A SYSTEMIC FRAMEWORK FOR THE EVALUATION OF RURAL TELECOMMUNICATIONS INFRASTRUCTURE

by

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PREFACE

The research on which this thesis is based was carried out in the Department of Computer Studies, M L Sultan Technikon, Durban, South Africa, under the supervision of Professor Don Petkov.

This thesis represents original work done by the author and has not been submitted in any form to any other universities.

Where use has been made of the work of other researchers, it has been duly acknowledged in the text.

ABSTRACT

The evaluation of telecommunications infrastructure in rural areas is a complex and messy problem that involves many tangible and intangible factors. Some of them are technical in nature while others are soft, involving social, cultural and political aspects of the problem. The evaluation requires, *inter alia*, societal intervention, and since societies reflect a multiplicity and diversity of values and goals, the intervention should confront these realities. One such reality that can be highlighted is the fact that we are dealing with rural communities that are disadvantaged in terms of telecommunication and other service provision. This underlies the need to consider the evaluation process from multiple perspectives, explore methodologies that will facilitate participation and engagement, and include emancipation of the disadvantaged. This research proposes a framework for the evaluation of rural telecommunications in a regional context. As such, it is viewed not just as an engineering phenomenon, but also as an economic and social phenomenon. Its complexity requires the use of a mix of methods in a complementary manner. It is based on the combination of the strengths of Soft Systems Methodology by Checkland, Critical Systems Thinking following some ideas of Jackson ensuring the guaranteeing of the interests of the poor and the weak in the rural environment, and the Analytic Hierarchy Process by Saaty.

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1.1 BACKGROUND TO THE PROBLEM

In spite of the worldwide progress in telecommunications, the situation in Africa and its rural areas shows tremendous differences from the rest of the world (see Creamer, 2001). Even South Africa, the continents telecommunications super power, falls well short when compared with the developed countries of the world, with an average of 12.53 main lines per 100 people. When contrasted with other parts of the world, the performance of both South Africa and Africa is far from satisfactory (Creamer, 2001). More than 50% of the South African population resides in rural areas. South Africa's apartheid past has resulted in telephone access being heavily skewed towards areas previously reserved for whites with telephone penetration amongst white households generally exceeding 85%.

The "new" South Africa has, unfortunately, inherited many of the socio-economic and political problems of the past. The enormous backlog in provision of basic needs and services must be met in a sustainable manner, which does not limit future growth possibilities. In order for any service provision programme to be successful as well as economically viable, it is vital that socio-economic factors be taken into account. The state's vision for telecommunications in South Africa is one that balances the provision of basic universal service to disadvantaged rural and urban communities with the delivery of high-level services capable of meeting the needs of a growing South African economy (White Paper on Telecommunications, 1996). The economic empowerment of historically disadvantaged communities is a programme of achieving meaningful participation by all members of these communities in all aspects of productive economic activities in South Africa as consumers, workers, managers and owners. The extension of affordable and accessible universal service will enhance social and economic activities in historically disadvantaged communities by providing the necessary infrastructure as well as generating employment in the telecommunication sector (White Paper on Telecommunications, 1996).

When the need to link underdeveloped rural areas with the more rapidly developing economic centres, as well as the general need to modernise the former, is considered, it is clear that this neglect has serious negative implications.

1.1.1 Telecommunication and Rural Development

Telecommunications is not simply a connection between people, but a link in the chain of the development process itself. According to Richardson (1998), with its ability to overcome the barrier of distance, telecommunications can facilitate the development process by improving:

- *efficiency*: the ratio of output to cost;
- *effectiveness*: the quality of output and services; and
- *equity*: the distribution of development throughout society.

Telecommunications is increasingly becoming a vital link between rural and urban areas, and between rural communities and the rest of the world. A basic information infrastructure in rural areas results in more than just good communication. It spurs small business development, job creation, income generation, agricultural processing and marketing, and improved health, education and social welfare (ITU Report, 1998). Rural areas are being affected strongly by the shift to an information economy. There have been dramatic changes in both the technology of telecommunications and the regulatory environment under which the information economy operates (Hudson, 1998). Technological innovation coupled with economic globalization has focused new attention on rural telecommunications. Terrestrial wireless and satellite technologies can extend connectivity to rural areas, while backbone fibre optic networks across continents and under oceans link the most isolated communities to the Internet.

Information technology, primarily telecommunications and computers, is part of the problem that requires rural communities to adapt to new communication technologies, and at the same time is part of the solution available to make successful adaptation possible. Telecommunications and other information technology do not offer a "magic solution" for rural economic development because the process of rural development is more complex than that.

According to Parker (1996), the essentials of rural economic development can be classified into three categories:

- Investment in human capital, which means providing education and health care for the residents of each rural community. People are the only important resource. All else depends on their thoughts and actions.

