of differences and alignment around a shared group, nature or God. The dominant institution in this sphere is religion, including secularized belief systems. The basis of evaluation in this subdimension is 'good versus bad'.

6.3.1.2 The techno-economic dimension

According to Gharajedaghi (1986), the function of the economic dimension of the sociosphere is the production and distribution of 'plenty'. Boulding (1978) adds that

the value of plenty refers to the production of material value (goods and services) in a society. Unlike the cultural sphere, which is mostly concerned with the expression of non-material values, the techno-economic sphere is primarily directed at the creation and distribution of material value, whereby the dominant interaction involved in the pursuit of plenty is exchanged and competitive behaviour. Money facilitates the measure of value on which the exchange is based. Technology is an inherent part of this process. The major institutions associated with this sphere relate to the production of goods and services and their distribution.

6.3.1.3 The political dimension

Having specific relevance to the theme of this thesis, politics are concerned with the governance of the various societal institutions as well as with the resolving of conflict, within and between the ecological, techno-economic and cultural dimensions of the sociosphere. It is concerned with the distribution of power between those who govern and the governed. It arises from conflicting interests and behavior in society. According to Boulding (1978) the handling of political conflict is mostly based on 'threat power'.

The main institutions associated with the political dimension include the legislative, executive and juristic institutions of society, as well as the institutions associated with security (police and defense). The three dominant values associated with this dimension are 'liberty', 'equality' and 'justice', whereby liberty is the governing ideal for the various freedoms of expression (exoteleons), equality the governing ideal of distributive processes in society (endoteleons), and justice is concerned with the balancing of the two (centroteleons) (refer Chapter 3, Paragraph 3.8.1). Equality governs the executive and distributive aspect of governance.

6.3.1.4 The ecological dimension

The ecological dimension is concerned with the naturosphere, as well as is one of the dimensions of the sociosphere. Ecological management is a 'social activity' and, due to the inseparable interrelatedness between the naturosphere and sociosphere, the

ecological dimension must therefore be one of the dimensions to be considered in any social system inquiry, intervention or design.

6.4 SYSTEM (RE) DESIGN METHOD

The Biomatrix Model which falls within the ambit of soft system problem solving methodologies uses the generic principles and some of the practical approaches which were developed by proponents of 'systems dynamics' as well as by proponents of the 'ideal systems design'. Moreover this method can be used to analyse the existing system as well as to design an ideal system. According to Dostal (2004:18), an 'ideal design' represents a new logic of system functioning, having as the most important proponents of the design school Ackoff (1981), Ackoff, Finnel and Gharajedaghi (1984), Banathy (1994), Checkland (1981), Checkland and Scholes (1990), Nadler (1981), Nadler and Hibino (1990) and Warfield (1990) amongst others.

6.4.1 Application of the Systems (re) design method

Although the Biomatrix is used as a framework for a (re)design exercise it is, according to Dostal (2004:419) applied with different emphasis, depending on the type of the system being dealt with. The type of systems to which the Biomatrix can be applied could pertain to the redesign of an activity system or the redesign of an entity system. While a holistic perspective will be provided of the redesign of activity and entity systems, the redesign of a web as it relates to the primary theme of this thesis will be expanded upon.

6.4.1.1 The (re) design of an activity system

The (re) design of an activity system utilizes the seven systems aspects (refer Chapter 3, Paragraph 3.6) as relating to the specific activity, the overall aims, ethos, organisational structure and governance frameworks of the whole organisation usually remain a given, thus the design has to be in harmony with, and integrated into the broader organisational context.

6.4.1.2 The (re) design of an entity system

The (re) design of an entity system utilizes the seven systems aspects from the perspective of the whole organisation (from an entity perspective). The design of an entity system emphasises the ethos, broad vision, mission, core objectives and strategies from which the various activity systems derive their specific ethos and aims, emphasising organisation structure as this determines the way the various activity systems interface with one another.

6.4.1.3 The (re) design of a web

The (re) design of a web refers to the (re) design of a range of activity and entity systems. This is typically used for large systems (re) design, especially in the context of a systemic problem (dis)solving requiring resolution, as in the instance of the complex phenomena which pertains to the Construction Engineering Industry in Mozambique. The 're-design of a web' would typically call for the following:

- The problem related co-factors for each core activity system associated with the problem issue need to be identified by casting the multi-levelled and multi-dimensional web of the Biomatrix at the problem.
- Ideals (commonly referred to as 'princes' within the context of the Biomatrix), strategies and evaluation criteria for each cluster of problem co-factors (commonly referred to as 'frogs' within the context of the Biomatrix), within each core activity system are brainstormed. In large design exercises, this would imply a design for each of the core activity systems, and it could even imply different designs for the different levels and dimensions within each core activity system.
- Integrating the different designs into one overarching design involving a linking of the core activity systems across levels and the harmonising of ethos, aims and regulation between different levels and dimensions.

For the purpose of absolute clarity, the attention of the reader is specifically drawn to the fact that in view of this author, the 'type of system' to which the Biomatrix Model will be applied to serve as an enquiry mechanism for the Construction Engineering Industry in Mozambique in this thesis falls within the ambit of the description attributed above to the concept "The (re) design of a web".

Creating the actual design for the purpose of the (re) design of a web based on the Biomatrix Model, involves the following steps:

- **Problem analysis:** This is executed through the process of Telentropy tracing (Refer Paragraph 6.5.1), whereby the multi-levelled and multi-dimensional web of the Biomatrix is cast at the system that needs to be redesigned or the problem that needs to be (dis)solved.
- **Brainstorming ideals:** Whereby the problem co-factors 'frogs' which were identified in the problem analysis phase, are transformed into ideals 'princes'.
- **Creating the ideal design:** By integrating the brainstorming output into a coherent design by following the clockwise sequence of the seven systems aspects.

The attention of the reader is drawn to the fact that the complexity in executing the above steps is high. Furthermore, adding to the complexity, the fact that there are 'steps within steps' which are described within the text of this thesis and subsequently elaborated upon in a number of appendices. To aid the reader in this maelstrom of processes which are executed to achieve the ultimate ideal design, Figure 6.3 represents a graphical depiction of the process which will be followed to ultimately culminate in an 'ideal design'.

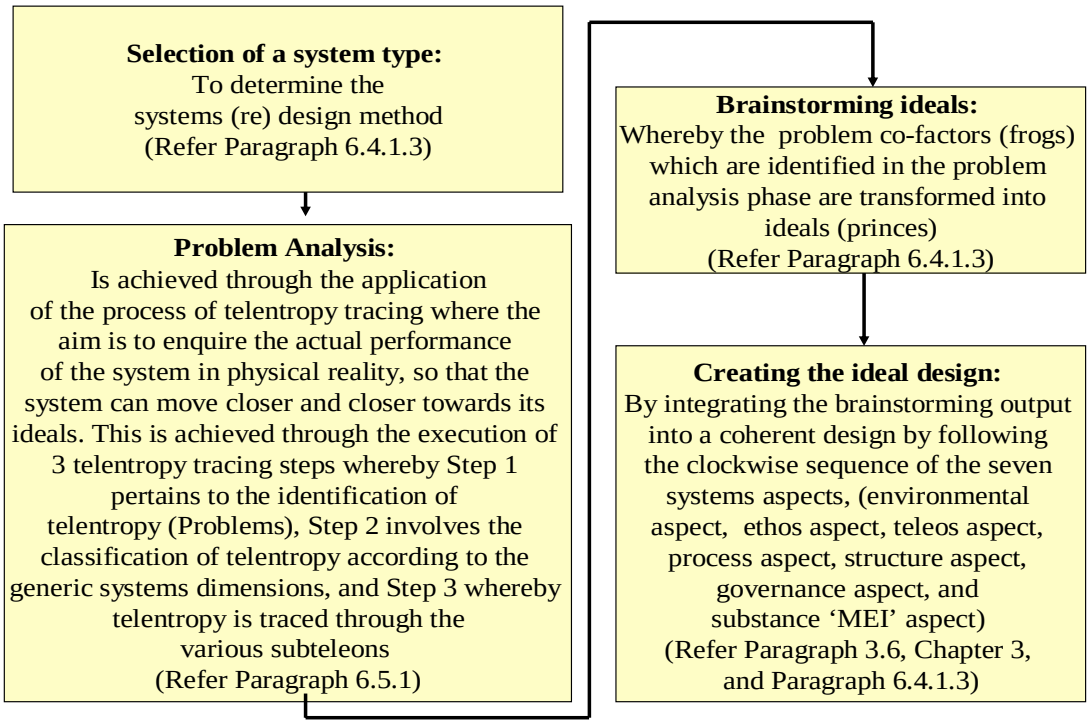

Figure 6.3: Process which was followed to create a design for the enquiry into the complexities associated with the Construction Engineering Industry in Mozambique, using the Biomatrix Model. (**Source:** Own Source)

The concept of 'brainstorm ideals' falling within the context of the systems type 'redesign of a web' referred to above, calls for closer scrutiny. This focus in particular as 'brainstorming ideals' forms the core of the enquiry approach into the complexities of the Construction Engineering Industry in Mozambique to be applied within the context of this thesis.

The brainstorm technique as applied within the context of Biomatrix, is commonly referred to as the process of 'turning frogs into princes' and is suitable to be used in the context of business process redesign within a variety of organisations. Examples are organisational transformation and redesign of business organisations, in public policy design, in redesign of government departments, in strategy development and organisational redesign of various NGO's and in personal planning including personal transformation, all of which falls within the context of the definition of 'messes' or problems pertaining to a complex paradigm. Furthermore, the method turning 'frogs' into 'princes' is simple and can be easily understood.

This method can produce a large number of 'creative ideals' and 'practical strategies' requiring paradigmatic change.

Dostal (2004:407-414) adds that this method uses the Biomatrix Model as a comprehensive framework within which problems regarding the current functioning of the system can be identified, transformed into their ideal and integrated into a coherent design. The method is applied as follow:

- Identifying problem co-factors (frogs) within a system asking the question 'What are the problems experiences with respect to this issue?'
- Transforming problem co-factors (frogs) into ideals (princes). This implies that a problem will be replaced by a desirable ideal, asking the question 'What ideal should be in the place of the problem?'
- Assuming that ideals should be positively formulated, due to the fact that only positive aims inspire workable strategies.
- Determining strategies to achieve the ideals.
- Defining measuring criteria which allow for evaluation if the strategies move the system towards attainment of the ideal. These measures are typically an important input to the governance aspect of the design, especially with respect to standards, control and regulatory mechanisms. Both qualitative and quantitative measures need to be considered.
- Integrating the output from the brainstorm exercise into a coherent design.

Moreover, the turning problem co-factors (frogs) into ideals (princes) method is based on the systemic principles of emergence, namely that the new system has properties and an underlying logic, which the old system did not have. The logic of this method is, according to Dostal (1997:129-130) based on the following reasoning:

- Each 'frog' is important as it holds the potential of becoming a 'prince'.
- 'Kissing the frog', which means that the frog, as in the fairy tale implies that the problem is recognised and accepted as needing to be dealt with.
- The 'frog' looks different from the 'prince'. It needs imagination and creativity to see an ideal in the place of a problem.
- Each 'frog' provides a 'cue' where to look for a 'prince'.

- The 'prince' is a higher order phenomenon than the 'frog'. The 'prince' displays properties that the 'frog' does not have. This implies that the solution is not inherent in the problem.
- The existence of 'frogs' enables improvements in the system. It is very difficult to improve a perfect system.
- Manifesting 'princes' requires different strategies than merely getting rid of 'frogs'.

6.5 THE CONCEPT OF TELENTROPY

The word 'telentropy' is according to Dostal (2004:177), derived from the Greek word teleos, meaning aim or purpose and the concept of entropy developed in physics, relating to the deterioration of matter due to the dissipation of energy. Telentropy is a concept that indicates that a system is not functioning optimally, that it is unable to achieve its teleos and that there are problems regarding the internal and external functioning of the system (Katakis and Katakis, 1982:118-124). More specific, telentropy refers to the likelihood of a system achieving its teleos. It serves as an indicator of how well a system functions in terms of its purpose and goals. 'High' telentropy means that the probability of the activity system achieving its aims is 'low'.

According to Dostal (2004: 431) telentropy is "….the 'tension' arising from the difference between what the system wants to achieve and what it manifests in its process and structure, and it is not necessarily negative". When the telentropy transfer or transformation is in excess of what an activity system can handle it is destructive to the system, but if a system is exposed to telentropy but nevertheless reaches its goal, the telentropy has been managed successfully.

Large social or organizational systems are characterised by diverse complex problems, typically residing in all parts of the system. Moreover, these problems interact and mutually reinforce and influence each other, to form a huge system of problems, which is also referred as a 'mess' (Ackoff, 1974, 1981; Ackoff, Finnel & Gharajedaghi, 1984). By means of a 'mess analysis', the analyst tries to understand this interrelated system of problems and to intervene at points and in a manner that

allows the system to become less 'messy', and to approximate a more ideal state over time. Telentropy analysis is a 'mess analysis' or system analysis method similar to the systems dynamics methods discussed by Coyle (1977), Forrester (1969), Gomez & Prost (1987), Senge (1990) and Vester (1990), adapted according to the inherent dynamics of the Biomatrix Model.

The fundamental question which uncovers telentropy in a system is 'what prevents the system from achieving its purpose and goals?' Dostal (2004:175) adds that telentropy can arise from both 'inefficiency' and 'entropy' within the system and its environment. Entropy and efficiency tend to be mathematical measures, however in systems that do not have pre-determined functioning, as is the case of social systems, (in) efficiency is difficult to measure and telentropy which is a statistical measure, would be better.

6.5.1 Telentropy tracing

According to Dostal (2004: 433), the difference between the 'ideal design' method and the 'telentropy tracing' method is that the ideal design method is aimed at establishing the ideal conceptual reality of the system, while the telentropy tracing method is aimed at improving the actual performance of the system in physical reality, so that the system can move closer and closer towards its ideals.

The problem identification method 'telentropy tracing' as applied within the ambit of this thesis, aims to identify the flow of problems within the existing Construction Engineering Industry in Mozambique. It does not attempt to do it in an empirical, quantifiable and explanatory way, rather its purpose is to create an understanding of the complex dynamics that occur within the existing system. The analogy can be drawn that as a method, telentropy analysis is located within the new paradigm research of science (Keeney, 1983; Miles & Huberman, 1984; Reason, 1988; Reason & Rowan 1981).

Telentropy tracing as applied within the ambit of this thesis and which is expanded upon in Appendix C for ease of reference involve three steps, namely:

- **The first step:** Pertains to the identification of telentropy (problems) within the system, using the Biomatrix as a multi-levelled and multi-dimensional framework of inquiry. The results from the telentropy tracing process (Step 1) which was undertaken within the Construction Engineering Industry in Mozambique are reflected in Appendix C, Paragraph C2. The results from the telentropy tracing process (Step 1) conducted within the context of the Construction Engineering Industry in Mozambique, output of which are reflected in Appendix C, calls for validation and benchmarking from a real-world perspective. This was achieved through the process of conducting two extensive triangulation surveys amongst 30 respondents made up from the following two groups:
  - Respondents from the private sectors of Mozambique and South Africa.
  - Respondents from the Government of Mozambique.

  See Appendix D for detail and results of the validation survey, and Appendix E for a comparative analysis of the Mozambican and South African survey results. Appendix F reflects the results of the benchmarking in support of the telentropy tracing process (Step 1).
- **The second step:** Classifies telentropy in terms of the generic Biomatrix systems dimensions (ethos, teleos, processes, structure, substance and governance pertaining to each of the former aspects) (Refer Chapter 3, Paragraph 3.6). The results from this second step conducted within the context of the Construction Engineering Industry in Mozambique, are reflected in Appendix C, Paragraph C3.
- **In the third step:** The flow of the telentopy is traced through the various subteleons of the system in terms of the generic system dynamics inherent to the Biomatrix (Refer Chapter 3, Paragraph 3.6). The flow of telentropy as it pertains to the Construction Engineering Industry in Mozambique was traced through the various subteleons of the system, results of which are depicted in Appendix C, Paragraph C4. The results of the flow tracing culminated in a graphical depiction of the flow of telentropy in the Mozambican Construction Engineering Industry mapped to ethos, teleos, process and structure (See Appendix C, Paragraph C4, Figure C1).

Having completed the problem analysis phase as described under Paragraph 6.4.1.3, the next phase of the (re) design of the web pertains to the concept of 'brainstorming of ideals'. In terms of this phase, problem co-factors (frogs) which were identified in the analysis phase are transformed into ideals (princes).

The attention of the reader is drawn to the fact that within the context of the telentropy tracing steps, keys (1-41) will be attributed to each identified element, signifying a 'mess' within the Mozambican construction engineering industry. These keys, once allocated will remain static for a particular element throughout the process. This is to facilitate the process of using keys as opposed to extensive verbiage within the various scenarios presented.

The results from this phase returned the following:

Societal Level / Cultural Dimension

26 Systematically eradicate corruption within all spheres of the Construction Engineering Industry, and optimally utilise resources in terms of skills levels.

Societal Level / Political Dimension

1 Privatization of land ownership

27 Settle political conflicts as they pertain to the Construction Engineering Industry, and establish with the relevant ministry open communication lines on issues pertaining to the industry.

Governmental Level / Techno-Economic Dimension

10 Establish systemic thinking in the understanding of problems associated with Construction Engineering Industry.

22 Process re-engineer the Government payment process relating to public works.

25 Shorten the value chain eliminating red tape in all governmental sectors.

Governmental Level / Political Dimension

20 Establishment of a sound working relationship between Construction Engineering Industry and the incumbent ministry.

21 Re-design the fiscal policy in terms of taxes to change the current system based on previous year invoicing.

23 Lower equity capital requirements, de-link from operating licences and currency fluctuations.

38 Attract investors to the Construction Engineering Industry.

41 Re-design the economic model to stimulate investment in the Construction Engineering Industry.

Organizational Level / Cultural Dimension

7 Instill an element of trust between companies and individuals.

29 Raise the quality of works though the introduction of work standards.

Organisational Level / Techno-Economic Dimension

8 Create company competitiveness.

9 Manage the Construction Engineering Industry in terms of sound management principles.

30 Raise skills levels of workers.

31 Stimulate individual talent and potential.

32 Improve technical level education.

33 Improve Construction Engineering skills.

34 Benchmark processes and procedures to the latest technologies available.

35 Facilitate change via sound change management principles.

Organisational Level / Political Dimension

5 Re-design labour laws to stimulate business activity.

11 Re-design labour legislation to provide equal protection to employers and employees within the Construction Engineering Industry.

13 Modernize labour inspection legislation to benefit the Construction Engineering Industry.

14 Address the insufficiencies of Decree 57/2003 to de-politicize the authorization of work permits, and prohibit the interfering with management of private ventures.

15 Re-design the process of labour conflict resolution in terms of speed and fairness to benefit the Construction Engineering Industry and workers.

17 Re-design the judicial system in terms of inefficiency and effectiveness.

18 Re-design procurement rules of credit institutions and donors to include Mozambicans in the tender process.

24 Re-evaluate international procurement rules to enable Mozambican companies to participate in tenders.

Individual Level / Cultural Dimension

28 Accommodate language diversity within the industry.

Individual Level / Techno-Economic Dimension

2 Facilitate loan procurement from financial institutions.

3 Lower cost of funding.

4 Create capacity for the implementation of quality policies and certification management.

6 Increase productivity.

19 Implement capacity management to facilitate the capacity planning process of projects.

36 Raise productivity through worker motivation.

39 Improve cash flow through structured money management.

40 Review cost structure of construction companies.

Individual Level / Political Dimension

12 Expand coverage and benefits of social security system.

16 Simplify registration procedures of construction engineering companies and facilitate the granting of operating licences.

37 Address issues of malnutrition

The above can now be mapped to the elements of ethos, teleos, process and structure, and from Figure C1 (Appendix C) an ideal design can be extrapolated returning data as depicted in Figure 6.4

	Cultural Dimension	Techno-Economic Dimension	Political Dimension
Societal level	26		1, 27
Governmental level		10, 22, 25	20, 21, 23, 38, 41
Organisational level	7, 29	8, 9, 30, 31, 32, 33, 34, 35	5, 11, 13, 14, 15, 17, 18, 24
Individual level	28	2, 3, 4, 6, 19, 36, 39, 40	12, 16, 37

Figure 6.4: Ideal design extrapolated from Figure C1 – Appendix C (**Source:** Own source)

6.6 CLOSURE

In this chapter a complex process was elaborated upon in terms of which the ultimate objective was to formulate an 'ideal design' for the Construction Engineering Industry in Mozambique. This complexity was approached through the deployment of a structured sequence of events which involved:

- The selection of a system type to determine the design method.
- Conducting of a problem analysis though the deployment of the concept of telentropy tracing.
- The identification of problem co-factors.

In the next chapter, an evolutionary systems approach will be formulated to transform the 'ideal design' created within the ambit of this chapter into a viable solution to be applied within the Construction Engineering Industry of Mozambique.

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CHAPTER 7: FORMULATION OF THE EVOLUTIONARY SYSTEM APPROACH

CHAPTER 7

FORMULATION OF THE EVOLUTIONARY SYSTEMS APPROACH

7.1 INTRODUCTION

This chapter forms the crux of the research contained within the ambit of this research. Elements contained and analysed within the context of Chapters 1-6 are justaposed in the actual formulation of the evolutionary systems approach to Construction Engineering Industry.

The chapter, to provide a comprehensive understanding of all of the elements addressed in the aforegoing chapters provides perspectives on the formulation of the evolutionary systems approach to create a holistic understanding of the proposed conceptual model. Furthermore a refocus of the research process is provided leading into key elements of the proposed evolutionary systems approach and the 'ideal design' as basis for the approach.

The chapter is concluded with a conceptual validation of the success potential of the evolutionary systems approach.

The analytical process followed thus far, is graphically depicted in Figure 7.1, which places the chapters in context with the overall thesis objectives, and furthermore indicates the relative positioning of this chapter.