- Investment in the physical infrastructure necessary for economic development, water, power, transportation, and telecommunications. The telecommunications infrastructure is important today because of the dramatic changes in what is possible and because failure to change may leave rural communities at a serious competitive disadvantage. Nevertheless, we must not forget that telecommunications is only one element of essential infrastructure.

- Reform of our social organizations, the ways in which we collectively relate to each other. The potential accomplishment of an individual acting alone is minuscule compared to the potential of organized groups working together. Social pressures are strong, particularly in small rural communities. The changes necessary for rural economic development require local leadership. Change involves risk, which makes change difficult in some risk-averse rural cultures.

Much of the economic development in rural communities will depend on risk-taking entrepreneurial small businesses. Role models, incentives, social support, and a variety of services including financial, technical, accounting, legal, consulting, training, and marketing services may all be required. Installing computers and telecommunications equipment and networks will not magically change rural culture and bring about development. It may take strong leadership and organized social pressure to obtain the necessary infrastructure in the first place.

Telecommunications can be used for a wide range of applications in education, health care and social services, by small businesses, cooperatives, and individual entrepreneurs. Whether these applications are widely implemented depends on the vision of policy-makers. According to Hudson (1999), this vision must include both social and economic goals for national development, and recognize that information access, sharing, and dissemination will contribute to achieving these goals. Several fundamental criteria, according to the same authors, are critical in implementing this vision: accessibility, equity, connectivity, flexibility, and oversight.

Telecommunication systems are powerful communication and knowledge sharing tools. They can bring new information resources and open up new communication channels to facilitate dialogue and the flow of information between rural people and their organizations, institutions and governments. Rural telecommunication systems are a means through which people can access new options to help make their lives more secure, prosperous and meaningful. Innovative, organized uses of the technologies to enhance or provide competitive advantages to rural communities are the real stuff of development (Richardson, 1998). Also, since electronic commerce (e-commerce) is rapidly changing the way business is being conducted, the provision of infrastructure provides an ideal opportunity to "level the playing fields" for the rural community to be equal players/partners in the business field.

How does one determine the impact, especially the socio-economic impact of rural telecommunications infrastructure? How do we know whether the playing fields have been levelled for all stakeholders? These are just two examples of the concerns associated with the need for the improvement of rural telecommunications. It is not possible to determine the facts without carrying out some detailed analysis. It is the author's view that an evaluation of the rural telecommunications infrastructure is a necessary step towards the provision of information with respect to the improvement or lack thereof of rural development in a given area.

1.1.2 The Need for a Systems Approach for the Evaluation of Rural Telecommunications Infrastructure

The evaluation of rural telecommunications infrastructure is a complex process that involves both technical and socio-economic factors. Evaluation approaches are often confronted with the challenge of dealing appropriately with complex social systems, where a wide (and often ever changing) variety of actors with different values, interest and motives are interacting. Evaluation findings often reveal a diverse picture of the reality of a programme/project, particularly when viewed through the eyes of various stakeholders. And any attempt at reducing this complex picture in an inappropriate manner will not only harm the credibility of the evaluation, but also bring forth resistance from those which feel not properly represented.

A review of the literature on evaluation revealed that the main contemporary perspectives in research practice could be identified as (Kazi *et al.*, 1999):

- Empirical practice, which emphasizes evaluation activities based on outcomes, and concentrates almost exclusively on the effects of practice as defined in terms of measurable outcomes. Its emphasis is on judging past practice; and based on a hypothetico-deductive approach, it provides a hierarchy of methodologies ranging from single-case designs which systematically track progress to randomized controlled trials which enable a causal link to be made between the social work intervention and its effects.

  However, these methods are essentially testing procedures and usually provide very little account of the content of the interventions that are tested. Moreover, future successes cannot be guaranteed because of the inadequate descriptions of content which make replication difficult, and also because typically there is no analysis of contexts which are inherently unpredictable.

- The interpretivist approaches provide an emphasis on participatory evaluation of practice. These approaches tend to emphasize qualitative methods such as ethnography. However, these perspectives tend to be suspicious of outcome-based methodologies, and therefore their focus tends to be one-sided in capturing the dimensions of practice.

Systems thinking can be used to avoid undue simplification and provide useful tools for practical work with complex systems. A holistic approach that recognizes the limitations of both empirical practice and interpretivist approaches, and attempts to provide a perspective, which goes beyond the consideration of either outcomes or interpretivist insights, is therefore required. However, this may include a combination of outcome-based methodologies and interpretive approaches. This research explores a systems approach for the evaluation of rural telecommunications infrastructure. The next section outlines the goals of the research.

1.2 GOALS OF THE RESEARCH

The main goal of this research is to propose a systemic framework for evaluation of rural telecommunications infrastructure. The main goal is further broken down into the following sub goals:

- Investigation of the socio-economic factors that can be used as indicators of socio-economic development associated with telecommunications infrastructure in rural development.

- Investigation of approaches for encouraging stakeholder participation in the evaluation of rural telecommunications infrastructure.

- Proposal of a framework for better participative decision-making in the improvement of rural telecommunications infrastructure.

- Testing of the framework on a case study related to the planning and evaluation of development of telecommunications infrastructure in KwaZulu-Natal.

- Conclusions for the improvement of the development of rural telecommunications in KwaZulu-Natal.

1.3 SCOPE AND DELIMITATIONS OF THE RESEARCH

Rural telecommunication infrastructure is seen in this research as a subsystem of a larger Rural Telecommunications System (RTS), which comprises other subsystems like the economic subsystem, the physical environment subsystem, the social subsystem, other parallel infrastructure that is part of the built environment (for example roads, water, electricity), etc. The rural telecommunications infrastructure does not therefore operate in a vacuum or in isolation but is interdependent on the other subsystems within the larger rural telecommunications system (RTS).

The experimental part of the research explores the role of evaluation in the improvement of rural telecommunications infrastructure in an area within KwaZulu-Natal. Evaluation in this

context is not seen as some appraisal exercise but more as an emancipatory tool. It provides an opportunity for those that are disadvantaged, that is those traditionally without the power of being heard, to participate in the improved development of their rural community.

Telecommunication infrastructure refers to the core technologies ability to support, apart from the traditional telephone service, other communication technologies such as the Internet, including e-commerce, video conferencing, telemedicine, and distance education. Information and Communication Technologies (ICTs) represent the wider scope of services normally associated with telecommunication as a result of the rapid convergence of technologies especially in the last few years. However, the evaluation of the impact of ICTs *per se* is a major research area on its own and is not included within the scope of this research.

Although the experimental implementation of this research covers the evaluation of rural telecommunications in the Estcourt/Wembezi area of the KwaZulu-Natal Midlands, it is assumed that the framework can be used in other rural areas as well. However, it may need to be modified to suit the unique needs of a particular area.

1.4 RESEARCH METHODOLOGY

Following Landry and Banville (1992) and Robey (1996), a suitable triad for the justification of research includes the research aim, the theoretical foundation and the research methods. The research aim determines both the theoretical foundation and the methods. The methods are determined by the theoretical foundation as well (see Figure 1.1.).

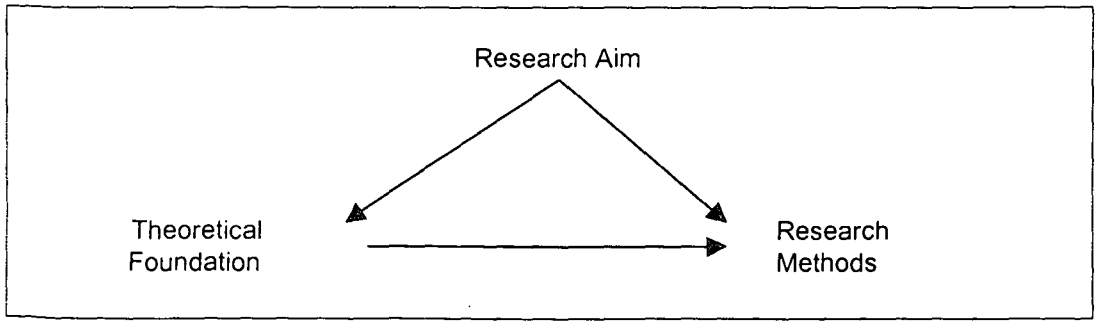

Figure 1.1: Triad for the Justification of Research (adapted from Landry and Banville (1992) and Robey (1996)).

The research aim is to develop a framework for the evaluation of rural telecommunications infrastructure. According to Checkland and Holwell (1998), the theoretical foundation is very important for revealing the basic features of the research. Following Jackson (1995), the theoretical foundation of the work is what distinguishes research from the realm of theoretically unfounded management consultancy. The questions that need to be answered are related to whether a single approach could be applied to this problem or a combination of several approaches or parts of them. The research method used is action research.

Action research can be described as a family of research methodologies that pursue action (or change) and research (or understanding) at the same time (Dick, 1999). In most of its forms it does this by:

- using a cyclic or spiral process which alternates between action and critical reflection; and

- in the later cycles, continuously refining methods, data and interpretation in the light of the understanding developed in the earlier cycles.

It is thus an emergent process that takes shape as understanding increases; it is an iterative process that converges towards a better understanding of what happens. In most of its forms it is also participative (among other reasons, change is usually easier to achieve when those affected by the change are involved) and qualitative.

The ideal domain of the action research method is revealed in three distinctive characteristics of the method (Baskerville and Wood-Harper, 1996):

- The researcher is *actively involved*, with expected benefit for both *researcher* and *organisation*.
- *The knowledge obtained* can be *immediately applied*. There is not the sense of the detached observer, but that of an active participant wishing to utilize any new knowledge based on an explicit, clear conceptual framework.
- The research is a cyclical process *linking theory and practice*.