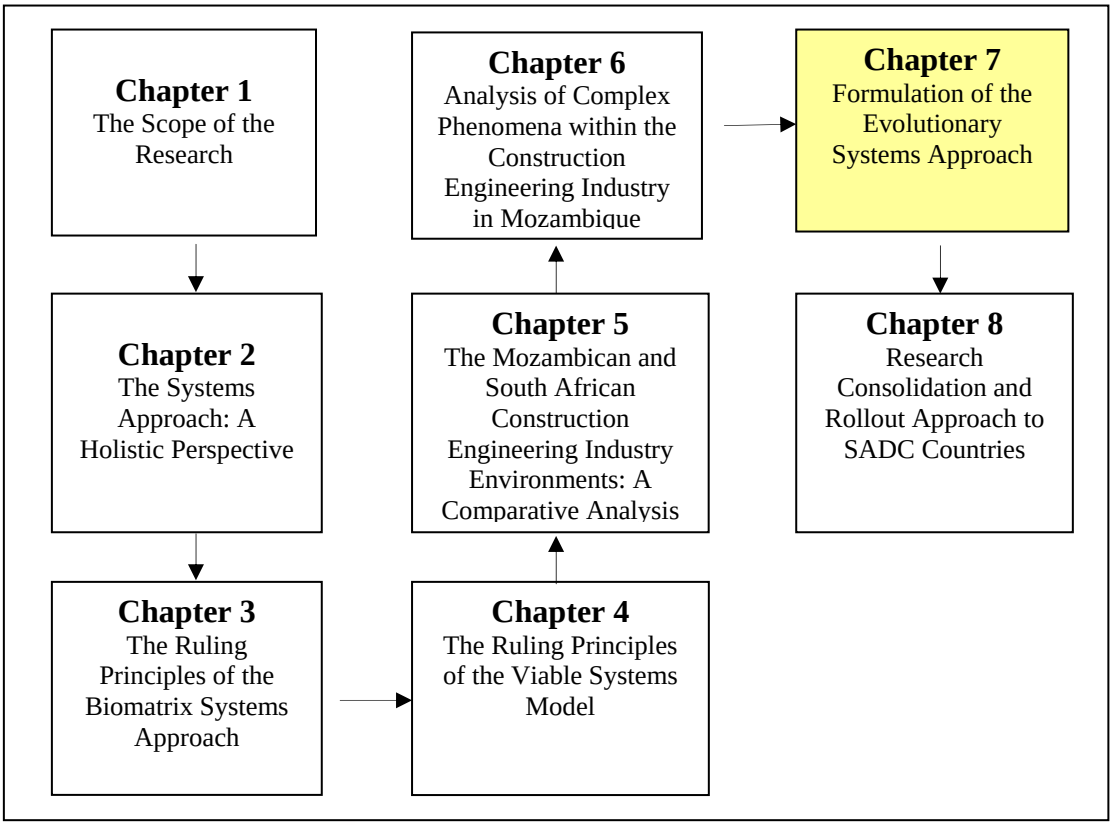

Figure 7.1: Chapters in context of the overall research

7.2 PERSPECTIVES ON THE FORMULATION OF THE EVOLUTIONARY SYSTEMS APPROACH

The evolutionary Systems Approach to be formulated within the ambit of this thesis will manifest in the form of 'a model'. Against this background, it would be appropriate to provide a scientific underpinning of the 'evolutionary Systems Approach' as 'a model' functioning within the greater ambit of a system. The perspectives which will be provided on the formulation of the 'evolutionary Systems Approach' will include the following:

- Mozambique as a system.
- Construction Engineering Industry as a system.
- The Evolutionary System Approach as a system model.

7.2.1 Mozambique as a System

Mozambican society, more specific Mozambique as a country is being governed in terms of democratic principles. The process of governance can only be successful if portfolios are created within government, each being administered in terms of its own unique laws and complexities. As a result, a typical government will have portfolios dedicated to be governed under the auspices of a minister who takes the responsibility for the functioning of such portfolio within the greater context of governance. This portfolio (be it public health, safety and security, housing, finance, construction engineering, education, build environment and technology) to function within the context of 'governance' should not only autonomously manifest as a viable entity, but should interact with other portfolios making up the government of the day.

From the above, the analogy can be drawn that Mozambique per sé can be termed as a system falling within the ambit of the definitions of systems defined by Ackoff (1960:332), Churchman (1968:29), Cleland & King (1975:15), Flood & Jackson (2002:5) and Takahashi & Takahara (1995:7). More specific to the government of Mozambique being considered as 'a system', it is perhaps the definition of Kast & Rosenzweig (1974:101), which is the most appropriate in this instance. The definition of Kast & Rosenzweig (1974:101) reads as follow:

> *"…system consists of an organized, unitary whole composed of two or more interdependent parts, components, or subsystems, and delineated by identifiable boundaries from its environmental supra systems"*

This notion to view the government of Mozambique as a system is further supported by the view of Flood & Jackson (1991:4) who are of the opinion that "…a system is a highly complex and highly interlinked network of parts exhibiting synergistic properties where the whole is greater than the sum of the parts".

7.2.2 Construction Engineering Industry as a System

Construction Engineering represents one of the portfolios of the Mozambican government. The obvious analogy which can be drawn is that Construction Engineering by implication being a 'subset' of the Mozambican government can be termed a system in its own right. This however, calls for closer scrutiny.

Viewed from the perspective that Construction Engineering forms a 'subset' the Mozambican government (a system), the interpretation which Capra (1996:27) attributes to such a dispensation, maps to the term 'system' which can be associated with a plethora of interpretations depending on the field one wishes to apply the concept. This is supported by Churchman (1968:29) who views a system as "…a set of parts co-ordinated to accomplish a set of goals". In turn this 'set of goals' can be viewed as being determined by the Government of Mozambique in the execution of governance. This notion is also supported by Athey (1982:12) who defines a system as "…any set of components which could be seen as making together the overall objective of the whole".

The various elements, sub elements and problems associated with Construction Engineering, the latter as identified within the context of Chapter 6, maps to the definition of 'a system' as proposed by Cleland & King (1972:27). This definition reads as follows:

> *"…A system, by its nature, is made up of interdependent elements. As such, actions which affect one element must affect others also. And actions of one element cause reactions on the part of others. The recognition of such interactions and interdependencies bath within and without the organization is the essence of the systems viewpoint"*.

7.2.3 The Evolutionary Systems Approach as a Systems Model

The approach in this thesis for the formulation of an Evolutionary Systems Approach as a model to address the complex phenomena associated with Construction

Engineering in Mozambique finds support in the opinion of Athey (1982). Within this context, Athey (1982:152) is of the opinion that, "…it may be a definitive advantage for the analyst to build a model of the system allowing to better understand the complex interrelationship of the system and through the model the analyst could generate specifically tailored information that he could not retrieve from any place else".

Further support to formulate the Evolutionary Systems Approach as a system model, comes from Cleland & King (1975:97) who view the concept 'model' in a scientific sense as a system, which is used to predict the effort of changes on the performance of the system. Furthermore, it is perhaps the views provided by Takahashi & Takahara (1995:3) which underpin the logic of this author to formulate the Evolutionary Systems Approach as a system model. Takahashi & Takahara (1995:3) argue that, "…systems theory is not a theory of systems themselves that are objects with complexity whose properties one may want to examine, but a theory of 'system models' for such systems.

7.3 A REFOCUS ON THE RESEARCH PROCESS FOLLOWED THUS FAR

In the previous chapter an ideal design was formulated for the Construction Engineering Industry in Mozambique. For the purpose of clarity of the reader, this 'ideal design' was formulated using a structured sequence of events which are depicted in Figure 7.2.

The next step would be to transform the 'ideal design' created with the ambit of Chapter 6 into a viable solution through the application of an evolutionary Systems Approach. More specific, the evolutionary Systems Approach to be formulated will be applied to the ideal design (formulated within the ambit of Chapter 6, Paragraph 6.5.1, Figure 6.4) reflected here as Figure 7.3.

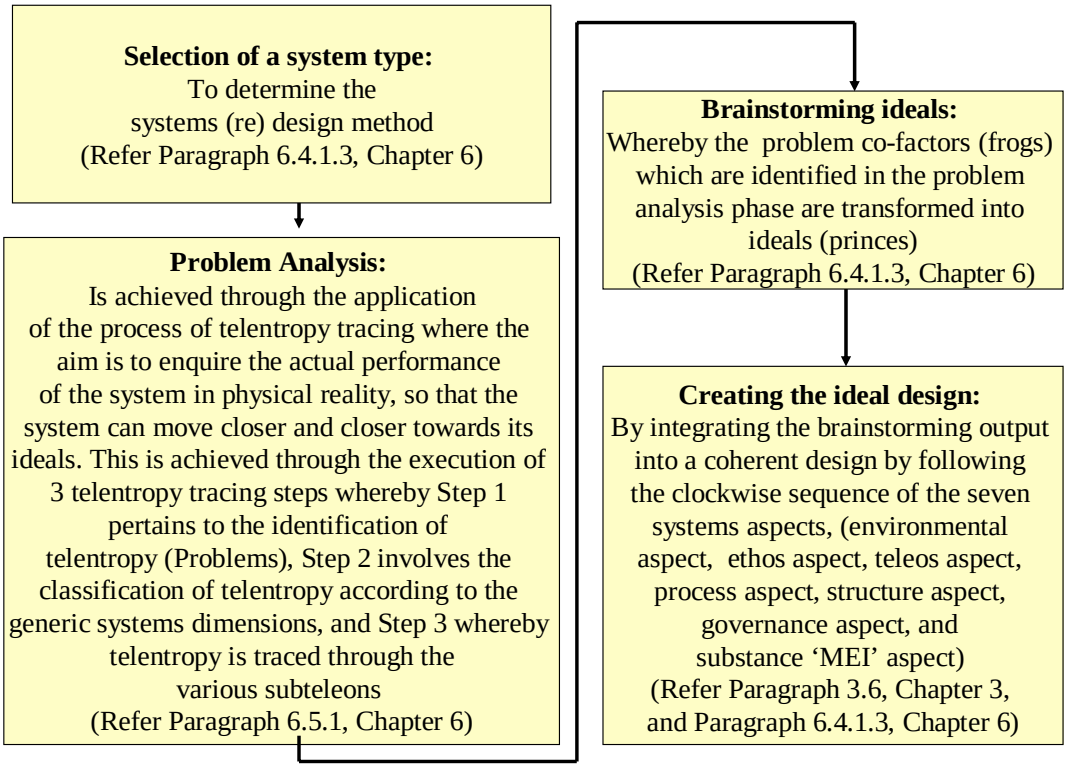

Figure 7.2: The 'ideal design' formulation using a structured sequence of events

(Source: Own source)

	Cultural Dimension	Techno-Economic Dimension	Political Dimension
Societal level	26		1, 27
Governmental level		10, 22, 25	20, 21, 23, 38, 41
Organisational level	7, 29	8, 9, 30, 31, 32, 33, 34, 35	5, 11, 13, 14, 15, 17, 18, 24
Individual level	28	2, 3, 4, 6, 19, 36, 39, 40	12, 16, 37

Figure 7.3: The 'ideal design' (**Source:** Own Source)

7.4 KEY ELEMENTS OF THE PROPOSED EVOLUTIONARY SYSTEMS APPROACH

The evolutionary systems approach to be formulated within the ambit of this thesis to culminate in a structured sequence of events to mitigate the research problem as depicted in Chapter 1, Paragraph 1.3.2 will have as its basis principles of the Viable System Model, juxtaposed with this author's own contribution.

The Viable Systems Model, elaborated upon in Chapter 4, makes it in particular suitable to address the research problem as it focuses on, "…diagnosing problems of organisations, particularly those arising in complex probabilistic systems that comprise purposeful organised parts and are open to a changing environment" (Flood and Jackson, 1991:88).

The suitability of the Viable Systems Model to serve as a basis for the Evolutionary Systems Approach to be formulated in this thesis is accentuated by Flood and Jackson (1991:88) when the authors expresses the opinion that, "…Beer's Viable Systems Model focuses on organisation rather than structure". By focusing on 'organisation rather than structure', by implication dictates the approach to be taken in the structuring of an evolutionary systems approach to be applied to the Construction Engineering Industry in Mozambique giving effect to the maxim that the Viable Systems Model "…encapsulates all of organisational cybernetics" (Jackson, 1991:104).

Should the views of Clemson (1984:99) be mapped to the current reality within the Construction Engineering Industry in Mozambique, the analogy can be drawn that the Viable Systems Model should:

- Re-create the Construction Engineering Industry in Mozambique to meet the needs of the government and all those who benefit from the organisation.
- Facilitate the concept of a 'learning organisation' within the Construction Engineering Industry.
- Facilitate inter-connectiveness for construction engineering to maintain itself and to adapt to change.
- Increase the effectiveness of the Construction Engineering Industry.

7.5 THE 'IDEAL DESIGN' AS BASIS FOR THE EVOLUTIONARY SYSTEMS APPROACH MODEL

The 'ideal design' depicted in Figure 7.3 extrapolated from Figure 6.4, Paragraph 6.5.1, Chapter 6, now form the basis onto which the Viable Systems Model will be mapped, ultimately to form the evolutionary systems approach model, being the primary theme of this thesis. A number of aspects however impact adversely on the above calling for a re-defining of the ideal design in terms of its real world application. These aspects are listed below:

- Churchman (1979:8) holds that one of the elements pertaining to the concept 'systems approach' is that, "…all aspects of the human world should be tied together in one grand rational scheme".
- Cleland & King (1972:79) citing Drucker (1967) viewing the systems approach as, "…a host of formally unrelated activities and processes as all parts of a large, integrated whole".

A re-definition of the 'ideal design' to map to the requirements of the systems approach in terms of a 'real world' application is schematically depicted in Figure 7.4.

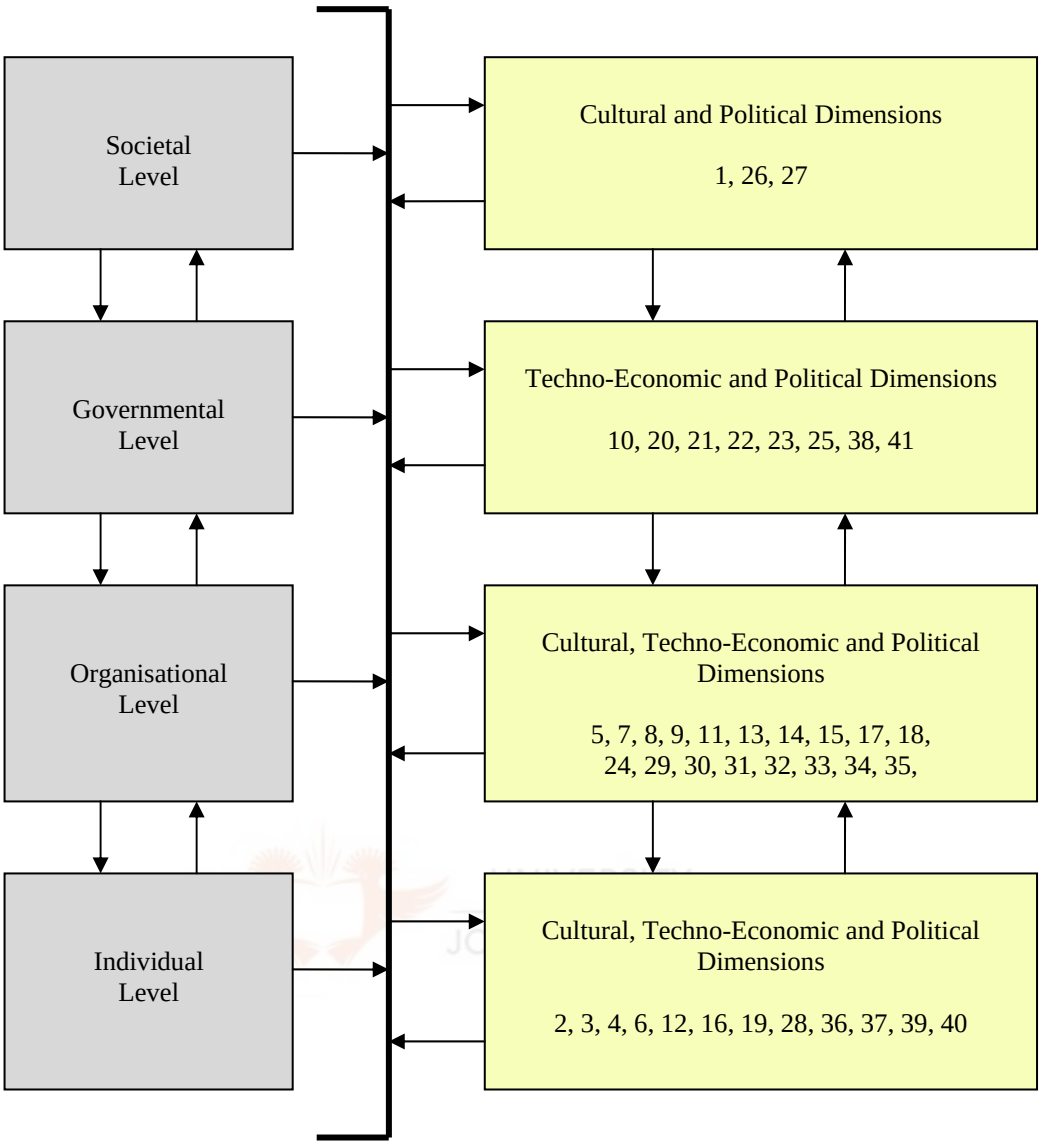

Figure 7.4: Redefinition of the 'ideal design' mapped to the requirements of the systems approach (**Source:** Own Source)

7.6 REDEFINITION OF THE 'IDEAL DESIGN' MAPPED TO THE VIABLE SYSTEMS MODEL

The next step in the process is to map the redefinition of the 'ideal design' (Refer to Figure 7.4) to the key determinants of the Viable Systems Model thus forming the Evolutionary Systems Approach Model, being the primary objective of this thesis. A holistic perspective of the Evolutionary Systems Approach is schematically depicted in Figure 7.5.

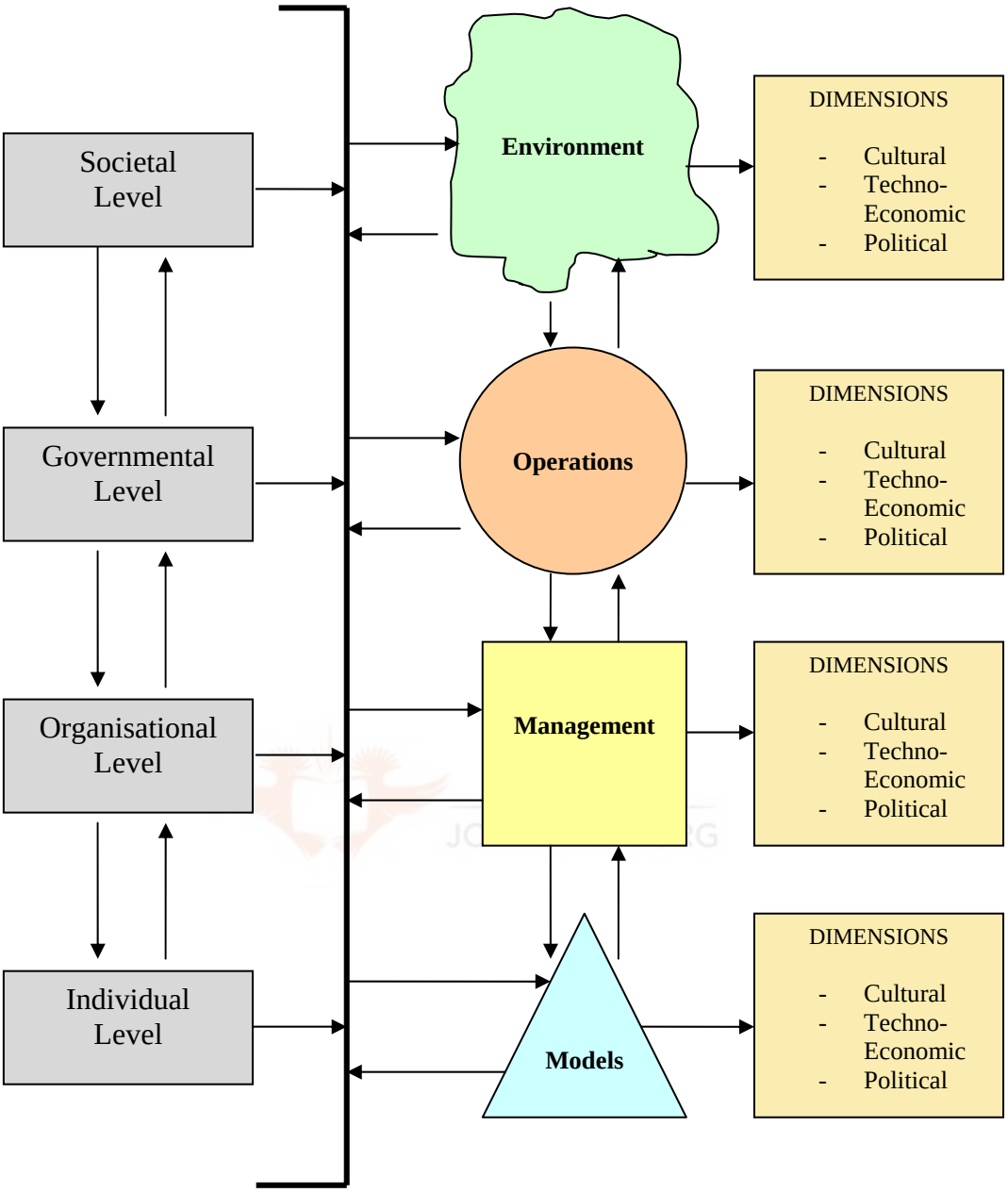

Figure 7.5: A holistic perspective of the Evolutionary Systems Approach Model

(**Source:** Own Source)

Figure 7.5 can now be individually analysed to reflect the four elements of the Evolutionary Systems Approach model and to determine the actions required to realize the ideals for each of the levels (Societal, Governmental, Organisational and individual) in terms of the determinants of the Viable Systems Model to mitigate the research problem and find an answer to the research question.