Checkland (1985) based the intellectual context on a simple model of the elements of any piece of research (see Figure 1.2). He referred to this as the "organised use of rational thought". The essential elements of this model are **F**, an intellectual framework of linked ideas, that is a theory; **M**, a methodology for using this framework; and **A** the area of application, that is the research question.

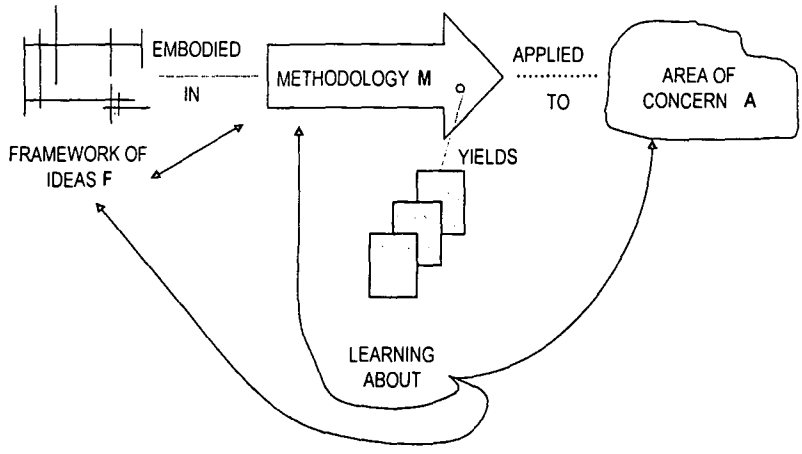

Figure 1.2: Cycle of Action Research (Checkland, 1991).

The ideal domain of a research method is one where **M** provides the richest scientific knowledge about F in the context of A. Considering action research within this model, Figure 1.2 depicts how this method cycles the research themes of **F** and **M** through **A** to generate reflection, action and ultimately scientific findings (Checkland, 1991). From Checkland's perspective, action research is a cycle of continuous inquiry where theory interacts with practice. This continuous interaction of theory and practice is the major characteristic of the ideal domain of the action research method.

The evaluation of rural telecommunications infrastructure is a complex activity, involving various stakeholders with views that do not necessarily coincide. Due to the nature of disparities in rural development in South Africa and in most countries (especially developing) of the world, the underlying philosophy for the evaluation framework needs to take into account the interests of the disadvantaged stakeholders in the evaluation process.

Hence the framework has to be of a neohumanist nature and for this reason it was defined within the Critical Systems Thinking paradigm.

In line with Checkland (1981), Jackson (1991) and others, this research acknowledges the social dimension of the problem situation and the multiplicity of interpretations related to it. The complexity of the problem situation leads to the need to explore the applicability of existing methods for solving complex problems like systems thinking and multiple criteria decision-making. The analysis of these fields and their potential contribution is presented from a historical perspective, as the understanding of pluralism in systems thinking is constantly evolving and can be understood better in relationship to past developments.

On the basis of the above a detailed literature survey was conducted in several directions:

- past research on several issues with regards to evaluation practice and evaluation theory;
- past research on several issues with regards to problem structuring techniques of complex systems;
- the role of critical systems thinking for the acceptance of pluralist approaches in management science and systems thinking;
- the current status of the field of Multiple Criteria Decision Making (MCDM), and its potential applicability to prioritisation of factors affecting rural telecommunications infrastructure.

On the basis of the literature analysis, a systemic framework (**F**) for the evaluation of rural telecommunications infrastructure is proposed. This conceptual framework is justified through the triad in Figure 1.1 as suggested earlier in Landry and Banville (1992) and Robey (1996).

It can be stated that the underlying philosophical assumptions of this research are based on critical systems thinking in the sense that the purpose of the evaluation of rural telecommunications infrastructure is seen to be the creation of the preconditions for

improvement in rural development. Following Midgley (1996), the notion of improvement plays an important role as an emancipatory idea in critical systems thinking. In line with Jackson (1991), "emancipatory" here is seen as synonymous with releasing the full potential of those previously disadvantaged that is those that did not have the power to be heard. In order to make this idea operational, the intervention framework includes not only a mixture of elements from Soft Systems Methodology and Multicriteria Decision Making, but also elements of the recently simplified form of Critical Systems Heuristics (Ulrich, 1998). The latter component is in the form of a checklist adapted to the problem area of critically heuristic boundary questions for systematic boundary critique.

This thesis is based on research that uses a systems thinking approach for the evaluation of rural telecommunications infrastructure. Critical Systems Thinking is used to provide a suitable theoretical and philosophical foundation for a systemic framework. Soft Systems Methodology is used as the dominant methodology and is complemented by a Multi-criteria Decision Analysis technique, the Analytic Hierarchy Process. These approaches could be referred to as the methodology M in Figure 1.2. This framework was tested on a real case study in a rural area in KwaZulu-Natal. It involved a Multicriteria Decision Making (MCDM) technique, the Analytic Hierarchy Process (AHP) and Soft Systems Methodology (SSM) for the synthesis of an approach enabling better stakeholder participation. As the resources for development are scarce, it was necessary to provide the conditions for their better distribution and utilisation through a more careful analysis of the needs of the stakeholders and their expectations before, during and after the development of a telecommunications infrastructure.