7.6.1 Actions required to realize Societal Level ideals upon application of the Viable Systems Model

The actions required to realize the ideals pertaining to the construction engineering in Mozambique at the societal level are reflected in Figure 7.5.1, which forms the first element of the Evolutionary Systems Approach model.

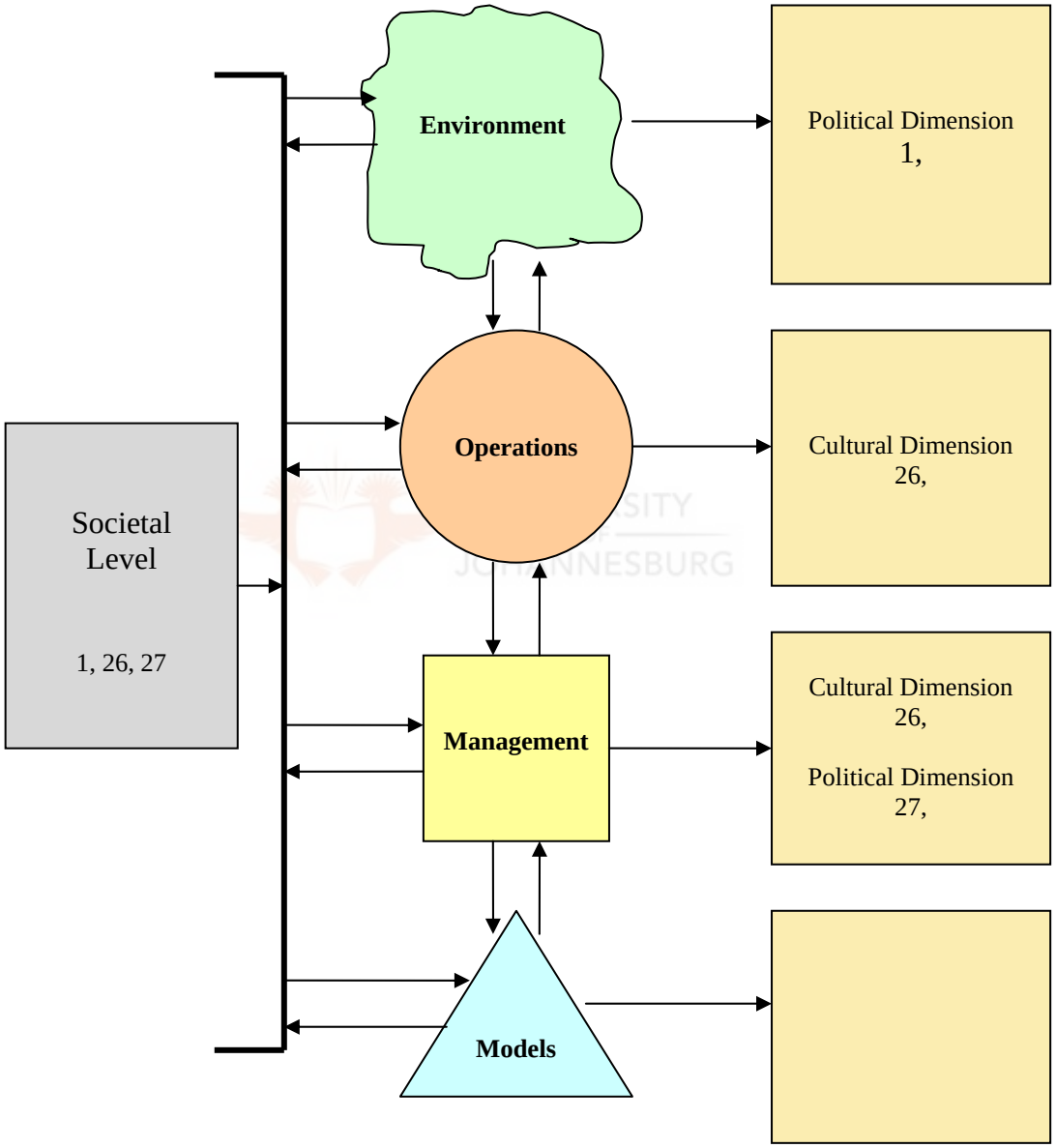

Figure 7.5.1: First element of the Evolutionary Systems Approach model
(**Source:** Own Source)

7.6.2 Actions required to realize Governmental Level ideals upon application of the Viable Systems Model

The actions required to realize the ideals pertaining to the construction engineering in Mozambique at the governmental level are reflected in Figure 7.5.2, which forms the second element of the Evolutionary Systems Approach model.

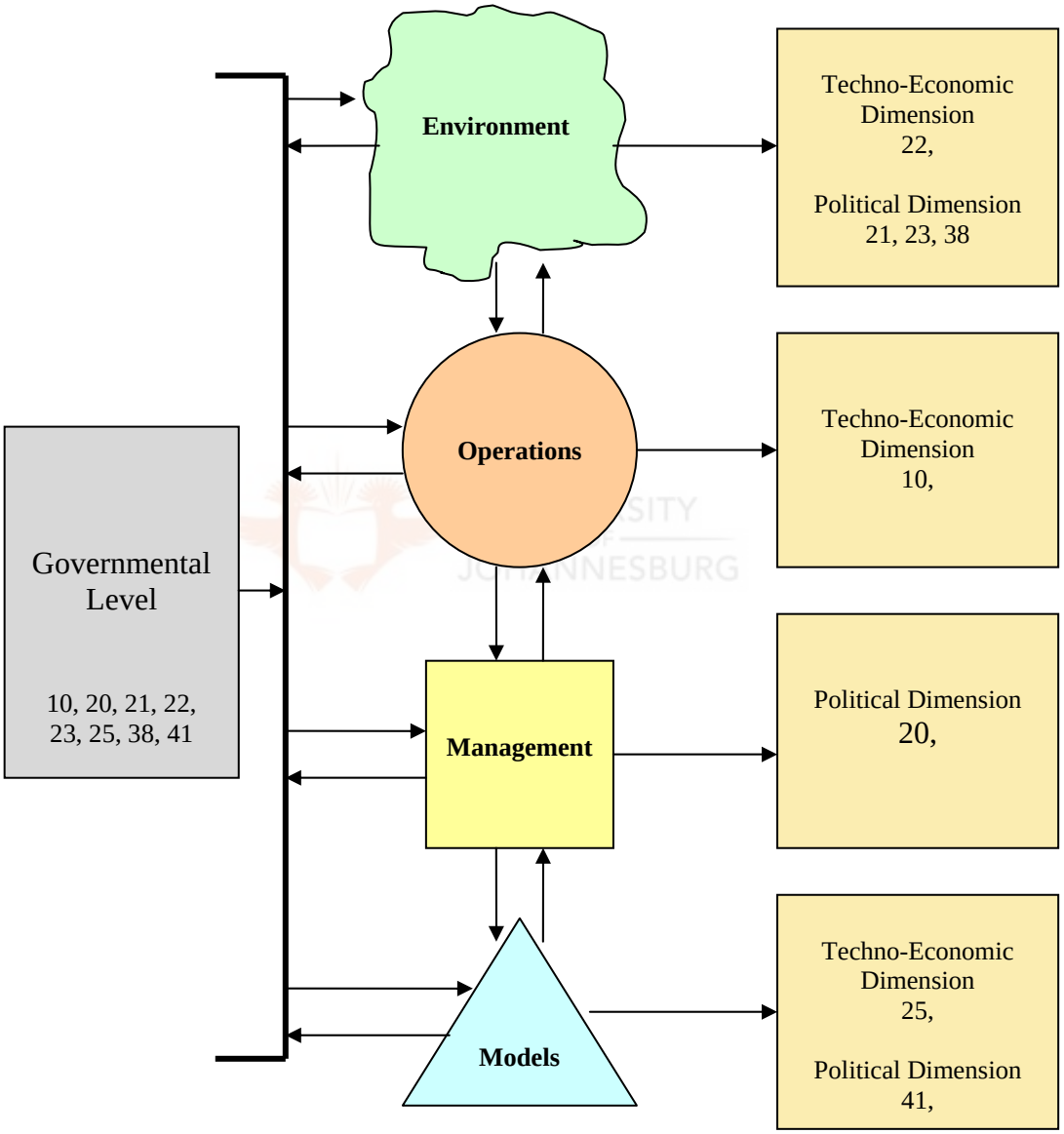

Figure 7.5.2: Second element of the Evolutionary Systems Approach Model (**Source:** Own Source)

7.6.3 Actions required to realize Organisational Level ideals upon application of the Viable Systems Model

The actions required to realize the ideals pertaining to construction engineering in Mozambique at the organisational level are reflected in Figure 7.5.3, which forms the third element of the Evolutionary Systems Approach model.

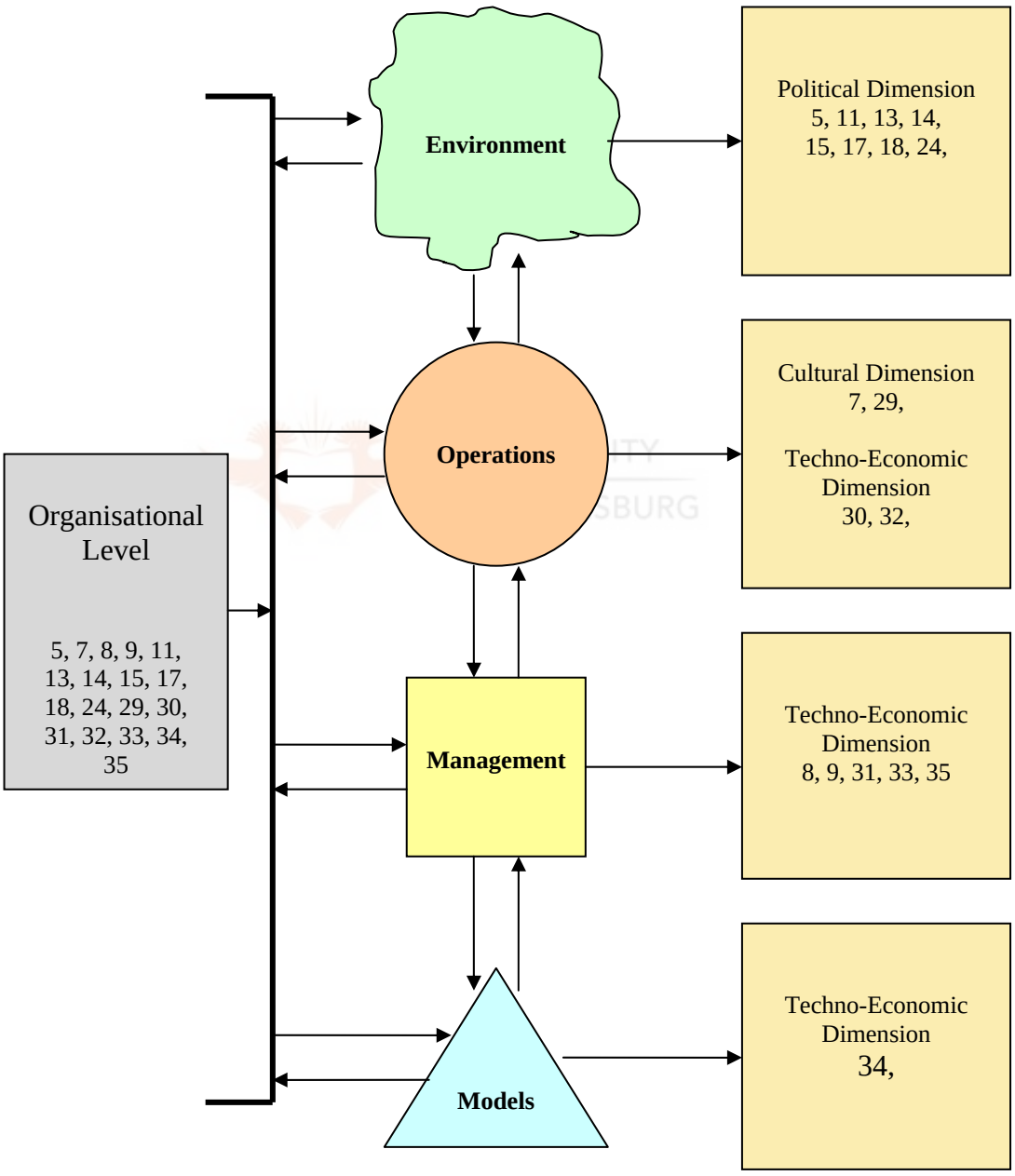

Figure 7.5.3: Third element of the Evolutionary Systems Approach Model
(**Source:** Own Source)

7.6.4 Actions required to realize Individual Level ideals upon application of the Viable Systems Model

The actions required to realize the ideals pertaining to construction engineering in Mozambique at the individual level are reflected in Figure 7.5.4 forms the fourth element of the Evolutionary Systems Approach Model.

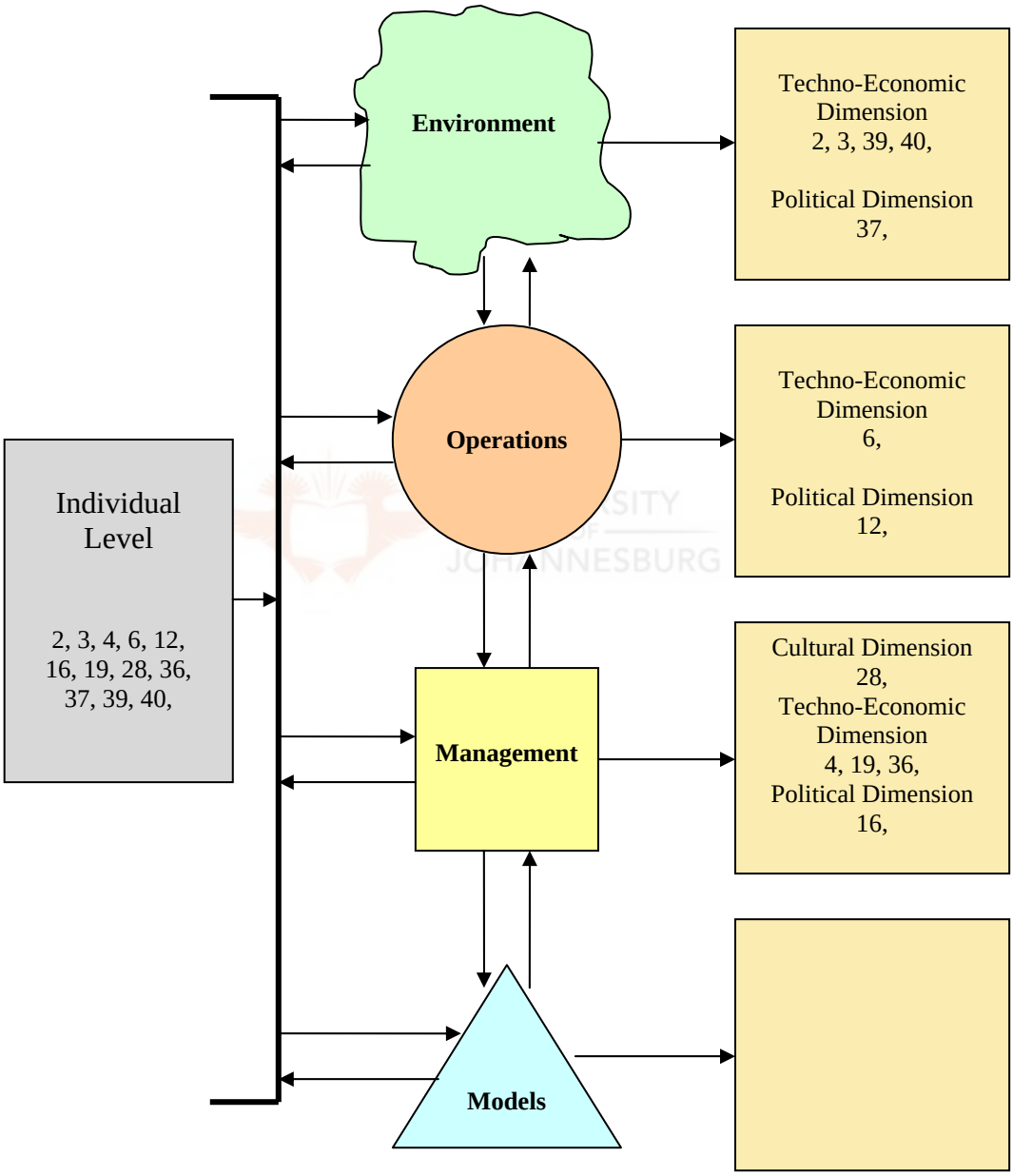

Figure 7.5.4: Fourth element of the Evolutionary Systems Approach Model
(**Source:** Own Source)

7.7 CONCEPTUAL VALIDATION

The four elements of the Evolutionary Systems Approach Model formulated within the ambit of Paragraphs 7.6.1 – 7.6.4, calls for validation of the conceptual approach. This requirement is due to the following:

- Change dynamics with a governmental systems demand 'change over time' as opposed to immediate change where results (as applied to the concept of action research) can be monitored.
- Recommendations would require extensive lobbying from Government, which by implication is a time consuming undertaking.
- Culture change being established 'over time' cannot be changed as a result of a 'quick fix' solution.

The 'time factors' are thus mitigated through a process of conceptual validation.

7.7.1 Primary Focus of the Conceptual Validation

The primary focus of the conceptual validation of the proposed four elements of the Evolutionary Systems Approach Model formulated within the ambit of this thesis is to determine:

- If the proposed model has the potential to mitigate the research problem as formulated within the ambit of chapter 1, Paragraph 1.3.1.
- If the proposed model has the potential to provide an answer to the research question as formulated within the ambit of Chapter 1, Paragraph 1.3.2.
- If the formulated Evolutionary Systems Approach Model do not only provide a feasible solution, but also a viable solution to ensure sustainability and growth of the construction engineering industry in Mozambique.

7.7.2 Data Collection

The primary data collection method used in this survey is the personal interview. This choice of data collection method was selected specifically as it "…allows for the identification of issues within the target environment, which may not be readily identifiable using a pure survey questionnaire" (Burgess, 1982).

7.7.3 The Target Population

Care has been taken to select a target population of fifteen prominent 'opinion leaders' not only within the Construction Engineering Industry of Mozambique, but also of government and economic environments. This is to solicit the broadest spectrum of opinions on the proposed success of the Evolutionary Systems Approach Model within the context of Construction Engineering.

7.7.4 Survey Design

During the personal interviews with the target population, open ended questions were posed to maximise comprehension of the complexities to be addressed by the proposed Evolutionary Systems Approach. Furthermore, the survey was descriptive in nature (Hussey & Hussey, 1997). Interviewees were provided with an extensive presentation of the research content, and specifically of the method of identification of complex phenomena within the Construction Engineering Industry, prior to the interviews being conducted. Furthermore, how the Evolutionary Systems Approach Model could be applied within the four elements of the Viable Systems Model were explained and practically elaborated upon to provide not only a holistic appreciation of the concept, but to provide insight in the viability of the approach.

7.7.5 Survey Constraints

The survey constraints pertaining to this validation survey are the following:

- Intervieiwees, in spite of being prominent opinion leaders, while happy to provide their input on the viability of the proposed Evolutionary Systems Approach Model, did not wish to be identified, an aspect which was understood and appreciated against the background of prevailing social distrust in the country.

7.7.6 Survey Results

The results from the unstructured survey are summarised into 4 general opinions upheld by the respondents reflecting the unsolicited views from the respondents.

Opinion 1: The Evolutionary Systems Approach Model is the first attempt in Mozambique to address the complexities of the Construction Engineering Industry. The model has the potential of addressing some of the issues as identified, however may not provide an overall incumbent solution to all of the issues listed.

Opinion 2: The ideal solution as proposed could facilitate the paradigm shift within the construction engineering to 'save' the industry from total collapse, however would call for extensive Governmental lobbying.

Opinion 3: In a country like Mozambique with political individual agendas a priority, the proposed Evolutionary Systems Approach Model will be subject to intense scrutiny. However, the multidimensional model based on four levels of application does not only provide a holistic approach to problems in the Construction Engineering Industry, but also a practical application of the concept. This will culminate in an opinion by government and officials that the approach is based on reciprocal communication as opposed to a one sided prescriptive directive as a solution to the problems within the industry.

Opinion 4: As opposed to one sided approaches aimed at individual issues within the Construction Engineering Industry, the Evolutionary Systems Approach Model as recommended address the issues from a multi-directional holistical perspective. This should ensure that tangent planes created by the various complexities get to be addressed from four perspectives as opposed to from only one perspective. Perhaps of more importance, the fact that communication between the four entities will not only ensure that the proposed Evolutionary Systems Approach Model is feasible, but will also culminate in a viable solution for the complexities within construction engineering to ensure its sustainability and growth.

7.8 CLOSURE

The significance of this chapter is embedded within the context of identified actions which pertains to the societal, the governmental, the organizational and the individual level should the Evolutionary Systems Approach Model be applied within Construction Engineering Industry in Mozambique.

Furthermore, the potential is validated through a conceptual validation to measure the proposed success of the proposed solution. In the next chapter, the research will be consolidated and a rollout approach to SADC countries provided.

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CHAPTER 8

RESEARCH CONSOLIDATION AND ROLLOUT APPROACH TO SADC COUNTRIES

8.1 INTRODUCTION

The research process thus far included the following:

- Chapter 1: Reflecting the scope of the research including a high level overview of the Construction Engineering Industry in Mozambique. More importantly, in this chapter the research problem and associated research question were formulated.
- Chapter 2-4: In depth literature review were conducted on:
  - The systems approach:- Forming the primary theme of this thesis.
  - The Biomatrix systems approach:- Forming the mechanism for a multi-levelled and multidimensional framework for enquiry within the context of the Construction Engineering Industry in Mozambique.
  - The Viable Systems Model:- Serves as the primary mechanism in the formulation of the Evolutionary Systems Approach which will be mapped onto the 'ideal design'
- Chapter 5-6: Served as basis for enquiry into not only Construction Engineering, but also the complex phenomena pertaining to the industry.
- Chapter 7: The evolutionary systems approach to Construction Engineering in Mozambique were formulated and applied within the context of four dimensions of the construction engineering industry problems. In addition, the 'time factor' impact was mitigated through a validation survey to validate the viability of the proposed Evolutionary Systems Approach.
- Chapter 8: In this final chapter, the research will be consolidated and a rollout approach to the SADC countries recommended.

The analytical process followed thus far, is graphically depicted in Figure 8.1, which places the chapters in context with the overall thesis objectives, and furthermore indicates the relative positioning of this chapter.

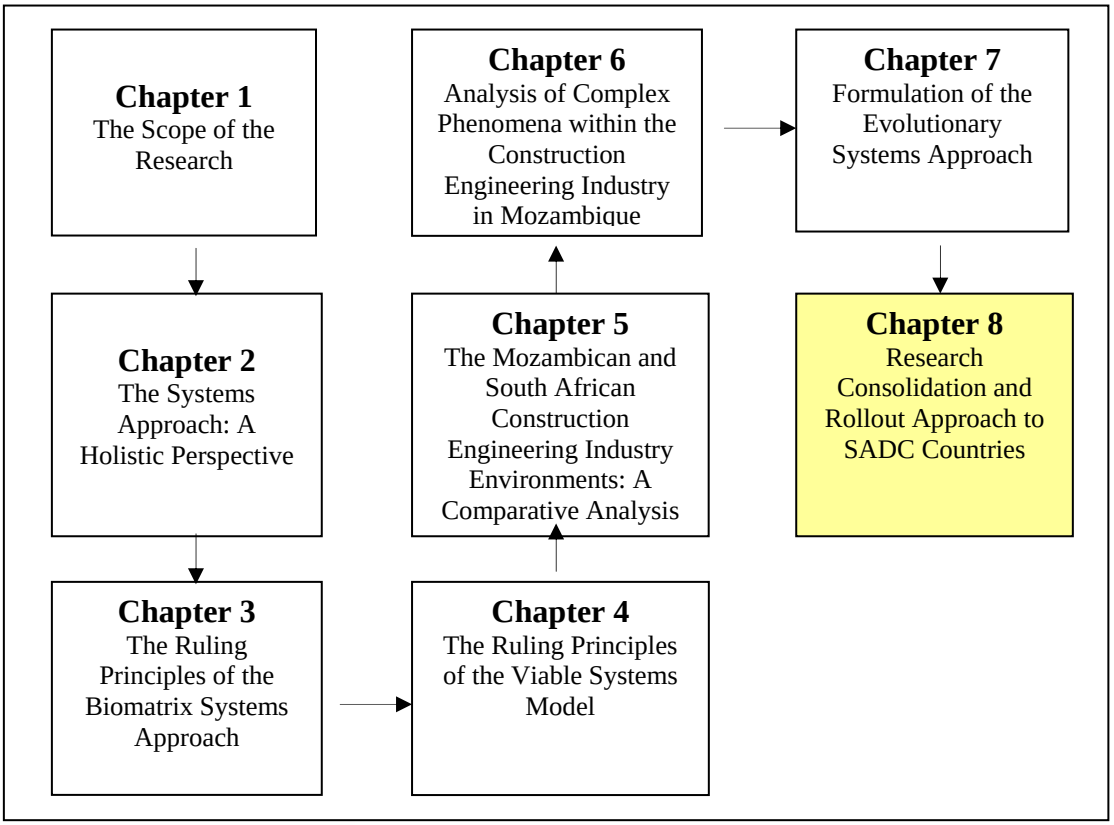

Figure 8.1: Chapters in context of the overall research

8.2 A REFOCUS ON KEY ELEMENTS

It would be appropriate to refocus on key elements forming the crux of this thesis. These elements pertain to the research problem, the research question, investigative questions, the research design and methodology and key research objectives.

8.2.1 The Research Problem

The research problem formulated within tha ambit of this thesis (Refer Chapter 1, Paragraph 1.3.1), reads as follow:

> *"The Construction Engineering Industry in Mozambique is operating within the context of an unstructured complex management paradigm, calling for an evolutionary solution to mitigate the complexities and ensure sustainability and growth"*

The research problem contains a plethora of complex phenomena ranging in diversity and complexity as identified within the contexts of the sociosphere dimensions, namely the cultural dimension, the techno-economic dimension, the political dimension and the ecological dimension. These complex phenomena were identified and analysed using the Biomatrix Systems Model as a framework for systems enquiry and design (Refer Chapter 6, Paragraph 6.3). For ease of reference, the extensive process which was followed to create a design for the enquiry into the complexities associated with Construction Engineering Industry in Mozambique using the Biomatrix Model is depicted in Figure 8.2 below.

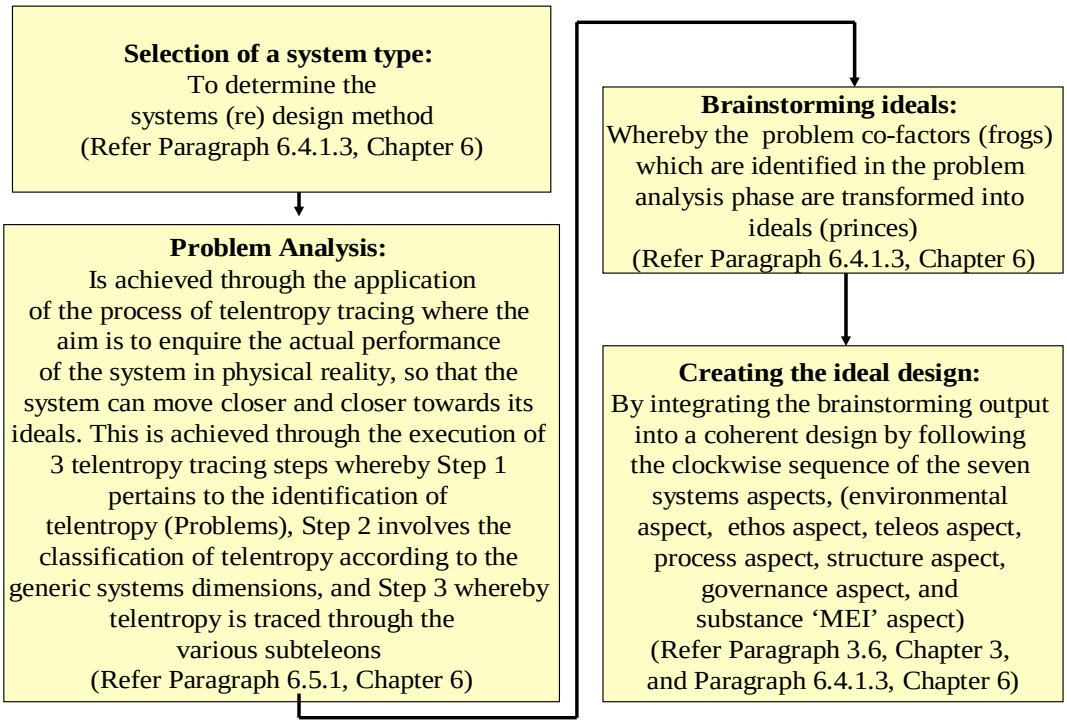

Figure 8.2: Process which was followed to create a design for the enquiry into the complexities associated with the Construction Engineering Industry in Mozambique, using the Biomatrix Model. (**Source:** Own Source)

The results gleaned from the enquiry reflected in Figure 8.2 have been validated in terms of accuracy and applicability by means of a validation survey and comparative analysis, which was conducted between the Mozambican and South African Construction Engineering Industry operation environments (Refer Appendix D).

8.2.2 The Research Question

The research question formulated within the ambit of this thesis (Refer Chapter 1, Paragraph 1.3.2) reads as follows:

> *"To what extent will an evolutionary Systems Approach facilitate paradigmatic change in the management of Construction Engineering in Mozambique, to ensure its sustainability and growth?"*

In the opinion of this author, the research conducted within the ambit of this thesis does not only provide a feasible, but also a viable answer to the research question.

This view is underpinned by the conceptual validation undertaken amongst fifteen prominent 'opinion leaders' not only within the Construction Engineering Industry of Mozambique, but also of government and economic environments. More specific, the conceptual validation was conducted to solicit the broadest spectrum of opinions on the proposed success of the Evolutionary Systems Approach within the context of Construction Engineering (Refer Chapter 7, Paragraph 7.7).

8.2.3 Investigative Questions

For ease of reference, each of the investigative questions will be cited followed by references in the thesis in terms of the individual research conducted within the ambit of each of the investigative questions.

- **Investigative Question 1:** How does the Biomatrix Systems Approach and the Viable Systems Model map to a holistic 'Systems Approach' perspective?

This aspect has been comprehensively analysed and reflected in Chapter 2, Paragraph 2.8. For ease of reference, the classification of systems falling within the context of the Systems Approach is graphically depicted in Figure 8.3 below.

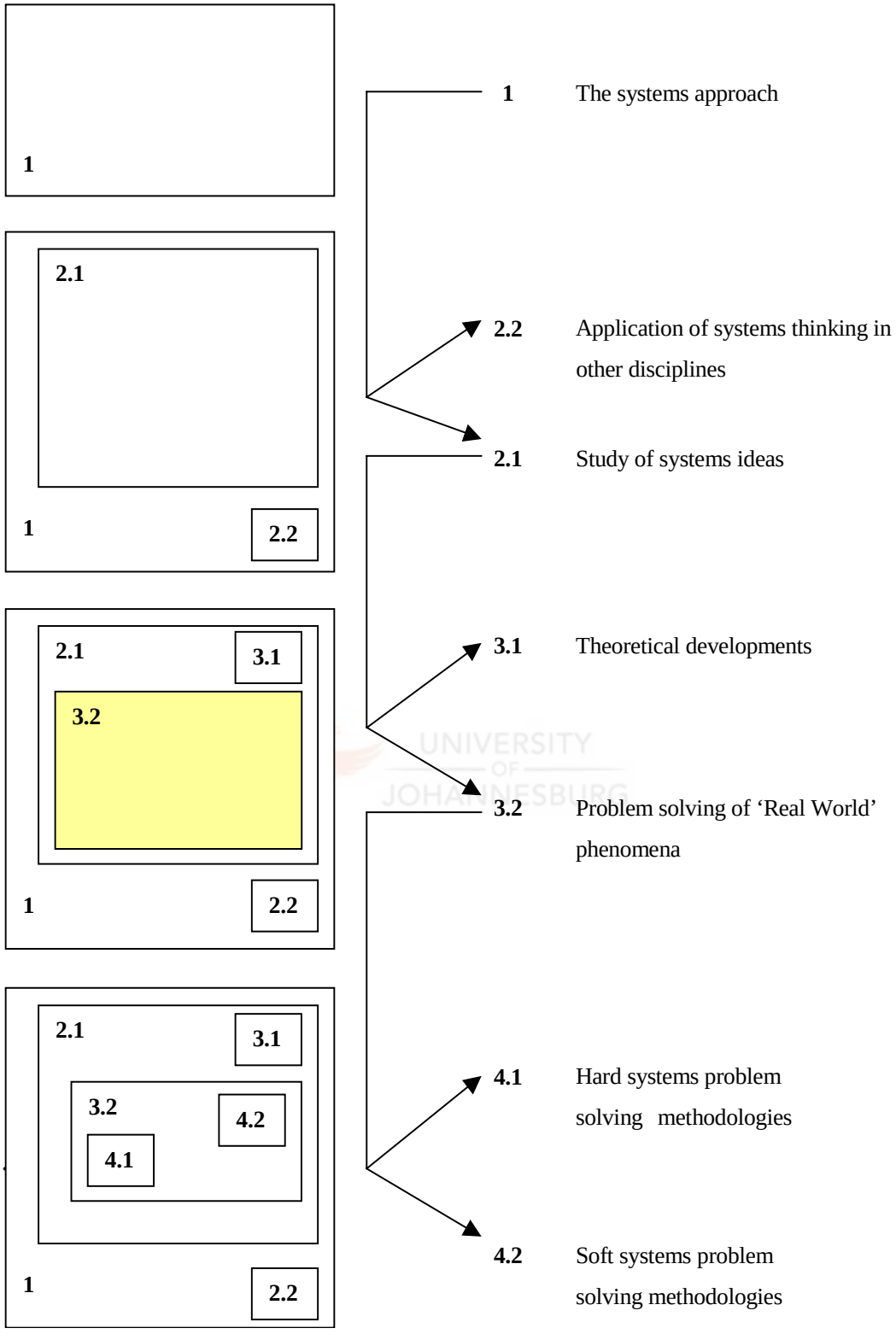

Figure 8.3: Classification of systems falling within the context of the 'Systems approach' (**Source:** Checkland, 1989: 95-97)

- **Investigative Question 2:** To what extend can elements of the Biomatrix Systems Approach be deployed to act as an enquiry mechanism to ultimately culminate in an 'ideal design' for the Construction Engineering Industry in Mozambique?

This investigative question was comprehensively addressed within the ambit of Chapter 6 where the Biomatrix Systems Model served as a framework for systems enquiry and design. Chapter 6 was supported with the analysis process as reflected within the ambit of Appendix C, whereby problem identification in the Mozambican Construction Industry was executed through the application of the telentropy tracing method.

- **Investigative Question 3:** How can the Viable Systems Model serve as the primary mechanism in the formulation of the Evolutionary Systems Approach which will be mapped onto the (to be) formulated 'ideal design'?

This highly complex process was addressed within the ambit of Chapter 7, Paragraphs 7.6.1 to 7.6.4. For ease of reference, see Figure 8.4 for a holistic perspective of the Evolutionary Systems Approach Model previously depicted as Figure 7.5, Chapter 7

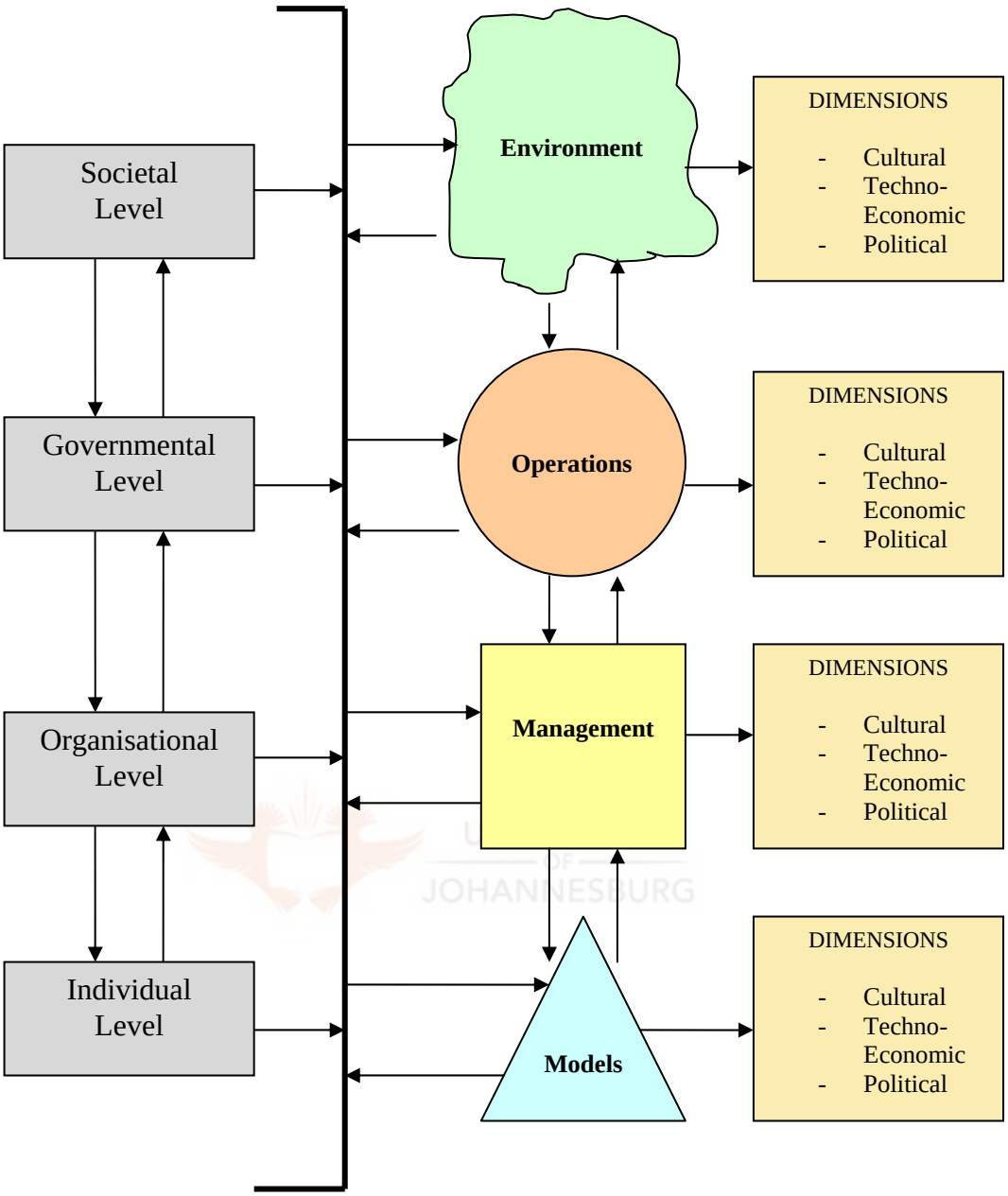

Figure 8.4: A holistic perspective of the Evolutionary Systems Approach Model

(**Source:** Own Source)

8.2.4 Research Design and Methodology

In this thesis, a case study research design and methodology underpinned by methodological triangulation served as research method (Refer Chapter 1, Paragraph 1.4).

8.2.5 Key Research Objectives

Against the background of the research conducted within the ambit of this thesis, the preliminary indications of acceptance, viability and feasibility of the formulated evolutionary systems approach to Construction Engineering in Mozambique (Refer Chapter 7, Paragraph 7.7), this researcher is of the opinion that the key research objectives are being met. These objectives initially stated in Chapter 1, Paragraph 1.9 are reflected here for ease of reference.

The key objectives of the author with this thesis and by implication forming the basis of any research undertaken at doctoral level according to Easterby-Smith *et al.* (2002:11) is:

- To make a significant contribution (add value) to the existing body of knowledge from the perspective of the academic reader in particular as it pertains to the Construction Engineering Industry of Mozambique.

The primary *raison d'être* for this thesis is to analyse, benchmark and compare the economic and business management environments as it pertains to the construction engineering industry in Mozambique to a more developed country, namely South Africa an SADC member. Furthermore, through this comparative analysis, formulate an evolutionary management strategy to bring about a paradigm shift in the management of the Construction Engineering Industry in Mozambique, to ensure its sustainability and growth. Moreover, this concept will be extrapolated to other SADC countries, to benefit the sub-continent as a whole.

8.3 IMPLEMENTATION OF THE EVOLUTIONARY SYSTEMS APPROACH

Being a developing third world country were anything evolutionary is treated with suspicion and apprehension, the following structured sequence of events have been formulated to implement the formulated Evolutionary Systems Approach Model within Construction Engineering Industry in Mozambique:

- **Phase 1: Lobby Actions.**
  - Lobby governmental decisionmakers in general on the viability and feasibility of the concept.
  - Lobby key decisionmakers within Government tasked with Construction Engineering to accept the concept to revolutionize the industry.
  - Lobby business decisionmakers to implement key elements of the proposed system as it relates to them individually.

- **Phase 2: Planning Phase.**
  - Form Individual task teams to address specific elements as identified within the research.
  - Formulate dynamic action plans based on a 'project approach'.
  - Communicate the dynamics of the formulated Evolutionary systems approach to the individual task teams and Government.

- **Phase 3: Implementation.**
  - Implement the Evolutionary Systems Approach Model in a structured way as to not cause confusion to its impact.
  - Monitor results.
  - Re-implement where the desired results have not been achieved.
  - Communicate results attained to stakeholders and government.

- **Phase 4: Monitoring.**
  - Re-evaluate on a sustained basis the achieved results.
  - Identify key areas of non performance
  - Focus effects in a structured approach based on the above to mitigate non performance areas.

8.4 ROLLOUT APPROACH TO SADC COUNTRIES

No rollout approach of the Evolutionary Systems Approach Model has the potential in any of the SADC countries to be adopted unless the following criteria has been met.

- Proven results can be provided of the viability of the concept as implemented within Mozambique.
- A paradigmatic change to the benefit of the Mozambican Construction Engineering Industry can be demonstrated.
- Tangible benefits culminated from the implementation of the Evolutionary Systems Approach Model in Mozambique.
- The Evolutionary Systems Approach Model can be proved to serve as a viable solution to similar problems in SADC countries as experienced within the Construction Engineering Industry in Mozambique.
- The concept accepted by the SADC countries in a unified forum as a solution to issues pertaining to the Construction Engineering as a whole.
- The structured sequence of events for implementation as set out in Paragraph 8.4 mapped for SADC countries.

8.5 AVENUES FOR FUTURE RESEARCH

The Evolutionary Systems Approach Model as formulated for the Construction Engineering Industry in Mozambique is a new paradigm in the approach to complex phenomena in the country due to its multidimensional, multileveled application. This would call for research into other spheres of government impacted upon by the same complexities as construction engineering in Mozambique and would serve as mitigation for a plethora of complexities within the country.

8.6 FINAL CONCLUSION

The unique Evolutionary Systems Approach Model to Construction Engineering Industry has, in the opinion of this researcher the potential to effect paradigmatic change within the Construction Engineering Industry in Mozambique. Furthermore, this model has the potential of not only benefit this specific industry, but also other sectors including sectors of government, in a country so often described within the context of “one of the poorest in the world”.

APPENDIX A: TABLE OF CONTENTS

APPENDIX A: CONSTRUCTION ELEMENTS OF BEER'S VIABLE SYSTEMS MODEL

APPENDIX A

CONSTRUCTION ELEMENTS OF BEER'S VIABLE SYSTEMS MODEL

A 1 INTRODUCTION AND BACKGROUND

The traditional company organisational chart is for Beer (1981:205) totally unsatisfactory as a model of a real organisation, offering his Viable Systems Model as a more useful and suitable alternative option. Beer's model consists of five sub-systems – System One to System Five. According to Jackson (1991:105), the same model is derived from cybernetics and can therefore be applied to firms and organisations of all kinds[1]

According to Jackson (1991:105), Beer believes that a system is viable if it can respond to environmental changes. To remain viable, a system has to achieve requisite variety with the complex environment with which it is faced. Beer sets out a number of strategies that can be used by managers to balance the variety equations, the most important of which involves 'variety engineering', previously discussed in Chapter 4. Having previously created some understanding of 'organisational cybernetics' *per se*, the philosophy and principles of the Viable Systems model of Stafford Beer which is intimately associated with this concept, require closer scrutiny.