The overall justification of the framework as a holistic approach to the evaluation of rural telecommunications infrastructure was done from the perspectives of the body of knowledge within Evaluation of Technological Infrastructure, Complex Systems and Systems Thinking. It was shown that the formulation of the framework could be based on a meta-theoretic approach for mixing methods and techniques from different paradigms, called Multimethodology (Mingers and Gill, 1997).

1.5 IMPORTANCE OF THE RESEARCH

To the best knowledge of the author it is the first systemic framework for the evaluation of rural telecommunications infrastructure, incorporating a combination of soft and hard approaches thereto. This framework contains a unique synthesis of elements and techniques from different methodologies. It is true that its components are parts of well-known approaches. However, the combination of the techniques concerned and the way they are used has not been reported before in the literature.

Firstly, this research has major implications for rural communities. The framework proposed provides an opportunity for all the relevant stakeholders, especially those that were previously ignored, to participate in a transparent process that will hopefully contribute positively to rural development.

Secondly, the business and local government sector can benefit immensely from improved telecommunications infrastructure. Networks that electronically link the parts of an organization together, improve productivity in the businesses and other organizations so connected. The flow of information in the reverse direction also brings value. The government and other appropriate organizations can now obtain statistical and other information electronically, and this can improve the quality and timeliness of decision-making and delivery of services.

More than 70% of the world's population live in rural areas (Brunner, 1999). Economic development initiatives will provide better employment opportunities. Increased employment can result in greater economic prosperity for the rural communities and the country as a whole.

This research is also important to the public telecommunications service provider. The service provider becomes aware of the importance to involve all the relevant stakeholders in determining the needs of the rural community. An inclusive process will result in a more efficient service being provided to the rural communities.

1.6 OVERVIEW OF CHAPTERS

Chapter 2 provides an overview of telecommunications and rural telecommunications with particular reference to the role of telecommunications in rural development, the socio-economic benefits of rural telecommunications, universal access to telecommunications, and the socio-economic indicators of rural telecommunications. This chapter also examines the current state of rural telecommunications in South Africa. The position of the South African government on infrastructure development and the provision of universal access are highlighted. The deficiencies in the current approaches to telecommunications infrastructure rollout and the need for a new approach are also highlighted.

Chapter 3 examines the issue of complexity and complex systems and how this impacts on socio-technical systems and on the evaluation of rural telecommunication systems. It emphasises the fact that a rural telecommunications system (RTS) is not just a combination of technology that forms the rural telecommunications infrastructure but that it is only part of the infrastructure. A RTS is interdependent on other subsystems (for example economic subsystem) and that the technology infrastructure is one but necessary subsystem. Since there are a number of different stakeholders and multiple criteria involved in the evaluation and improvement of infrastructure of rural telecommunications systems, it is also necessary to consider multiple perspectives of the relevant stakeholders involved and also to consider multiple criteria in the design of a framework for evaluation. This chapter discusses these issues and the need to include them in the framework for evaluation in order to ensure a holistic approach is used for the evaluation of rural telecommunications infrastructure.

Chapter 4 explores both theory-based and non theory-based approaches to evaluation. It examines in some detail fourth generation evaluation and the participatory approaches to evaluation because these approaches attempt to be an inclusive process as far as stakeholders are concerned. An overview of socio-technical approaches to evaluation and evaluation based on organisational theory and program theory are also covered. This chapter provides the background of evaluation approaches and also explores the appropriateness of these approaches to the problem context, that is the evaluation of rural telecommunications infrastructure.

Chapter 5 reviews the differences between hard systems and soft systems. It explores Soft Systems Methodology (SSM), Critical Systems Thinking (CST), Total Systems Intervention (TSI) and also Critical Systems Heuristics (CSH) in some detail. This chapter also provides the theoretical and philosophical foundation for the framework.

Chapter 6 discusses the development of the framework for the evaluation and provides motivation for mixing methodologies. The framework uses a mix of soft and hard approaches with SSM being the dominant methodology, which is complemented by the MCDA approach, AHP.

Chapter 7 provides a detailed account on the implementation of the framework. An account of the criteria that should be used for the selection of a rural area for the evaluation or rollout of infrastructure as developed by the regional managers from Telkom SA in a workshop is also given.

Chapter 8 concludes this thesis with concluding remarks and recommendation for future application of the framework.