The attention of the reader is drawn to the fact that the analyses of the ruling principles of the Viable Systems Model in certain instances have been reproduced verbatim from Watkins (1999) (with permission) as the analysis contained therein could not be improved upon.

[1] The reader is cautioned to view this statement against the background of the analysis of cybernetics (Refer chapter 4, Paragraphs 4.3 and 4.4), where a distinction is made between 'organisational cybernetics' and 'management cybernetics'.

A 2 PHILOSOPHY OF THE VIABLE SYSTEMS MODEL

The philosophy that drives Beer's view of cybernetics concerns the kind of changes to be experienced in the Twenty First Century, and that 'new ways' are required to deal with difficulties associated with changes. The main points underpinning the above are summarised by Flood and Jackson (2002:89), as follows:

- Organisational and social problems arise because of new degrees of complexity (organisational, technological, informational and so on) and are characterised by interdependency.
- Scientifically based management taking advantage of technological advances (e.g. increased information processing capability) is vital because more traditional approaches are quite simply too trivial, and in isolation are not well worked out. Therefore, a scientific model that is based on cybernetic principles and which encompasses many ideas from management science is fundamental in the efforts to deal with modern complexities.
- Since control is the main concern, the best approach is to replicate a well tried and tested control system. This being evident in the neuro-cybernetic processes of the human brain and nervous system as it has evolved over millennia (the same control model can, however, be derived from cybernetic first principles and is applicable to all systems.)
- Organisations ideally are ordered so as to achieve efficient and effective realisation of set goals, although the goals themselves have to be continually reconsidered in response to a rapidly changing environment through self-questioning, learning and by assessing future scenarios.

A 3 PRINCIPLES OF THE VIABLE SYSTEMS MODEL

The principles that underpin the approach are all cybernetic in nature and outlined by Flood and Jackson (2002:89), as follows:

- Recommendations endorsed by the Viable Systems model do not prescribe a specific structure, rather they are concerned with the essentials of organisation and maintenance of identity. They are therefore, relevant to all types of enterprise, whether small, medium or large, in all types of industry. The structural outline of the Viable Systems model is completed with one of the

basic concepts developed by Beer (1981:228) (1995:2), namely the concept of a 'recursion levels'. In its most elementary formulation according to Hoebeke (1993:40), the 'Recursive System Theory' reads as follows:

> *"In a recursive organizational structure, any viable system contains and is contained in a viable system".*

Recursion means that the whole system is replicated in the parts so that the same viable system principles may be used to model a sub-system (a division) in an organisation, and its supra-system (that of which the system is a part or a division of).

- In any viable unit, horizontally interdependent sub-systems (divisions) are integrated and guided by the viable unit's 'meta-system', or 'higher' management levels.
- Sources of command and control are of particular concern and in the Viable Systems model these sources are spread throughout the architecture of the Viable Systems model, which enhances self-organisation and localised management of problems.
- Emphasis is placed on the relationship between the viable unit and its environment in terms of influencing and being influenced by it and particularly on using this relationship to promote learning.
- There are many other cybernetic principles that make up the viable system view, from rather simple notions of feedback to important principles such as the 'Law of Requisite Variety', that is the variety of the controller must be equal to, or greater than that which is being controlled.

A 4 CONSTRUCTION OF THE VIABLE SYSTEMS MODEL

This highly complex model consists of basic building blocks forming the core of its structure and is comprehensively discussed by Beer in his work *'Brain of the Firm': 'The Managerial Cybernetics of Organization'*. Using the abbreviated analysis of Clemson (1984:84-144), as opposed to the comprehensive study of Beer, the interactive components, which forms an operational unit are shown in Figure A1.

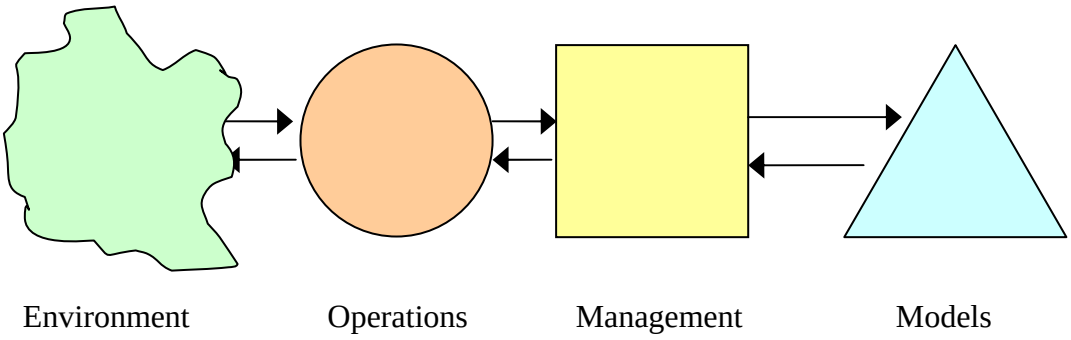

Figure A1: An operational unit dissected to show the major interactions

- **Operation:** Imbedded within the environment with a flux of interaction between the 'environment' and the 'operation'.
- **Management:** There is a clear distinction between the 'operation' and 'management' thereof.
- **Models:** As in the case between management and operation, a clear distinction can be drawn between the 'management' and the 'models' of the organisation or unit that the management holds. In whatever form these models exist, they constitute the management's view of the unit that is being managed.

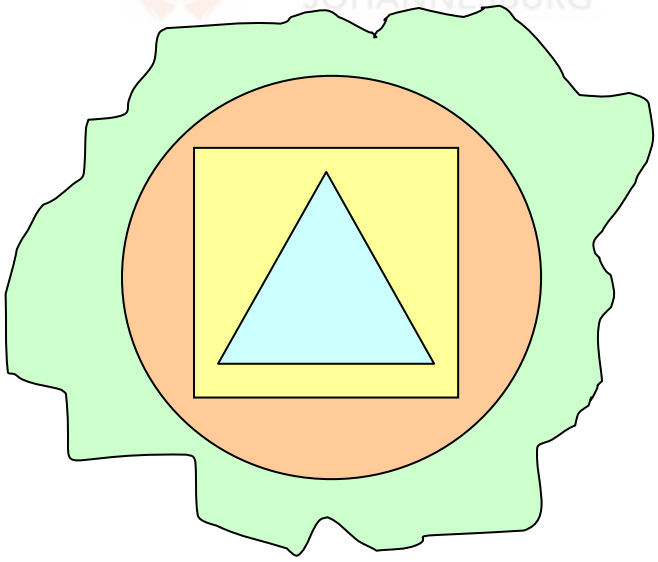

Figure A2: An operational unit showing the parts embedded

Figure A2 depicts an operational unit showing the parts environment, operations, management, and models embedded within one another. To represent a whole

organisation, Figure A2 can be expanded to reflect a set of related operational elements as depicted in Figure A3.

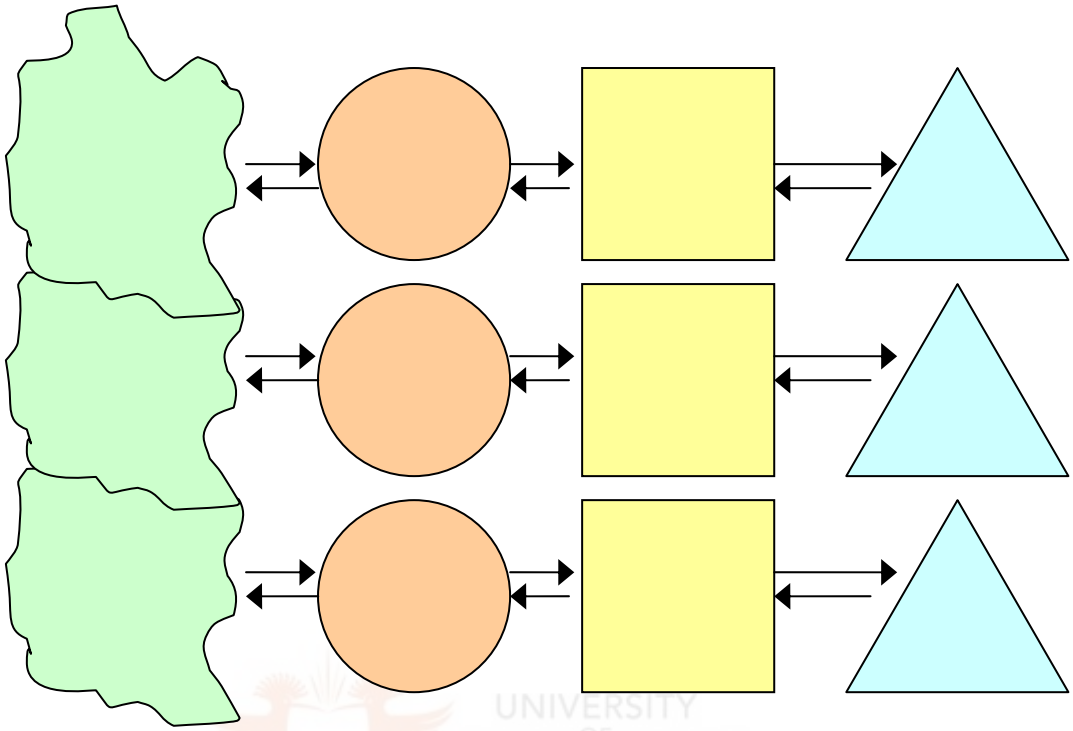

Figure A3: A set of related operational elements

The five components making up the Viable Systems model (System One to System Five) can be analysed as follows:

- **System One:** By linking the interaction of views of each manager in charge of each unit and the direct interaction which flows from one operation to the other, the set of related operational elements depicted in Figure A3 can be redrawn to collectively make up an organisational entity, termed 'System One' by Beer (1995:19) and depicted in Figure A4.

The completed structure of the Viable Systems model can now be graphically summarised by expanding Figure A3 to become Figure A4.

- **System One:** The collection of operational elements.
- **System Two:** The co-ordinating function.
- **System Three:** The 'internal' and 'now' management function.
- **System Four:** The 'external' and 'future' management function.
- **System Five:** The closure and identity management function.

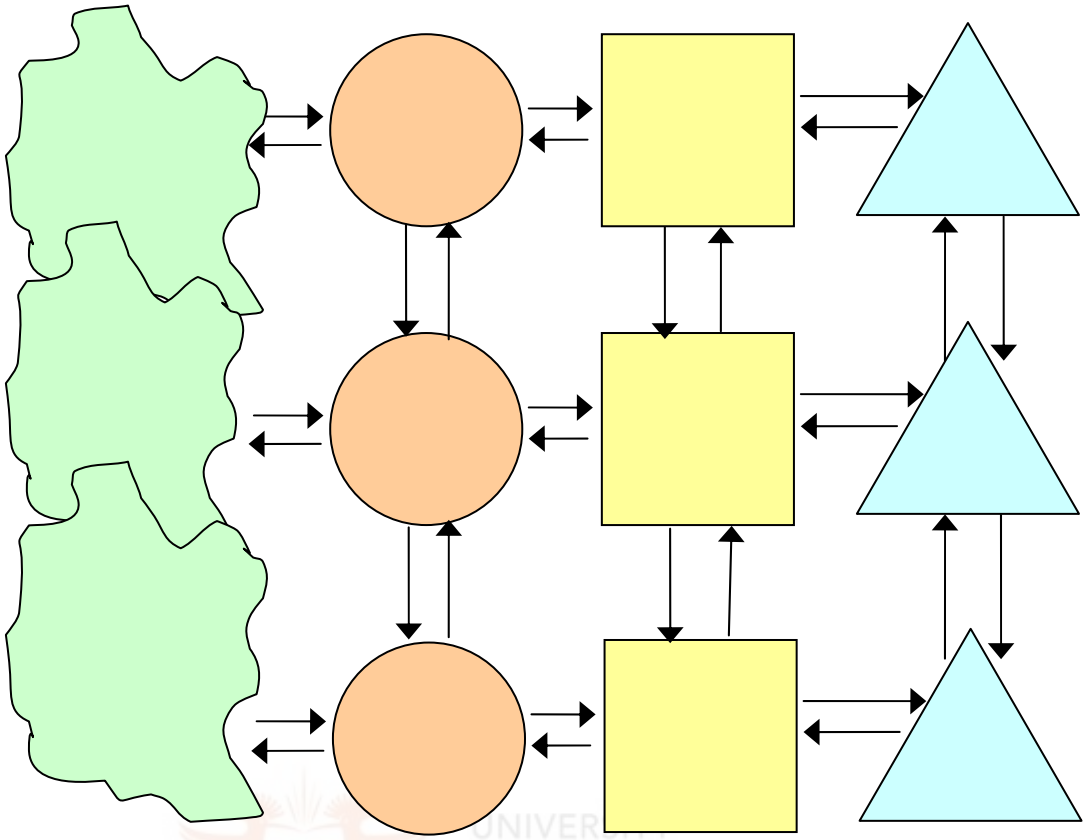

Figure A4: 'System One': A set of operational elements which collectively make up an organisational entity

Recursion: Level *'N'* of recursion – one level in a hierarchy of autonomous entities, each of which has a System One, a System Two, a System Three, a System Four, and a System Five.

Analysing the Viable Systems model holistically, Flood and Jackson (2002:90) proposes that the concept is made up of an arrangement of five (Systems One to Five) functional elements that are interconnected through a complex of information and control loops (communication links). Emphasis on recursion allows the utilisation of the 'same' basic model to represent for example, a company and its divisions together with the wider organisations of which it may also be a functional part.

APPENDIX B: TABLE OF CONTENTS

APPENDIX B: GOVERNANCE AND CORRUPTION SURVEY BY AUSTRAL CONSULTORIA E PROJECTOS, LDA

APPENDIX B

GOVERNANCE AND CORRUPTION SURVEY BY AUSTRAL CONSULTORIA E PROJECTOS, LDA[2]

B 1 INTRODUCTION AND BACKGROUND

The national survey on governance and corruption carried out in Mozambique by Austral Consultoria e Projectos, Lda (2004), using three parallel surveys targeting households, public officials and enterprises, with the aim to produce empirical evidence on society's views with regard to governance, corrupt practices and the quality of the services provided by the public sector. The information and knowledge produced by the survey, added to the subsequent complementary exploration of the collected empirical information, are to be used to underpin the debate and collaboration between the Government, Civil Society and the Private Sector in the formulation and implementation of policies and programs conceived to improve government's actions and reduce corruption within the framework of the Global Public Sector Reform Strategy.

Notwithstanding all reservations that should be had in relation to the validity and strictness of these indicators, the fact that the data relating to the control of corruption present a tendency contrary to the set of remaining governance indicators shows that the trend of corruption in Mozambique seems to be worsening and that the action by government and the legal bodies in this field has been unable to reverse the negative trend.

B 2 THE MAIN PROBLEMS IN MOZAMBIQUE

According to Austral Consultoria e Projectos, Lda (2004) data analysis shows that there is almost complete unanimity within the three groups interviewed with regard to the country's most pressing problems.

[2] Verbatin translation by the author of this thesis from the official report entitled Pesquisa Nacional sobre Governação e Corrupção, por Austral Consultoria e Projectos Lda (2004)

Although there are clear tangent planes in the sequence of the ten most serious problems, there are some notable differences in their classification. This has been summarised in Figure B1, which reflects the ten main problems indicated by each of the groups. The study highlights that the main difference between the enterprises and the other two groups surveyed is that the enterprises consider crime to be the most serious problem, and while this factor is also high up on the list for public officials (third place), it is placed lower on the list for households (seventh place).

B 3 MOZAMBIQUE IN A REGIONAL CONTEXT

According to the indicators produced by the World Bank Institute on the control of corruption, and taking the Southern African region as a reference, Mozambique is, according to Austral Consultoria e Projectos, Lda (2004) among the worst countries in terms of controlling corruption, with only Angola and Zimbabwe presenting lower scores. The analysis of some indicators at country level shows controversely that the problem is not restricted to the control of corruption. In fact, only one indicator namely political stability is placed slightly higher than 50 percent, with all of the remaining values falling under the 50 percent mark, highlighting in addition to the control of corruption, the limitations of the rule of law and regulatory quality.

Taking into consideration the evolution over the last couple of years (1996 to 2002), the control of corruption indicator is the only one that registered a negative impact. This tendency is confirmed by the data collected from the survey carried out on the citizens. In fact, most of the interviewees indicated an increase in corruption from 1999 to the present date.

B 4 CORRUPTION AND THE COUNTRY'S MAIN PROBLEMS

The analysis of survey data shows that there is almost complete unanimity within the three groups interviewed with regard to the country's most pressing problems, which are summarized and depicted in Figure B1.

The analysis returned that corruption appears to be less important, particularly as far as the households and public officials are concerned, ranking eighth and tenth

respectively, in the hierarchy of problems. As far as the enterprises are concerned, this problem ranks higher on the list, being placed midway (fifth place).

The main problems in Mozambique (the smaller the rank, the worst the problem)	Groups Surveyed		
	Households	Enterprises	Officials
Unemployment	1	2	1
Cost of living	2	3	2
Inflation	3	7	4
Water	4	8	8
Food	5		9
Roads	6	4	
Crime	7	1	3
Public corruption	8	5	10
Medical assistance	9	9	
Drugs	10		5
Sanitation		6	6
Housing		10	7

Figure B1: Summary of the ten main problems in Mozambique
Source: Austral Consultoria e Projectos, Lda (2004)

As depicted in Figure B2, the survey shows that for households, there are two problems which features prominently, namely unemployment and the cost of living (values close to 70%). Inflation, which appears in third place (51%), may be considered as another way of referring to the cost of living.

A set of problems (between 30% and 50%) which may be classified as second level and which include the lack of water, condition of the roads, crime and corruption in the public sector. In a third group of problems being of less importance to the households, the survey reflects the cost and quality of the services (15% to 30%).

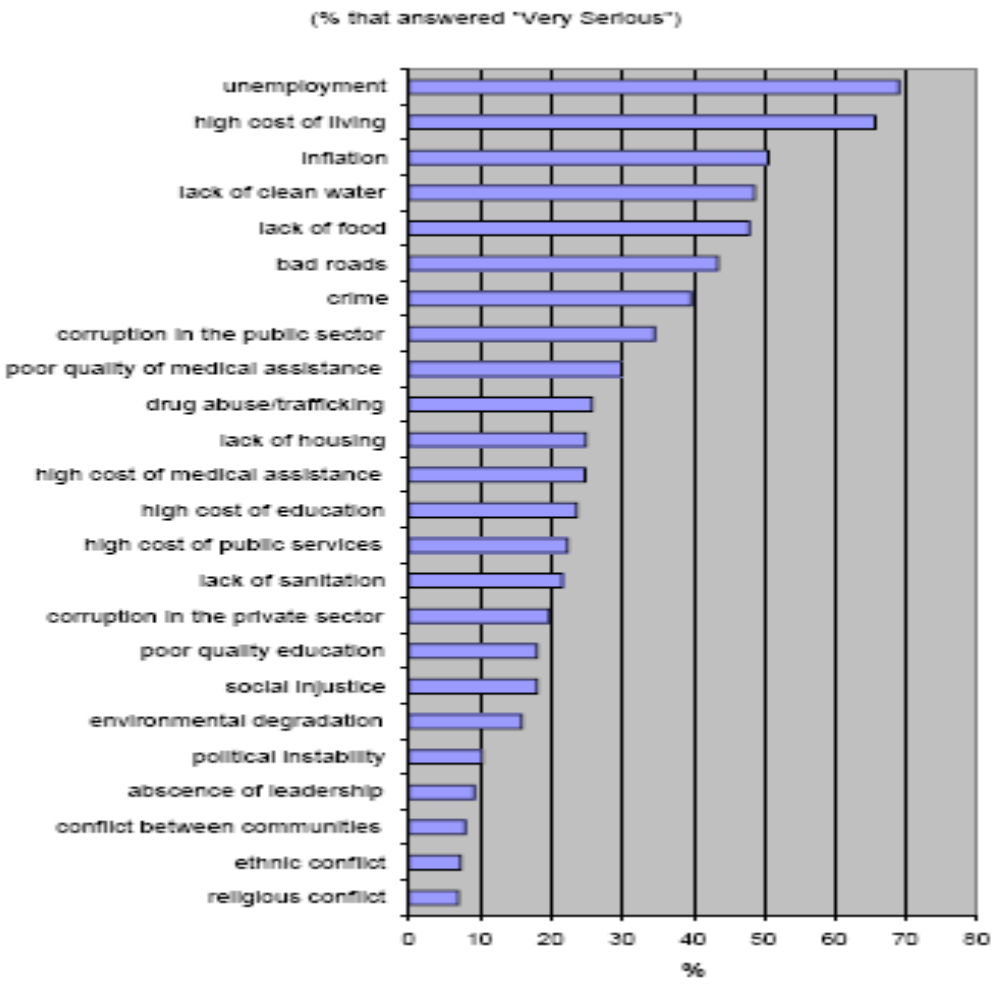

Figure B2: The problems seen as 'very serious' by households

Source: Austral Consultoria e Projectos, Lda (2004)

The public officials perceptions depicted on Figure B3 also highlight unemployment and the cost of living (83% and 82%, respectively), followed by crime (79%) and inflation (70%). In addition to this, they present values which fluctuate between 45% and 68% for the majority of the remaining problems, included in which are the quality and cost of the services, appearing in intermediate positions. This hierarchical classification is understandable in as much as these are the two factors that have a significant negative influence on the conditions, the environment and on the security of business. In the same realm, it is within this group that public sector corruption appears to have greater emphasis (42%).