Chapter 2

TELECOMMUNICATIONS AND RURAL DEVELOPMENT

2.1 RURAL TELECOMMUNICATIONS

In most countries around the world, the telecommunication industry has undergone some form of restructuring. Firstly, because it has became increasingly evident that telecommunications and economic development are very closely linked, and secondly because it is now widely realized that the old, rigid "government telecommunication monopoly model" meets neither the communicating public's needs nor the country's national policy objectives (Barr, 1998). The greatest challenge for developing countries is to ensure that telecommunication services, and the resulting benefits of economic, social and cultural development, which these services promote, are extended effectively and efficiently throughout the rural and remote areas. The provision of telecommunication services includes telephonic services, telex, telegraph, and data transmission.

There is no standard definition of what is rural and one's understanding varies considerably from country to country and also within countries. In the United States of America, rural areas are defined by the sparsity of population. In South Africa, one may define a rural area in connection with the disadvantaged nature of the population (Guillory, 1998). Rural population density also varies dramatically from one country to another, and often within the borders of larger nations. Rural population densities in India, Indonesia, and China enormously exceed the rural density in Mongolia and Kazahkstan. Rural population densities in Rwanda and Burundi, and parts of Nigeria and Kenya, are higher than the rest of rural sub-Saharan Africa (Hudson, 1999). However, rural areas may be characterised by some or all of the following: lack of available power; poor geographic conditions; adverse topography; low population density; low level of economic activity; low income level; underdeveloped social structures. (Heymann, 1987; ITU Report, 1997).

More than 70% of the world's population reside in rural areas which in many instances has remained underdeveloped (Brunner, 1998). Apart from the provision of some infrastructure for the provision of goods and services, the provision of proper telecommunications infrastructure remains neglected in many rural areas, especially in developing countries. When the need to link underdeveloped rural areas with the more rapidly developing economic centres, as well as the general need to modernise the former is considered, it is clear that the implications of this neglect has serious negative implications.

A financial appraisal for telecommunications projects in rural areas often yields an unprofitable rate of return on investment because of a number of factors. These include low rural prosperity and low population density and hence high capital cost per potential user/subscriber. Furthermore, the topography and climate can also result in higher capital, installation and maintenance costs. Therefore, if investment in such projects, is determined entirely by consideration of financial rates of return, the neglect of rural areas will continue. The resultant skewed development of the overall rural economy, particularly in terms of its infrastructure in public services such as telecommunications, may create a lack or indeed be counter productive in terms of long term economic growth.

Telecommunications is not simply a connection between people, but a link in the chain of the development process itself. With its ability to overcome the barrier of distance, telecommunications can facilitate the development process by improving (Richardson, 1998):

- *efficiency*: the ratio of output to cost;
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Telecommunications is increasingly becoming a vital link between rural and urban areas, and between rural and the rest of the world. A basic information infrastructure in rural areas results in more than just good communication. It spurs small business development, job creation, income generation, agricultural processing and marketing, and improved health, education and social welfare (ITU Report, 1998).

This chapter highlights the role of telecommunications in rural development, the socio-economic benefits of rural telecommunications, and then focuses on the state of telecommunications in South Africa, more specifically on KwaZulu-Natal.

2.2 THE ROLE OF TELECOMMUNICATIONS IN RURAL DEVELOPMENT

Communications are often not considered part of the primary bundle of development services in developing countries. Given the levels of underdevelopment and the shortages that exist in terms of basic necessities such as food, clothing, shelter, security, health, education and social integration, communications and information processing systems simply do not rank highly on the development agenda. Yet they are tools well suited to improving the supply of all the above necessities. In contrast, in developed societies these are taken for granted as key factors of economic, commercial and social activity and as a prime source of cultural activity. Reliable telecommunications provide access to information, employment opportunities, education and health facilities, which in turn impact on productivity, and social networks. All of these influence the ability of individuals and households to participate productively in the economic sphere (May, 1998).

Rural areas are usually characterised by the lack of basic services such as the supply of adequate supplies of clean water, food, fuel, shelter, roads and power. It is difficult therefore to even attempt to prioritise telecommunication development until these basic needs have been satisfied. When does telecommunication become a necessary ingredient in the development of such rural sectors and what level of technological advancement does the particular telecommunications medium have to attain in order to satisfy the telecommunications requirements of these regions? The crux of the matter lies in being able to determine at which moment in time the widespread distribution of telecommunication services becomes a necessity rather than a luxury. Unfortunately no formula exists which enables the relevant planners to determine with any degree of certainty, when a more advanced network has to be established.

Demand for rural access to telecommunications is growing as underserved populations in the developing world clamour for service, and rural residents in industrialized countries request upgrades to enable them to access the Internet and use network features and services primarily available in urban areas. Driving this demand is the growing need for information to be competitive in a global economy, for farmers, fishermen, and artisans who need to obtain price information and arrange transportation of their produce; for rural information

workers, whether they be writers or catalogue sales clerks; and for rural schools and health care services seeking access to expertise and resources unavailable in their communities.

Cronin *et al.* (1991) in a landmark study conducted a detailed economic analysis of the United States (US) economy from 1958 to 1988. They found a "cyclical, positive feedback process" in which telecommunications investment in any year led to growth in the US economy in later years, which in turn led to more demand for and investment in telecommunications infrastructure. A related study found that the mechanism by which this telecommunications-induced economic growth took place was productivity gains in other sectors of the economy that were able to operate more efficiently with improved telecommunications (Cronin *et al.*, 1991). The research team extended the analyses they had done on US national economic statistics by replicating the study in a single state, Pennsylvania, and in rural counties within Pennsylvania. They found that the significant causal relationship between telecommunications investment and economic growth evident in national statistics was also seen in rural counties.

These statistically rigorous studies are consistent with all of the prior studies on the subject of telecommunications and rural development (Parker, 1996). Earlier studies had found that both business and residential services contribute to economic growth and that the most rural and remote locations benefited even more than more densely populated areas. Studies have consistently found that economic benefits of telecommunications investment stem from the increased productivity of businesses using telecommunications and the improved education, health and social services made possible by telecommunications. In all cases, telecommunications is a catalyst for or a complement of other development activities (Hudson, 1999; Barr, 1998; Richardson, 1998; Parker, 1996; Cronin *et al.*, 1991).

Rural areas are being affected strongly by the shift to an information economy. There have been dramatic changes in both the technology of telecommunications and the regulatory environment under which the information economy operates (Hudson, 1998). Technological innovation coupled with economic globalization has focused new attention on rural telecommunications. Terrestrial wireless and satellite technologies can extend connectivity to rural areas, while backbone fibre optic networks across continents and under oceans link the most isolated communities to the Internet.

Information technology, primarily telecommunications and computers, is part of the problem that requires rural communities to adapt to new communication technologies, whether they want to or not, and at the same time is part of the solution available to make successful adaptation possible. However, telecommunications and other information technology do not offer a magic solution for rural economic development. The process of rural development is more complex than that. According to Parker (1996), the essentials of rural economic development can be classified into three categories:

- Investment in human capital, which means providing education and health care for the residents of each rural community. People are the only important resource. All else depends on their thoughts and actions.

- Investment in the physical infrastructure necessary for economic development, water, power, transportation, and telecommunications. The telecommunications infrastructure is important today because of the dramatic changes in what is possible and because failure to change may leave rural communities at a serious competitive disadvantage. Nevertheless, we must not forget that telecommunications is only one element of essential infrastructure.

- Reform of our social organizations, the ways in which we collectively relate to each other. The potential accomplishment of an individual acting alone is minuscule compared to the potential of organized groups working together. Social pressures are strong, particularly in small rural communities. The changes necessary for rural economic development require local leadership. Change involves risk, which makes change difficult in some risk-averse rural cultures.

Much of the economic development in rural communities will depend on risk-taking entrepreneurial small businesses. Role models, incentives, social support, and a variety of services including financial, technical, accounting, legal, consulting, training, and marketing services may all be required. Installing computers and telecommunications equipment and networks will not magically change rural culture and bring about development. It may take strong leadership and organized social pressure to obtain the necessary infrastructure in the first place.

Telecommunications can be used for a wide range of applications, in education, health care and social services, by small businesses, cooperatives, and individual entrepreneurs. Whether these applications are widely implemented depends on the vision of policy-makers. According to Hudson (1999), this vision must include both social and economic goals for national development, and recognize that information access, sharing, and dissemination will contribute to achieving these goals. Several fundamental criteria, according to the same authors, are critical in implementing this vision:

- **Accessibility:** The widest range of telecommunications facilities and services should be available throughout a country, and all residents should have access to basic services.

- **Equity:** There must not be major disparities in availability and price of telecommunications technologies and services. That is, in addition to maintaining universal access to basic services, policies must ensure that people are not penalized because of where they live or what companies offer services to them. Information services need to be available in rural as well as metropolitan areas, in inner cities as well as suburbs and rates for access to these services should not vary significantly throughout the country even if they are provided by different companies or using different technologies.

- **Connectivity:** In an era of new technologies and competing providers, there must be universal connectivity, so that people can communicate with each other and with information sources regardless of who provides their services or what technology links them to networks.

- **Flexibility:** Changing technologies and the introduction of new services mean that we will have to be flexible in setting targets and adjusting to change.

- **Oversight:** Regulatory oversight is necessary to monitor progress toward meeting targets, to enforce compliance with performance standards, and to review and revise benchmarks.

Telecommunication systems are powerful communication and knowledge sharing tools. They can bring new information resources and open up new communication channels to facilitate dialogue and the flow of information between rural people and their organizations, institutions and governments. Rural telecommunication systems are a means through which people can access new options to help make their lives more secure, prosperous and meaningful. Innovative, organized uses of the technologies to enhance or provide competitive advantages to rural communities are the real stuff of development (Richardson, 1998). Also, since electronic commerce (e-commerce) is rapidly changing the way business is being conducted, the provision of infrastructure provides an ideal opportunity to "level the playing fields" for the rural community to be equal players/partners in the business field.