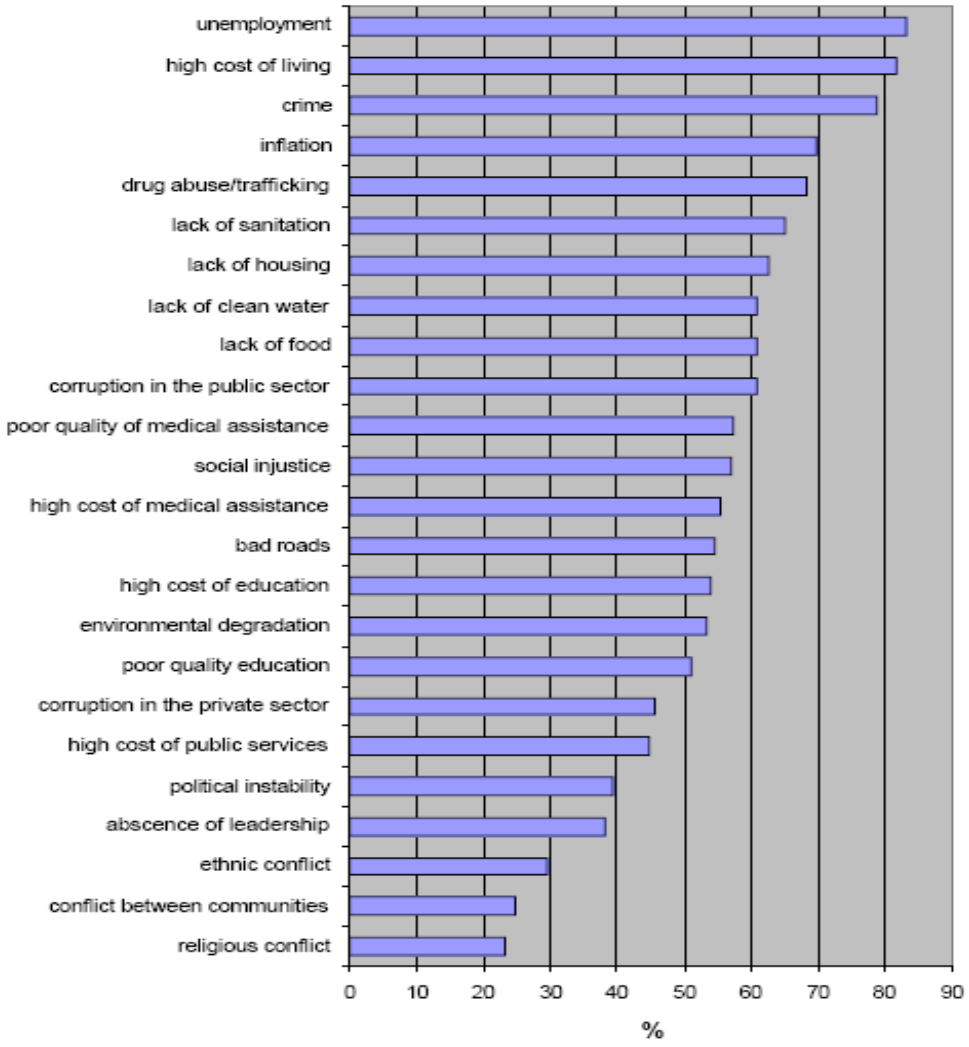

Figure B3: The problems seen as 'very serious' by officials

Source: Austral Consultoria e Projectos, Lda (2004)

There is unanimity with regard to the least important problems. Weak leadership and political instability as one part of the quantum, and ethnic, religious and community conflicts the other, obviously hold little relevance in the opinion of the majority of the interviewees from all groups interviewed.

Even though corruption does not appear at the top of the list of problems affecting the citizens, Austral Consultoria e Projectos, Lda (2004) adds that from a hierarchal point of view the citizens is aware that this is a serious problem, reflecting 70% of the interviewees classifying it as being a "very serious problem". In addition, the dominant opinion is that corruption has not been decreasing, and that 37% of the interviewees believe that corruption has already increased since the previous year as depicted on Figure B4.

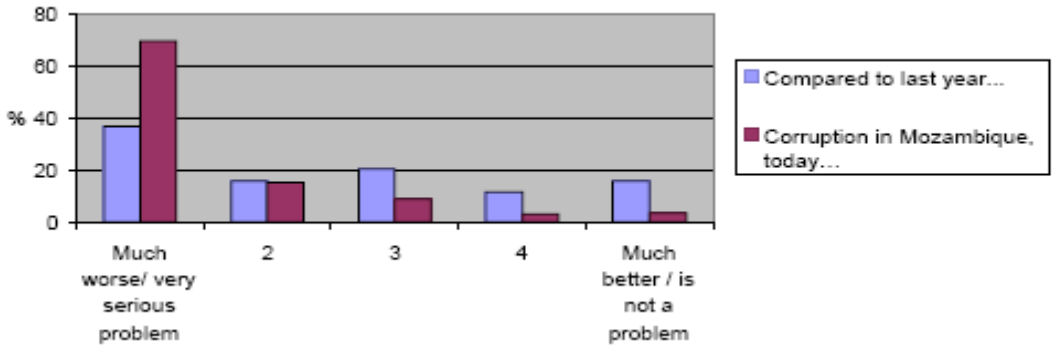

Figure B4: Feelings with regard to corruption compared to last year
Source: Austral Consultoria e Projectos, Lda (2004)

B 5 THE 'FIGHT' AGAINST CORRUPTION

Austral Consultoria e Projectos, Lda (2004) is of the opinion that corruption is carried out mainly by politicians and public officials (41%), while 13% of the interviewees think that corruption is carried out mainly by citizens and enterprises. At the same time, 42% agree that the government sincerely wishes to fight corruption while 56% appear to be convinced that if the government were to start a campaign to fight corruption, it would be very effective.

Notwithstanding this apparent trust in the government, the interviewees recognise that the institutions that are not dependent on 'political power' have a more significant role to play in the fight against corruption. Only the media and the NGOs reflect values higher than 30% agreeing that they could help significantly in the campaign to fight corruption, (see Figure B5).

A disturbing fact emerged, namely that there is general perception amongst the citizens of Mozambique that they cannot fight corruption. This due to the fact that the gatekeepers of corruption 'the police', are corrupt themselves.

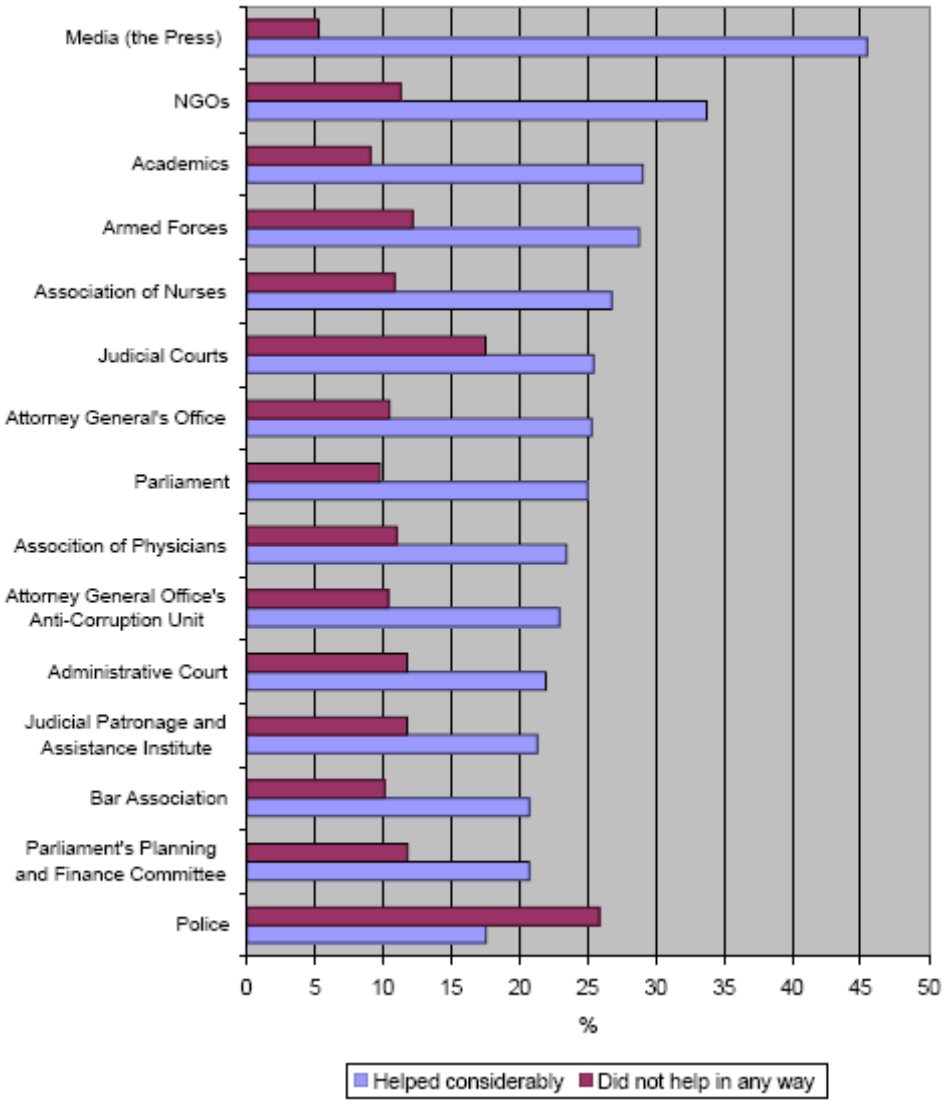

Figure B5: Institution's role in fighting corruption
Source: Austral Consultoria e Projectos, Lda (2004)

In view of the results of the survey, viewed against the reform efforts of the public sector in general, the first priority is a strategy to systematically fight corruption by means of an independent and efficient judicial system.

B 6 THE MECHANISMS TO EXPOSE CORRUPTION

Notwithstanding the clear condemnation of corruption, the exposure of corrupt acts is clearly not rooted within the households, enterprises and public officials. Of the households interviewed, a large majority (90%) does not know how to expose an act of corruption and only 8% stated that a family member had in fact exposed an act of corruption during the last two years. Although the number of answers is not

statistically significant, it is relevant to note that the efficacy of exposing corruption is deemed to be weak (35% as against 14% who consider it to be effective).

Enterprises are mainly requested to pay bribes in their dealings with customs (29% of the interviewees answered "always" or "frequently") for the installation of public services (28%) and 28% to win contracts, while approximately 25% consider commissions and bribes as a major obstacle in their business dealings with government.

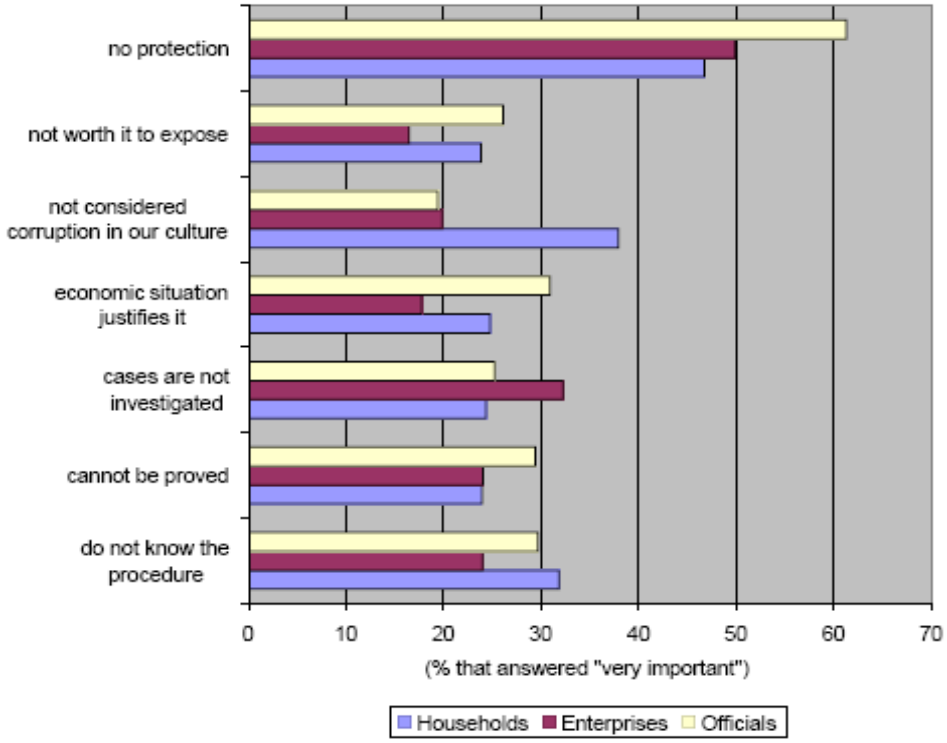

Figure B6: Reasons for not exposing corruption
Source: Austral Consultoria e Projectos, Lda (2004)

Figure B6 reflects that among the factors influencing the decision not to expose corruption, the interviewed enterprises consider firstly the lack of protection against possible retaliations as "extremely important" (50%), followed by the fact that these cases are never be investigated, or punished (32%). In addition to a balance in the positions relating to the difficulty in proving cases of corruption and in relation to the fear of retaliations (50% for enterprises, 47% for households and 61% for public officials), it is seen that the enterprises are less certain of the work done by the institutions in charge of carrying out investigations (32%) and also less tolerant with

regard to justifications based on the economic situation (18%). In turn, the households show less knowledge of the procedures (32%), while a significant number (38%) of them consider that there are many practices considered corrupt in other countries but which are accepted in Mozambique.

The survey further reflected that there is a widespread feeling that corruption has increased over the last couple of years, and that the biggest problem in relation to exposing acts of corruption is the lack of protection, while the public institutions whose objective is to fight corruption have a limited role.

B 7 USERS' PERCEPTION OF PUBLIC SERVICES

As reflected previously, there is reasonable consensus in relation to the different groups' opinion on the integrity of the institutions, both with regard to the most honest institutions, and to the least honest institutions.

As depicted in Figure B7 which presents the six least honest institutions referred by each of the groups interviewed, there is a practically unanimous classification which places the police (police force in general and traffic police) in the position of least honest institution in the public sector.

The least honest Organisations (the smaller the rank, the worst the problem)	Households	Officials	Enterprises
Police	1	2	1
Traffic police	2	1	2
Customs	3	4	
National Directorate of Water	4		
Political Parties	5	3	3
Electricity of Mozambique	6	6	
Municipal Government		5	4
Postal Services			5
Judicial Courts			6

Figure B7: The least honest Organisations in Mozambique
Source: Austral Consultoria e Projectos, Lda (2004)

It is also evident that the opinion on political parties as being less than honest organisations is also unanimous. Three other institutions are included in the group of the six least honest institutions by the two groups interviewed, namely Customs,

followed by the Municipal Government and the EDM (Electricity Company of Mozambique).

As is the case with the least honest organisations, there is also relative unanimity with regard to the two most honest institutions, namely the Media and Religious Institutions. NGOs are equally recognised by all interviewees as being honest. Three other institutions are pointed out as ranking among the six most honest by the two groups interviewed, with the Cabinet of Ministers heading the list followed by the Provincial Governments and lastly, the Ministry of Agriculture and Rural Development.

B 8 PERFORMANCE OF PUBLIC SERVICES

The weak performance of the public services and corruption are problems affecting both citizens and enterprises, although these are not at the top of their list of concerns. Institutions' internal operation reveals some weaknesses in terms of the transparency of the procedures and compliance with the rules in the recruitment and management of staff, together with centralised decision-making, which reduces the public officials' field of participation and accountability within their institutions.

From a remuneration point of view, which is hardly a motivating factor within the public sector, its impact appears to be concentrated mostly on the core group that most easily finds alternatives within the labour market namely, qualified technicians. They have greater tendency to abandon the sector, which leads to a weakening of the capacity and quality of the public services. Controversely, many employees resort to extra activities to supplement their salaries. However, even excluding the assumption that one of the resources used to supplement the salaries is the illegal charging for the provision of services, the simple fact that public officials carry out other income-generating activities to supplement their salaries impacts negatively on the performance of their normal duties. Austral Consultoria e Projectos, Lda (2004) adds that the first step to improve the public services operation, according to the opinion of the public officials interviewed, is a better capacity to detect and punish cases of corruption. However, other aspects such as better training of staff, better equipment and more budget resources are also decisive.

B 9 BUDGET AND FINANCIAL RULES

The budget management and public contract management areas are others that show up the weakness in the public sector. There is frequent over-spending in the goods and services budget lines, which demonstrates a shortage of available resources for the institutions' normal operation. At the same time, given the weak monitoring and control mechanisms for expenditure, this tends to fuel corruption through the system of commissions.

The disregard for the rules for public tenders was also noted as a relatively common practice. While the disregard for the financial rules that govern the institutions does not appear to be a problem, there are some sectors where non compliance were were considered higher than 10%. In this group, three of the five institutions in which the situation appears to be worse is the justice sector namely those that are most directly responsible for compliance with the law, namely the Ministry of the Interior, as well as the Ministry of Justice and the Attorney General's Office.

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APPENDIX C

PROBLEM IDENTIFICATION IN THE MOZAMBICAN CONSTRUCTION INDUSTRY THROUGH THE APPLICATION OF THE TELENTROPY TRACING METHOD

C 1 INTRODUCTION AND BACKGROUND

Large social or organizational systems are characterised by diverse complex problems, typically residing within all of the parts of the system. Moreover, these problems interact and mutually reinforce and influence each other, to form a 'huge system of problems', which is also referred as a 'mess' (Ackoff, 1974, 1981; Ackoff, Finnel & Gharajedaghi, 1984). By means of 'mess analysis', the analyst endeavours to understand this interrelated system of problems and to intervene at points and in a manner that allows the system to become less 'messy' and to approximate a more ideal state over time. Telentropy analysis represents a 'mess analysis' or system analysis method similar to the systems dynamics methods discussed by Coyle (1977), Forrester (1969), Gomez & Prost (1987), Senge (1990) and Vester (1990).

The problems identification method called 'telentropy tracing' and applied within the ambit of this thesis, aims to identify the flow of problems within the existing Construction Engineering Industry in Mozambique. It does not attempt to do it in an empirical, quantifiable and explanatory way, rather its purpose is to create an understanding of the complex dynamics that occur within the existing system.

C 2 TELENTROPY TRACING (THE FIRST STEP)

The 'first step' in the telentropy tracing process refers to the identification of 'problems' using the Biomatrix system as a multi-levelled and multidimensional framework for enquiry within the context of Construction Engineering Industry in Mozambique.

The attention of the reader is drawn to the fact that within the context of the telentropy tracing steps, keys (1-41) will be attributed to each identified element, signifying a 'mess' within the Mozambican construction engineering industry. These keys, once allocated will remain static for a particular element throughout the process. This is to facilitate the process of using keys as opposed to extensive verbiage within the various scenarios presented.

The results returned from Step 1 of the telentropy tracing process are the following:

1. Land in Mozambique is all state owned and as a result has no commercial value and is not used for the mobilization of capital for construction engineering investment.
2. It is not easy to procure a loan from financial institutions to finance construction engineering projects.
3. Cost for funding is exceptionally high making it inaccessible to the man in the street.
4. No capacity for the implementation of quality engineering policies and the absence of quality certification mechanisms.
5. Labour Laws are inadequate and does not stimulate business activity pertaining to construction engineering.
6. Low productivity making construction engineering not a viable business option.
7. Lack of trust between companies and individuals.
8. Absence of an element of competitiveness within companies.
9. Lack of vision and focus of management within construction engineering.
10. Lack of a systemic understanding of problems associated with construction engineering.

11. Labour legislation aimed to protect workers with little or no regard for the employer at the expense of productivity and business activities impacting adversely upon the construction engineering industry.
12. The social security system in Mozambique has limited coverage and benefits. Employers and beneficiaries are of the opinion that they are paying too much for societal security.
13. Legislation that regulates Labour Inspections (Decree 32/89) and the Ministerial Diploma 17/90, are outdated and does not benefit the construction engineering industry.
14. The insufficiencies of Decree 57/2003 impact upon the labour contracts with foreign workers as the authorities have the freedom in the approval or not of authorizations and work permits, interfering with the management of private enterprise.
15. Resolution of labour conflicts is slow, unfair, and impacting adversely on both the construction engineering industry and workers.
16. The establishment and registration of construction engineering and related companies is highly complex, and it is not easy to obtain operating licences.
17. The judicial system is inefficient and ineffective impacting adversely on the construction engineering industry.
18. Procurement rules of credit institutions and donors tend to exclude Mozambican businessmen from the tender process.
19. The capacity of many Mozambican construction engineering contractors to complete projects is limited.
20. The relationship between construction engineering companies and the incumbent ministry is weak.
21. Fiscal policy which dictates that companies should pay anticipated taxes based on the previous year invoicing does not stimulate investment, productivity, creation of employment and development of the construction engineering companies.
22. With construction engineering contracts with the Government, there are delays in the payment of public works and other debts, impacting the sustainability of the industry.

23. Small and medium construction engineering enterprises are required to raise their equity capital in order to maintain the level of their operating licences when the national currency is devaluated.
24. The international procurement rules make it difficult (and to an extent, impossible) for Mozambican construction engineering companies to participate in tenders.
25. Red tape in all government sectors inhibits the growth of construction engineering industry.
26. Corruption and misuse of resources in the construction engineering industry is a common (and socially accepted) practice.
27. Political conflicts (political instability, ideological conflicts, conflicts between cultural groups) impacting adversely on the viability of the construction engineering industry.
28. Language diversity within the construction engineering industry impacts upon productivity.
29. Unprofessional attitude from the industry workers invariable culminates in poor quality of work being produced.
30. Lack of skilled construction workers.
31. Individual talents and potential of construction engineering entrepreneurs are not exploited.
32. Lack of good engineering technicians (technical level education).
33. Lack of construction engineering management skills.
34. Lack of technological culture forcing the construction engineering industry to deploy outdated processes and procedures.
35. Inability for the construction engineering industry to adopt change.
36. Unmotivated construction engineering workers impacting on productivity.
37. Malnutrition impacting on the efficiency of construction engineering workers.
38. Demotivated investors contribute to the decline of the construction engineering industry activities.
39. Lack of cash flow, an aspect which impact most of the construction engineering companies in Mozambique.
40. High cost of construction inhibits the expansion of the industry.
41. Few successful economic models to guide the government to stimulate investment in construction engineering industry.

C 3 TELENTROPY TRACING (THE SECOND STEP)

The 'second step' in the telentropy tracing process pertains to the classification of telentropy according to the generic Biomatrix systems dimensions (ethos, teleos, processes, structure, substance and governance) as discussed in Chapter 3, Paragraph 3.6. The classification of telentropy elements in terms of the systems dimensions returned the following:

C 3.1 Ethos Related problems

Cultural Dimension:

7 Lack of trust between companies and individuals.

26 Corruption and misuse of resources in the construction engineering industry is a common (and socially accepted) practice.

Techno-economic Dimension:

- -

Political Dimension:

1 Land in Mozambique is all state owned and as a result has no commercial value and is not used for the mobilization of capital for construction engineering investment.

5 Labour Laws are inadequate and does not stimulate business activity pertaining to construction engineering.

11 Labour legislation aimed to protect workers with little or no regard for the employer at the expense of productivity and business activities impacting adversely upon the construction engineering industry.

12 The social security system in Mozambique has limited coverage and benefits. Employers and beneficiaries are of the opinion that they are paying too much for societal security.

13 Legislation that regulates Labour Inspections (Decree 32/89) and the Ministerial Diploma 17/90, are outdated and does not benefit the construction engineering industry.

14 The insufficiencies of Decree 57/2003 impact upon the labour contracts with foreign workers as the authorities have the freedom in

the approval or not of authorizations and work permits, interfering with the management of private entreprise.

15 Resolution of labour conflicts is slow, unfair, and impacting adversely on both the construction engineering industry and workers.

17 The judicial system is inefficient and ineffective impacting adversely on the construction engineering industry.

C 3.2 Teleos Related Problems

Cultural Dimension:

29 Unprofessional attitude from the industry workers invariable culminates in poor quality of work being produced.

Techno-economic Dimension:

8 Absence of an element of competitiveness within companies

9 Lack of vision and focus of management within construction engineering.

10 Lack of a systemic understanding of problems associated with construction engineering.

22 With construction engineering contracts with the Government, there are delays in the payment of public works and other debts, impacting the sustainability of the industry.

31 Individual talents and potential of construction engineering entrepreneurs are not exploited.

33 Lack of construction engineering management skills.

34 Lack of technological culture forcing the construction engineering industry to deploy outdated processes and procedures.

35 Inability for the construction engineering industry to adopt change.

36 Unmotivated construction engineering workers impacting on productivity.

Political Dimension:

38 Demotivated investors contribute for the decline of the construction engineering industry activities.

C 3.3 Process Related Problems

Cultural Dimension:

28 Language diversity within the construction engineering industry impacts upon productivity.

Techno-economic Dimension:

2 It is not easy to procure a loan from financial institutions to finance construction engineering projects.

3 Cost for funding is exceptionally high making inaccessible to the man in the street

4 No capacity for the implementation of quality engineering policies and the absence of quality certification mechanisms.

6 Low productivity making construction engineering not a viable business option.

19 The capacity of many Mozambican construction engineering contractors to complete projects is limited.

30 Lack of skilled construction workers.

32 Lack of good engineering technicians (technical level education)

Political Dimension:

16 The establishment and registration of construction engineering and related companies is highly complex, and it is not easy to obtain operating licences.

18 Procurement rules of credit institutions and donors tend to exclude Mozambican businessmen from the tender process.

23 Small and medium construction engineering enterprises are required to raise their equity capital in order to maintain the level of their operating licences when the national currency is devaluated.

24 The international procurement rules make it difficult (on to an extent, impossible) for Mozambican construction engineering companies to participate in tenders.

37 Malnutrition impacting on the efficiency of construction engineering workers.

C 3.4 Structure Related Problems

Cultural Dimension:

- -

Techno-economic Dimension:

25 Red tape in all government sectors inhibits the growth of construction engineering industry.

39 Lack of cash flow, an aspect which impact most of the construction engineering companies in Mozambique.

40 High cost of construction inhibits the expansion of the industry.

Political Dimension:

- -

C 4 TELENTROPY TRACING (THE THIRD STEP)

The third step refers to the tracing of the flow of telentropy through the various subteleons. The attention of the reader is drawn to the fact that as 'substance' and 'governence' are considered part and parcel of the elements 'ethos, teleos, propcess and structure, the tracing of the flow of telentropy will only be mapped in terms of the latter four elements. Major telentropy with respect to ethos and teleos of the system, would indicate the necessity of a fundamental redesign of the system.

The attention of the reader is also drawn to the fact that the process of classification of telentropy is not a simple exercise, and subject to the personal observation of the observer. Ideally, the classification of telentropy must be executed by a team as opposed by one analyst only, however even then the element of bias can not be excluded. Against this background Figure C1 is reflected as a graphical depiction of the flow of telentropy in the Mozambican Construction Engineering Industry mapped to ethos, teleos, process and structure.

	Dimensions				Dimensions			
	Cultural	Techno-Economic	Political		Cultural	Techno-Economic	Political	
ETHOS	26		1, 27	**Societal level**				TELEOS
			20, 21 41	**Governmental Level**		10, 22	38	
	7		5, 11,13 14,15 17	**Organisational Level**	29	8, 9, 31 33, 34 35		
			12	**Individual level**		36		
STRUCTURE				**Societal level**				PROCESS
		25		**Governmental Level**			23	
				Organisational Level		30, 32	24, 18	
		39, 40		**Individual level**	28	2, 3, 4 6, 19	16, 37	

Figure C1: Graphical depiction of the flow of Telentropy in the Mozambican Construction Engineering Industry, mapped to ethos, teleos, process and structure (**Source:** Own Source)

In evaluating Figure C1, it is of interest to note that the highest number of elements fall within the ethos and teleos parameters, calling for a total redesign of the Construction Engineering Industry in Mozambique.

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APPENDIX D

VALIDATION SURVEY AND COMPARATIVE ANALYSIS BETWEEN THE MOZAMBICAN AND SOUTH AFRICAN CONSTRUCTION ENGINEERING INDUSTRY OPERATING ENVIRONMENTS

D 1 INTRODUCTION AND BACKGROUND

The survey contained herein is to determine to what extend problems (frogs) identified through the process of telentropy tracing are seen as impacting the Construction Engineering Industry in Mozambique. In addition, the survey serves to determine to what extent the legislation pertaining to the Construction Engineering Industry of South African can be applied to Mozambican within the same framework, to possible mitigate the impact of unstructured Mozambican legislation affecting the sustainability of its Construction Engineering Industry. The survey was not only directed at the private sector impacted upon by the legislation, but also at respondents from the government of Mozambique to obtain a balanced view on the future of the construction industry in the country. Furthermore the survey was conducted in South Africa and Mozambique to compare the two legislative approaches of the two countries in respect of construction engineering.

The primary focus, however was to elicit from respondents, views on the adverse impact of legislation and other factors on the sustainability and grouth of Construction Engineering Industry in Mozambique and in South Africa. The research was conducted at two levels namely:

- Respondents from the private sector in Mozambique and in South Africa.
- Respondents from the government of Mozambique.

D 2 DATA COLLECTION

The primary data collection method used in this survey is the personal interview, described by Burgess (1982), as "…the opportunity the for researcher to probe deeply to uncover new clues, open up new dimensions of a problem and to secure vivid, accurate inclusive accounts that are based on personal experience".

The use of personal interviews as an additional element to the data collection process is in the opinion of this author important, since this allows for the identification of issues within the target environment, which may not be readily identifiable using a pure survey questionnaire. Furthermore, according to Hussey & Hussey (1997), interviews are associated with both positivist and phenomenological methodologies as employed within the ambit of this thesis.

D 3 THE TARGET POPULATION

The target population was specifically chosen in order to validate the practicality of the concepts as presented here. The risk of bias, which cannot be statistically eliminated, is recognised by this author, based on the very definition of the target population as well as the number of respondents selected.

The survey to be conducted within the ambit of this thesis will be aimed at two levels namely:

- Respondents from the private sector in Mozambique.
- Respondents from the government of Mozambique.

Respondents from the private sector will be randomly selected from the following:

- Managers from national construction companies.
- Managers from foreign construction companies.
- Former construction company owners.
- Clients from construction companies.

D 4 MEASUREMENT SCALES

The surveys were so structured as to elicit from the respondents, very specific views on the adverse impact of legislation the sustainability of the Construction Engineering Industry in Mozambique. The survey will be based on the Lickert scale, (Parasuraman 1991:410). The reason for choosing the Lickert scale, the fact that the scale can be used in both respondent-centred (how responses differ between people) and stimulus-centred (how responses differ between various stimuli) studies, most appropriate to glean data in support of the research problem in question (Emory and Cooper 1995:180-181). The advantages in using the popular Lickert scale according to Emory and Cooper (1995:180-181) are:

- Easy and quick to construct.
- Each item meets an empirical test for discriminating ability.
- The Lickert scale is probably more reliable than the Thurston scale, and it provides a greater volume of data than the Thurston differential scale.
- The Lickert scale is also treated as an interval scale.

D 5 SURVEY DESIGN

Hussey and Hussey (1997), is of the opinion that, 'if a research is to be conducted in an efficient manner and make the best of opportunities and resources available, it must be organised. Furthermore, if it is to provide a coherent and logical route to a reliable outcome, it must be conducted systematically using appropriate methods to collect and analyse the data. A survey according to Hussey & Hussey (1977) should be designed in accordance with the following stages:

- **Stage one:** Identify the topic and set some objectives.
- **Stage two:** Pilot a questionnaire to find out what people know and what they see as the important issue.
- **Stage three:** List the areas of information needed and refine the objectives
- **Stage four:** Review the responses to the pilot.
- **Stage five:** Finalise the objectives.
- **Stage six:** Write the questionnaire.
- **Stage seven:** Re-pilot questionnaire.
- **Stage eight:** Finalise the questionnaire.

- **Stage nine:** Code the questionnaire

The survey design to be used in this instance is that of the descriptive survey as opposed to the analytical survey. The descriptive survey is according to Hussey & Hussey (1997), frequently used in business research in the form of attitude surveys, which maps to the questionnaire of this survey.

D 6 SURVEY CONSTRAINTS

The survey constraints are listed below for ease of reference:

- Interviews were conducted for the research in two physical locations, namely Mozambique and South Africa.
- Governmental staff was reluctant to be interviewed as it is being perceived as impacting on their personal inexperience.
- The sample groups were limited to Maputo and Johannesburg.

D 7 THE VALIDATION SURVEY QUESTIONS

This author has developed the following survey questionnaire, designed to determine the opinions of survey respondents to the adverse impact of legislation on the sustainability of the Construction Engineering Industry in Mozambique, drawing a comparative analysis with the South African construction legislation. As a result, two questionnaires were formulated for this purpose. Due to the fact that face to face interviews are highly structured, questions were prepared and piloted to ensure they reflected a high degree of 'validity' (Easterby-Smith, Thorpe & Lowe, 2002).

D 7.1 THE MOZAMBICAN QUESTIONNAIRE

The survey conducted in Mozambique, comprised of the following questions:

Question 1: The devaluation of the national currency called for the raising of capital and capital adequacy of companies in order to maintain the level of their operating licences. This impacted negatively on growth of construction industry in Mozambique. To what extent do you agree with this statement?

Question 2: Legislation in Mozambique facilitates the establishment of construction companies. To what extent do you agree with this statement?

Question 3: It is relatively easy to procure a construction operating licence ('alvará') in Mozambique. To what extent do you agree with this statement?

Question 4: There has been a significant decline in the activities of construction companies in Mozambique the last 24 months. To what extent do you agree with this statement?

Question 5: It is relatively easy to procure a loan from a financial institution in Mozambique to finance construction projects. To what extent do you agree with this statement?

Question 6: Construction pricing in Mozambique are above average as a result of high interest rates, high material costs and import duties. To what extent do you agree with this statement?

Question 7: Construction in Mozambique was stimulated by individuals who 'build to rent'. This trend has been adversely impacted the requirement to pay an additional 25-32% tax (IRPS – tax applied to individuals income) on the rental invoice in addition to the current 14% tax levy. To what extent do you agree with this statement?

Question 8: Current labour legislation protects the construction industry workers with little or no regard for the employer. To what extent do you agree with this statement?

Question 9: The judicial system can be termed 'ineffective' and 'inefficient' in cases involving the construction industry. To what extent do you agree with this statement?

Question 10: Land tenure rights impact foreign investment adversely. To what extent do you agree with this statement?

Question 11: Fiscal imposition, which dictates that companies should pay anticipated taxes based on the previous year invoicing, impact the construction industry adversely. To what extent do you agree with this statement?

D 7.2 THE SOUTH AFRICAN QUESTIONNAIRE

The survey conducted in South Africa, comprised of the following questions:

Question 1: If the devaluation of the national currency should call for raising the capital and capital adequacy of construction companies in order to maintain their level of operating licenses, this should impact negatively on growth of construction industry in South Africa. To what extent do you agree with this statement?

Question 2: Legislation in South Africa facilitates the establishment of construction companies. To what extent do you agree with this statement?

Question 3: It is relatively easy to procure a construction operating license in South Africa. To what extent do you agree with this statement?

Question 4: In South Africa there has been a significant decline in the activities of construction companies in the last 24 months. To what extent do you agree with this statement?

Question 5: In South Africa it is relatively easy to procure a loan from a financial institution to finance construction projects. To what extent do you agree with this statement?

Question 6: In South Africa, construction pricing are above average as a result of high interest rates, high material costs and high import duties. To what extent do you agree with this statement?

Question 7: Individuals who 'build to rent' stimulate construction in South Africa. This trend can be adversely impacted if those individuals will be required to pay 14% tax levy on the monthly rental invoices, bearing in mind that they have also to pay

the already established taxes based on their total annual income, which also includes rental earnings. To what extent do you agree with this statement?

Question 8: In South Africa current labour legislation protects the construction industry workers with little or no regard to the employer. To what extent do you agree with this statement?

Question 9: In South Africa the judicial system can be termed 'ineffective' and 'inefficient' in cases which involves the construction industry. To what extent do you agree with this statement?

Question 10: This question was omitted from the questionnaire to be conducted in South Africa, due to the fact that legislation allows land ownership.

Question 11: Fiscal imposition, which dictates that companies should pay anticipated taxes based on the previous year invoicing, impact the construction industry adversely. To what extent do you agree with this statement?

D 8 ANALYSIS OF SURVEY RESULTS FROM MOZAMBIQUE

The Mozambican survey returned the following results:

Question 1: The devaluation of the national currency called for the raising of capital and capital adequacy of companies in order to maintain the level of their operating licences. This impacted negatively on growth of construction industry in Mozambique. To what extent do you agree with this statement?

Survey Results in Mozambique	Strongly agree	Agree	Undecided	Disagree	Strongly disagree	Total
Frequency	24	6				30
Percent	80%	20%				100%

All the respondents, 100%, agreed that the devaluation of the national currency of Mozambique impacted negatively on the growth of the construction industry in the country. The primary reason being that construction companies as a result of the

devaluation are forced to raise their capital stakes to maintain the level of their operating licence requirements.

Question 2: Legislation in Mozambique facilitates the establishment of construction companies. To what extent do you agree with this statement?

Survey Results in Mozambique	Strongly agree	Agree	Undecided	Disagree	Strongly disagree	Total
Frequency				12	18	30
Percent				40%	60%	100%

The overwhelming 'strongly disagree' (60% of the respondents) clearly establishes the fact that legislation in Mozambique does not facilitate the establishment of construction companies. The 'disagreement' becomes more evident if the 'disagree' and 'strongly disagree' data are juxtaposed, returning that all of the respondents were *ad idem* that the government of Mozambique were in fact restricting growth of construction companies though the enforcement of legislation. This data provides in addition, an answer to the first of the investigative questions, clearly depicting that Mozambican legislation impacts negatively on the building industry.

Question 3: It is relatively easy to procure a construction operating licence ('alvará') in Mozambique. To what extent do you agree with this statement?

Survey Results in Mozambique	Strongly Agree	Agree	Undecided	Disagree	Strongly disagree	Total
Frequency			2	16	12	30
Percent			6,6%	53,4%	40%	100%

The two respondents who were undecided on whether or not it was easy to procure a construction operating licence in Mozambique, come from the Mozambican Banking industry, and their answer to this question being 'undecided' was expected. The rest of the respondents (93,4%) who are intimately involved with the industry, clearly indicated that procuring a construction operating licence is not easy.

Question 4: There has been a significant decline in the activities of construction companies in Mozambique the last 24 months. To what extent do you agree with this statement?

Survey Results in Mozambique	Strongly agree	Agree	Undecided	Disagree	Strongly disagree	Total
Frequency	16	12	2			30
Percent	53,4%	40%	6,6%			100%

The decline in the activities of construction companies in Mozambique whereby it has been estimated that construction companies are operating at less than 50% of capacity, can be attributed to a plethora of reasons. Furthermore the industry in the past 24 months saw a number of company closures. The primary reasons for this trend the following:

- No contracts being mooted by government or the private sector.
- High taxes to be paid by companies and clients.
- Cash flow implication as a result of unpaid bills.
- Impact of legislation.
- High construction prices.

This analogy is supported by 93,4% the respondents agreeing that there is a measurable trend in the decline of activities of construction companies in Mozambique.

Question 5: It is relatively easy to procure a loan from a financial institution in Mozambique to finance construction projects. To what extent do you agree with this statement?

Survey Results in Mozambique	Strongly agree	Agree	Undecided	Disagree	Strongly disagree	Total
Frequency		2		10	18	30
Percent		6,6%		33,4%	60%	100%

Only two of respondents (6,6%) was of the opinion that it was easy to procure a loan from a financial institution in Mozambique. As in the instance of question 3, these views of the two respondents were from the banking industry, hence the clear bias in

their responses to this question. As expected, the remainder of the respondents (28) agreed that procuring a loan from a financial institution could culminate in a tasking exercise, if not an exercise in futility.

Question 6: Construction pricing in Mozambique are above average as a result of high interest rates, high material costs and import duties. To what extent do you agree with this statement?

Survey Results in Mozambique	Strongly agree	Agree	Undecided	Disagree	Strongly disagree	Total
Frequency	16	12	1	1		30
Percent	53,4%	40%	3,3%	3,3%		100%

Should the responses from the respondents selecting 'undecided' and 'disagree' be excluded, 93,4% of the respondents either 'agreed' of 'strongly agreed' that the construction pricing in Mozambique is above average. From this, the analogy can be drawn that consumers are adversely impacted by such high prices, which culminates in either 'a delay', or in some instances 'abandoning' of their building initiatives.

Question 7: Construction in Mozambique was stimulated by individuals who 'build to rent out'. This trend has been adversely impacted the requirement to pay an additional 25-32% tax (IRPS) on the rental invoice in addition to the current 14% tax levy. To what extent do you agree with this statement?

Survey Results in Mozambique	Strongly agree	Agree	Undecided	Disagree	Strongly disagree	Total
Frequency	20	8		2		30
Percent	66,7%	26,7%		6,6%		100%

The requirement to pay an additional 25-32% tax (IRPS) on the rental invoice in addition to the current 14% tax levy, returned 93,4% of the respondents agreeing that this has a detrimental effect on the building industry. The effect of this transposes into the fact that the 'build to rent' option, is no longer a viable initiative for investors to make, impacting adversely on the economy as a whole.

Question 8: Current labour legislation protects the construction industry workers with little or no regard for the employer. To what extent do you agree with this statement?

Survey Results in Mozambique	Strongly agree	Agree	Undecided	Disagree	Strongly disagree	Total
Frequency	16	14				30
Percent	53,4%	46,6%				100%

While Mozambique has a democratic elected government, there are clear tangent planes with a 'socialist' orientation. This observation is echoed by all of the respondents (100%), who agreed that labour legislation in Mozambique protects the workers, with little or no regard for the employer.

Question 9: The judicial system can be termed 'ineffective' and 'inefficient' in cases which involves the construction industry. To what extent do you agree with this statement?

Survey Results in Mozambique	Strongly agree	Agree	Undecided	Disagree	Strongly disagree	Total
Frequency	16	14				30
Percent	53,4%	46,6%				100%

Yet another aspect which impacts adversely on the construction industry is the judicial system and its effectiveness in supporting the industry in terms of fairness and speedily executing pending cases involving the industry. All of the respondents (100%), agreed that the judicial system of Mozambique is in fact 'ineffective' in supporting the construction industry.

Question 10: Land tenure rights impact foreign investment adversely. To what extent do you agree with this statement?

Survey Results in Mozambique	Strongly agree	Agree	Undecided	Disagree	Strongly disagree	Total
Frequency	14	14	2			30
Percent	46,6%	46,6%	6,8%			100%

As indicated in the analysis of question 8, the 'socialist' orientation of the government impacts the inhabitants on various fronts. One of the 'socialist' aspects which impact the building industry adversely, can be mapped to the land tenure rights whereby all land are government owned, which is then allocated to individuals as a 100 year 'lease hold' property, after which it reverts back to the government. Property owners are not willing to spend vast amounts on construction only to have it reverting back to the government. This animosity is clearly reflected in the responses of the respondents with 46,6% 'strongly agreeing' and 46,6% 'agreeing' that this fact adversely impacts on the building industry.

Question 11: Fiscal imposition, which dictates that companies should pay anticipated taxes based on the previous year invoicing, impact the construction industry adversely. To what extent do you agree with this statement?

Survey Results in Mozambique	Strongly agree	Agree	Undecided	Disagree	Strongly disagree	Total
Frequency	26	4				30
Percent	86,6%	13,4%				100%

To calculate future income in a volatile building industry culminates in proverbial 'financial suicide' for companies, which in most cases have extended funding in place, just to survive. The high level of agreement on the adverse impact of this unpopular policy is clearly evident.

D 9 SUMMARY OF SURVEY RESULT IN MOZAMBIQUE

The results returned by the respondents reflect a high degree of synergy on most of the questions posed. Only in the instance of question 3 and question 5, were bias clearly evident. This was however also expected as the respondents came from the banking industry and did not have in depth insight into the 'real world' problems as perceived by respondents in the building industry.

The results from the survey returned the following factors as having an adverse impact on the building industry in Mozambique:

- The devaluation of the national currency.

- Legislation (various impacts).
- Procurement of a construction operating licence.
- Procurement of a bank building loans.
- Price of construction.
- Requirement of IRPS taxes of 'build to rent' options.
- Inadequate labour legislation.
- Land tenure rights.
- Fiscal policy.

D 10 ANALYSIS OF SURVEY RESULTS FROM SOUTH AFRICA

The South African survey returned the following results:

Question 1: If the devaluation of the national currency should call for raising the capital and capital adequacy of construction companies in order to maintain their level of operating licenses, this should impact negatively on growth of construction industry in South Africa. To what extent do you agree with this statement?

Survey Results in South Africa	Strongly agree	Agree	Undecided	Disagree	Strongly disagree	Total
Frequency	2	10		1		13
Percent	15,4%	76,9%		7,7%		100%

92,3% of the South African respondents agree that if the devaluation of national currency should force companies to raise their equity capital in order to maintain operating licences, it should impact negatively on the growth and sustainability of the construction companies.

Question 2: Legislation in South Africa facilitates the establishment of construction companies. To what extent do you agree with this statement?

Survey Results in South Africa	Strongly agree	Agree	Undecided	Disagree	Strongly disagree	Total
Frequency	1	9	1	1	1	13
Percent	7,7%	69,2%	7,7%	7,7%	7,7%	100%

76,9% of respondents either 'agree' and 'strongly agree' that in South Africa, the legislation facilitates the establishment of construction companies.

Question 3: It is relatively easy to procure a construction operating license in South Africa. To what extent do you agree with this statement?

Survey Results in South Africa	Strongly agree	Agree	Undecided	Disagree	Strongly disagree	Total
Frequency	1	7	2	3		13
Percent	7,7%	53,8%	15,4%	23,1%		100%

The views from the two respondents which were 'undecided' and three respondents 'disagreeing' can be transposed into the analogy that their perception is that it is not easy to procure a construction licence in South Africa, while 61,5 % of respondents agree that a construction licence can be relatively easy to obtain.

Question 4: In South Africa there has been a significant decline in the activities of construction companies in the last 24 months. To what extent do you agree with this statement?

Survey Results in South Africa	Strongly agree	Agree	Undecided	Disagree	Strongly disagree	Total
Frequency	1	5		7		13
Percent	7,7%	38,5%		53,8%		100%

53,8% agree that the construction activities in South Africa is on the increase and escalating year on year as opposed to declining.

Question 5: In South Africa it is relatively easy to procure a loan from a financial institution to finance construction projects. To what extent do you agree with this statement?

Survey Results in South Africa	Strongly agree	Agree	Undecided	Disagree	Strongly disagree	Total
Frequency		5	1	7		13
Percent		38,5%	7,7%	53,8%		100%

Five respondents (38,5%) agree that it is easy to procure a loan from a financial institution in South Africa. One respondent was 'undecided' while seven respondents (53,8%), agree that procuring a loan from a financial institution is not easy. The respondents confirmed that loans could only be procured by providing extensive guarantees to support loans for construction projects.

Question 6: In South Africa construction pricing are above average as a result of high interest rates, high material costs and high import duties. To what extent do you agree with this statement?

Survey Results in South Africa	Strongly agree	Agree	Undecided	Disagree	Strongly disagree	Total
Frequency		1		12		13
Percent		7,7%		92,3%		100%

Only one respondent was of the opinion that the construction prices in South Africa are above average as a result of high interest rates, high material costs and high import duties. Twelve respondents (92,3%) 'disagree' that construction prices in South Africa are above average. Respondents were also of the opinion that there is no reason to assume that current taxes, current interest rates and current import duties could raise the construction prices to 'above average'.

Question 7: Individuals who 'build to rent' stimulate construction in South Africa. This trend can be adversely impacted upon if those individuals will be required to pay 14% tax levy on the monthly rental invoices, bearing in mind that they have also to pay the already established taxes based on their total annual income, which also includes rental earnings. To what extent do you agree with this statement?

Survey Results in South Africa	Strongly agree	Agree	Undecided	Disagree	Strongly disagree	Total
Frequency	2	11				13
Percent	15,4%	84,6%				100%

Mapping the same question posed in the Mozambican survey, respondents agree that this fiscal requirement will adversely impact on the building industry. All respondents (100%) expressed the opinion that such a policy would impact upon the

viability of their investments in construction initiatives earmarked for renting. Some of respondents were of the opinion that private investments should be stimulated by the government, and not be discouraged.

Question 8: In South Africa current labour legislation protects the construction industry workers with little or no regard to the employer. To what extent do you agree with this statement?

Survey Results in South Africa	Strongly agree	Agree	Undecided	Disagree	Strongly disagree	Total
Frequency		3		10		13
Percent		23,1%		76,9%		100%

Contra to the Mozambican survey results, ten respondents (76,9%) 'disagree' that in South Africa, the labour legislation protects only the workers with little or no regard to the employers. Respondents were of the opinion that government is committed in improving labour relations between employees and employers in order to create sustainable employment.

Question 9: In South Africa the judicial system can be termed 'ineffective' and 'inefficient' in cases which involves the construction industry. To what extent do you agree with this statement?

Survey Results in South Africa	Strongly agree	Agree	Undecided	Disagree	Strongly disagree	Total
Frequency			1	12		13
Percent			7,7%	92,3%		100%

Contra to perceptions in Mozambique, 92,3% of the respondents in South Africa was of the opinion that their judicial system is fast and efficient, resolving conflicts, which involves the construction industry.

Question 10: Land tenure right is a problem that does not exist in South Africa, and for this reason, this question is omitted from the questionnaire.

Question 11: Fiscal imposition, which dictates that companies should pay anticipated taxes based on the previous year invoicing, will impact the construction industry adversely. To what extent do you agree with this statement?

Survey Results in South Africa	Strongly agree	Agree	Undecided	Disagree	Strongly disagree	Total
Frequency	4	9				13
Percent	30,8%	69,2%				100%

Like the respondents in Mozambique, 100% of the respondents in South Africa 'agree' that by asking construction companies to pay taxes based on the previous year invoicing can adversely impact industry growth.

D 11 SUMMARY OF SURVEY RESULT IN SOUTH AFRICA

The results from the survey returned the following factors as having an adverse impact on the building industry in South Africa:

- Of respondents, 93,2% agree that the need of raising the equity capital when there has been a devaluation of the national currency just to maintain the operating licence will impact negatively with the growth and sustainability of construction industry.
- Of respondents, 79,9 agree that the South African legislation facilitates the establishment of construction companies.
- Of respondents, 61,5% agree that it is relatively easy to procure a construction operating licence in South Africa.
- Of respondents, 53,8% agree that in South Africa, there has been a significant boost in construction activities for the last 24 months.
- According to 53,8% of respondents, in South Africa it is not easy to procure a bank building loan.
- Of respondents, 92,3% disagree that construction pricing in South Africa is above average.
- Of respondents, 100% agree that the fiscal requirement to pay 14% of rental invoicing in addition to the normal taxes applied on individual annual income will discourage private investments for construction.

- Of respondents, 79,6% in South Africa disagree that their labour legislation protects employees with little or no regard to the employers. The government was furthermore committed in promoting a good relationship between employees and employers in order to maintain the companies operating and maximising job opportunities.
- Of respondents, 92,3% disagree that the South African judicial system can be considered ineffective in cases which involves the construction industry.
- Of respondents, 100% agreed that a fiscal policy that requires construction companies to pay advanced taxes based on previous year invoicing in an instable market can lead companies to 'financial suicide'.

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APPENDIX E: COMPARATIVE ANALYSIS AND SUMMARY OF MOZAMBICAN AND SOUTH AFRICAN SURVEY RESULTS

APPENDIX E

COMPARATIVE ANALISYS AND SUMMARY OF MOZAMBICAN AND SOUTH AFRICAN SURVEY RESULTS

E 1 INTRODUCTION AND BACKGROUND

The survey was conducted within Mozambique and South Africa to compare the two legislative approaches, having as primary focus, however, to elicit from respondents views on the adverse impact of legislation and other factors on the sustainability of Construction Engineering Industry in Mozambique and in South Africa. Furthermore, the survey is to determine to what extent the legislation pertaining to the Construction Engineering Industry of South Africa can be applied to the Mozambican legislation pertaining to the same entity, to possibly mitigate the impact of the unstructured Mozambican legislation to ensure the sustainability and growth of its Construction Engineering Industry.

E 2 COMPARATIVE ANALYSIS OF SURVEY RESULTS

A one to one, 'per question' survey result comparative analysis returned the following:

Ascertaining if the need of raising the equity capital and capital adequacy of construction companies when the national currency devaluates, in order to maintain the operating licence will impact adversely on the construction industry, the results returned by respondents as follow:

- In Mozambique, 20% of respondents agree and 80% strongly agree.
- In South Africa, 15,4% of respondents strongly agree, 76,9% agree and 7,7% disagree.

Comparative Survey Results	Strongly agree	Agree	Undecided	Disagree	Strongly Disagree
In Mozambique	80%	20%			
In South Africa	15,4%	76,9%		7,7%	

Ascertaining if legislation facilitates the establishment of construction companies, the results returned by respondents as follow:

- In Mozambique, 40% of respondents disagree and 60% strongly disagree.
- In South Africa, 7,7% of respondents strongly agree, 69,2% agree, 7,7% are undecided, 7,7% disagree and 7,7% strongly disagree.

Comparative Survey Results	Strongly agree	Agree	Undecided	Disagree	Strongly Disagree
In Mozambique				40%	60%
In South Africa	7,7%	69,2%	7,7%	7,7%	7,7%

Ascertaining if it is relatively easy to procure a construction operating licence, the results returned by respondents as follow:

- In Mozambique, 53,4% of respondents disagree, 40% strongly disagree and 6,6% are undecided.
- In South Africa, 53,8% of respondents agree, 7,7% strongly agree, 15,4% are undecided and 23,1% disagree.

Comparative Survey Results	Strongly agree	Agree	Undecided	Disagree	Strongly Disagree
In Mozambique			6,6%	53,4%	40%
In South Africa	7,7%	53,8%	15,4%	23,1%	

Ascertaining if there has been a significant decline in the activities of construction companies in the last 24 months, the results returned by respondents as follow:

- In Mozambique 53,4% of respondents strongly agree, 40% agree and 6,6% are undecided.
- In South Africa 53,8% of respondents disagree, 38,5% agree and 7,7% strongly agree.

Comparative Survey Results	Strongly agree	Agree	Undecided	Disagree	Strongly Disagree
In Mozambique	53,4%	40%	6,6%		
In South Africa	7,7%	38,5%		53,8%	

Ascertaining if it is relatively easy to procure a loan from a financial institution to finance construction projects, the results returned by respondents as follow:

- In Mozambique 60% of respondents strongly disagree, 33,4% disagree and 6,6% agree.
- In South Africa 53,8% of respondents disagree, 38,5% agree and 7,7% are undecided.

Comparative Survey Results	Strongly agree	Agree	Undecided	Disagree	Strongly Disagree
In Mozambique		6,6%		33,4%	60%
In South Africa		38,5%	7,7%	53,8%	

Ascertaining if construction pricing are above average as a result of high interest rates, high material costs and import duties, the results returned by respondents as follow:

- In Mozambique 53,4% of respondents strongly agree, 26,7% agree and 6,6% disagree.
- In South Africa 92,3% of respondents disagree and 7,7% agree.

Comparative Survey Results	Strongly agree	Agree	Undecided	Disagree	Strongly Disagree
In Mozambique	53,4%	26,6%		6,6%	
In South Africa		7,7%		92,3%	

Individuals who build to rent out stimulate construction activities. Ascertaining if this trend is being adversely impacted by the requirement to pay 14% tax levy on the rental invoicing additionally the normal annual tax collected on basis of the total individual income, the results returned by respondents as follow:

- In Mozambique 66,6% of respondents strongly agree, 26,6% agree and 6,6% disagree.
- In South Africa 84,6% of respondents strongly agree and 15,4% agree.

Comparative Survey Results	Strongly agree	Agree	Undecided	Disagree	Strongly Disagree
In Mozambique	66,6%	26,6%		6,6%	
In South Africa	84,6%	15,4%			

Ascertaining if labour legislation protects the construction industry workers with little or no regard to the employer, the results returned by respondents as follow:

- In Mozambique 53,4% of respondents strongly agree and 46,6% agree.
- In South Africa 76,9% of respondents disagree and 23,1% agree.

Comparative Survey Results	Strongly agree	Agree	Undecided	Disagree	Strongly Disagree
In Mozambique	53,4%	46,6%			
In South Africa		23,1%		76,9%	

Ascertaining if the judicial system can be termed ineffective in cases which involve the construction industry, the results returned by respondents as follow:

- In Mozambique 53,4% of respondents strongly agree and 46,6% agree.
- In South Africa 92,3% disagree and 7,7% are undecided.

Comparative Survey Results	Strongly agree	Agree	Undecided	Disagree	Strongly Disagree
In Mozambique	53,4%	46,6%			
In South Africa			7,7%	92,3%	

Ascertaining if land tenure rights impact foreign investment adversely, the results returned by respondents as follow:

- In Mozambique 46,6% of respondents strongly agree, 46,6% agree and 6,8% are undecided.
- In South Africa this question was removed from questionnaire due to the fact that this kind of problems does not exist.

Comparative Survey Results	Strongly agree	Agree	Undecided	Disagree	Strongly Disagree
In Mozambique	46,6%	46,6%	6,8%		
In South Africa					

Ascertaining if a fiscal imposition which dictates that companies must pay provisional tax based on previous year invoicing will impact adversely on the construction industry, the results returned by respondents as follow:

- In Mozambique 86,6% of respondents strongly agree and 13,4% agree.
- In South Africa 69,2% of respondents agree and 30,8% strongly agree.

Comparative Survey Results	Strongly agree	Agree	Undecided	Disagree	Strongly Disagree
In Mozambique	86,6%	13,4%			
In South Africa	30,8%	69,2%			

E 3 SUMMARY OF SURVEY RESULT IN MOZAMBIQUE

The results returned by the respondents reflect a high degree of synergy on most of the questions posed. Only in the instance of question 3 and question 5, were bias clearly evident. This was however also expected as the respondents came from the banking industry and did not have in depth insight into the 'real world' problems as perceived by respondents in the building industry.

The results from the survey returned the following factors as having an adverse impact on the Construction Engineering Industry in Mozambique:

- The devaluation of the national currency.
- Legislation (various impacts).
- Procurement of a construction operating licence.
- Procurement of a bank building loans.
- Price of construction.
- Requirement of IRPS taxes of 'build to rent' options.
- Inadequate labour legislation.
- Land tenure rights.
- Fiscal policy.

E 4 SUMMARY OF SURVEY RESULT IN SOUTH AFRICA

The results from the survey returned the following factors as having an adverse impact on the Construction Engineering Industry in South Africa:

- Of respondents, 93,2% agree that the need of raising the equity capital when there has been a devaluation of the national currency just to maintain the

operating licence will impact negatively with the growth and sustainability of construction industry.

- Of respondents, 79,9 agree that the South African legislation facilitates the establishment of construction companies.
- Of respondents, 61,5% agree that it is relatively easy to procure a construction operating licence in South Africa.
- Of respondents, 53,8% agree that in South Africa, there has been a significant boost in construction activities for the last 24 months.
- According to 53,8% of respondents, in South Africa it is not easy to procure a bank building loan.
- Of respondents, 92,3% disagree that construction pricing in South Africa is above average.
- Of respondents, 100% agree that the fiscal requirement to pay 14% of rental invoicing in addition to the normal taxes applied on individual annual income will discourage private investments for construction.
- Of respondents, 79,6% in South Africa disagree that their labour legislation protects employees with little or no regard to the employers. The government was furthermore committed in promoting a good relationship between employees and employers in order to maintain the companies operating and maximising job opportunities.
- Of respondents, 92,3% disagree that the South African judicial system can be considered ineffective in cases which involves the construction industry.
- Of respondents, 100% agreed that a fiscal policy that requires construction companies to pay advanced taxes based on previous year invoicing in an instable market can lead companies to 'financial suicide'.

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APPENDIX F

BENCHMARKING THE MOZAMBICAN AND SOUTH AFRICAN CONSTRUCTION ENGINEERING INDUSTRY LEGISLATION

F 1 INTRODUCTION

A country's economic growth and business sustainability depends largely on the human resource quality, the technological level and its general legislation. Benchmarking the impact of legislation on the sustainability and growth of an industry, can help to develop new standards against which performance can be assessed. Furthermore, benchmarking can improve the policy and legislation formulation, avoiding impact on the construction industry caused by adverse limitations of legislation.

F 2 COMPARATIVE ANALYSIS

A one to one comparative analysis between the Mozambican and South African construction legislation is depicted in Table F1. A benchmarking approach is utilised to compare and analyse to what extent the fiscal and economic legislation pertaining to South Africa can be applied to Mozambique to mitigate the adverse impact of Mozambican legislation on the sustainability of its Construction Engineering Industry.

Comparative variable	In Mozambique	In South Africa
1- Devaluation of the national currency.	In Mozambique, when the national currency is devaluated, the legislation demands that the equity capital must be raised should companies wish to keep their already issued operating licences. 100% of the respondents agreed that this legal imposition impact negatively on the growth and sustainability of the construction engineering industry.	In South Africa, companies are not requested to increase their equity capital to maintain their operating licences, when the national currency is devaluated. 92,3% of respondents are of opinion that if this imposition should be implemented in South Africa, it will affect adversely the industry.
2- Construction company setup.	In Mozambique, 100% of respondents agree that it is very difficult to establish a construction company.	In South Africa, 76,9% of respondents agree that it is easy to establish a construction company.
3 – Procurement of a construction operating licence.	In Mozambique, 93,4% of respondents are of opinion that it is not easy to procure a construction operating licence.	In South Africa, 61,5% of respondents are of the opinion that it is easy to procure a construction operating licence.
4 - Construction activities companies in the last 24 months.	In Mozambique 93,4% of respondents agree that there are a decline in the construction activities on the last 24 months.	In South Africa only 53,8% of respondents are of opinion that there are no decline in the construction activities in the last 24 months.
5 - Loan procurement for construction projects.	In Mozambique, 93,4% of respondents strongly agreed that it is extremely difficult to get a bank loan to finance construction projects.	In South Africa only 53,8% of respondents are of opinion that it is difficult to procure a bank loan to finance construction projects.
6 - Construction pricing	In Mozambique 93,4% of respondents agree that construction pricing is above average due to the high taxes, high import duties and consequently high material prices.	In South Africa 92,3% of respondents disagree that construction prices are above average, as well as they disagree that current taxes, current interest rates and current import duties are above average.

7- Build to rent stimulates construction activities.	In Mozambique, 93,4% of the respondents agree that this fiscal measure has detrimental effect on the building industry.	In South Africa all respondents (100%) agree that this fiscal imposition will make unviable any initiative for individuals to invest their money in construction for renting not viable.
8 - Labour legislation	In Mozambique, 100% of respondents agree that labour legislation protects the workers, with little or no regard for the employer.	In South Africa 76,9% of respondents disagree that labour legislation protects only the workers with little or no regard to the employer.
9 - The judicial system	All respondents (100%) agree that the judicial system in Mozambique is in fact 'ineffective' in supporting the industry.	92,3% of respondents in South Africa stated that their judicial system is fast and 'efficient' resolving conflicts involving the construction industry.
10 - Land tenure rights impacting foreign investment	In Mozambique, 92,2% of respondents agree that the problem of land tenure impact negatively on the foreign construction investments.	This question was removed from the questionnaire due to the fact that this kind of problems does not exist in South Africa.
11- Payment of provisional tax based on previous year invoicing	In Mozambique 100% of respondents agree that this fiscal requirement impact negatively on the construction industry.	100% of the respondents in South Africa 'agree' that asking construction companies to pay anticipated taxes based on the previous year invoicing would 'kill' the industry.

Table F1: Mozambican and South African legislature comparative analysis

(**Source**: Own source)

F 3 SUMMARY OF BENCHMARKING ANALYSIS

The benchmarking approach utilised to compare and analyse to what extent the fiscal and economic legislation pertaining to South Africa can be applied to Mozambique

to mitigate the adverse impact of Mozambican legislation governing the Construction Engineering Industry, can be summarised as follows:

The Mozambican survey returned the following factors as having adverse impact on the building industry:

- The devaluation of the national currency, which calls for the raising of equity capital in order to maintain the operating licence.
- Legislation, which do not facilitate the establishment of construction companies.
- The procurement of a construction operating licence, which is not easy to obtain.
- The decline in construction investments in the last 24 months.
- The procurement of a bank building loan, which is not easy to facilitate.
- The price of construction, which is high mainly due to high import duties and taxes.
- The requirement to pay 14% tax levy on the rental invoicing in addition to the normal tax collected on the basis of the total individual income, makes the build to rent option not a viable proposition.
- The labour legislation, which is inadequate.
- The judicial system is seen as inefficient in solving cases that involves the construction industry.
- The land tenure rights, which is seen as a foreign investment constraint.
- The fiscal policy, which dictates that companies must pay provisional tax based on previous year invoicing.

The South Africa survey returned the following factors as having contributed for the establishment, growth and sustainability of the construction industry:

- The devaluation of the national currency does not call for the raising of equity capital in order to maintain the operating licence.
- The legislation facilitates the establishment of construction companies.
- The procurement of a construction operating licence is easy to obtain.
- There was no decline in construction investments in the last 24 months.
- The price of construction is seen as reasonable and within the world average.

- There is no fiscal requirement to pay 14% tax levy on the rental invoicing in addition to the normal tax collected on the basis of the total individual income making the build to rent option a viable investment option.
- The labour legislation is seen as adequate.
- The judicial system is seen as efficient in solving cases that involves the construction industry.
- Land tenure right is a problem that does not exists in South Africa.
- There is no Fiscal policy, which dictates that construction companies must pay provisional tax based on previous year invoicing.

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