The African Regional Telecommunication Development Conference held in Abidjan, Cote d'Ivoire (1996) recommended five key principles as a basis for providing telecommunication services in rural and isolated areas. The Arab Regional Telecommunication Development Conference held in Beirut, Lebanon, November 1996, also resolved to support these same five principles. These principles have been defined to provide the appropriate framework for creating a profitable and sustainable telecommunications network of telecommunication services in the rural areas of developing countries (Barr, 1998):

- **Universal Access:** Access to telecommunication facilities and services will be provided at a convenient central location in each community. The portfolio of services offered will meet the needs of the community. Both the types and quantity of services offered will increase as demand grows, and new applications and opportunities emerge.

- **Rural Telecommunications Programme:** Rural telecommunications should be introduced through a carefully planned, well-structured and managed, rigorous and orderly programme. The programme should start in those rural areas that are expected to have the greatest service demand, and to be the most profitable. Experience indicates that the successful planning, organization and management of the rural telecommunications programme are very important factors in creating a cost-effective rural telecommunications infrastructure that provides a service which can be priced low enough to be widely used, and is hence valuable to the residents, and yet profitable and sustainable.

- **Regulatory Framework**: An appropriate regulatory framework will be required, which creates the necessary terms and conditions to promote the initial provision and continuing sustainability of the rural service. The regulatory agency must monitor the sustained availability, quality and financial viability of the rural service, preferably through aggregated versions of the same indicators that the service provider uses for his own internal management requirements.

- **Financial Resources**: There are only two substantive sources of funds for investment in rural telecommunications programmes. These are the service provider's own internal funds, and funds from private sector investors, including individuals and organizations, both national and international. It is important that funds that are already in the service provider's hands (for example from depreciation charges or from retained earnings) should be permitted to remain in the service provider's hands, for reinvestment in the network. This may require changes in legislation at the national level; for example, to encourage investment in the network, the government may very wisely specify that earnings will not be taxed if they are reinvested in the network. For investment funds to be forthcoming from potential private sector investors, it is essential that the rural telecommunications network must be expected to be, and in practice must be seen to be, a profitable enterprise.

- **A Commercial Approach**: This principle underlies the other four principles. The rural telecommunications network must be operated as a commercial, entrepreneurial, profit-focused and profitable enterprise. It is this "mind set" that will motivate the service provider to continually seek to maximize revenues and minimize costs. There are many opportunities to do this. The service provider's success will be directly reflected in minimizing the amount of subsidy that is needed to support the Universal Service Organisation (USO).

The provision of good infrastructure in rural areas has a major impact on the development of the rural communities. The next section highlights the socio-economic impact and benefits of rural telecommunications infrastructure.

2.3 UNIVERSAL ACCESS TO RURAL TELECOMMUNICATIONS

2.3.1 The Communication and Information Revolution

The world is in the midst of a communication and information revolution, complemented by an explosive growth in knowledge. Information and knowledge have become some of the most important factors in societal and economic development. As generic technologies, information and communication technologies (ICT) permeate and cut across all areas of economic, social, cultural and political activity. In the process they affect all social institutions, perceptions and thought processes. Globally the information and communication sector is already expanding at twice the rate of the world economy (ITU, 1997).

Decreasing costs of increasingly powerful, reliable hardware and software, as well as the fact that much hardware has become a desktop item, will continue to drive the use of information and communication technologies, facilitating access by ever-wider segments of society. But this tendency can have profound benefits only if gains in physical access are accompanied by capacities to exploit these technologies for individual and societal development through production and dissemination of appropriate content and applications.

Those communities that have access to information and communication technologies are busy finding ways and means to exploit these technologies for social, economic, political, and cultural development. Unfortunately, a large part of the world population is excluded from this opportunity. This was highlighted at the First International Conference on Rural Telecommunications (1998) that drew 250 delegates from 46 countries and 170 institutions. The delegates came together to explore dozens of case studies and lessons learned about delivering dial tone, Internet, and other services to rural communities throughout the world. The conference highlighted, *inter alia*, the inadequate provision of telecommunication services to rural areas (Norton, 1998):

> "More than 70 percent of the world's people live in rural areas, yet the majority of those people have never made a phone call. There are more phones in Manhattan than in all of sub-Saharan Africa", (Michael E. Brunner, The National Telephone Cooperative Association (NTCA) Executive Vice President).

> "80 percent of all access lines are in 26 countries. One-eighth of the population has only 2 percent of telephone lines. Ireland has four times the number of phones as India. . . . Our challenge is to close the gap" (Senator Byron Dorgan (D-ND)).
>
> "Three billion people in the world today live on less than $2 a day. Four billion people have never made a telephone call. There is substantial overlap between the people in these two groups. Most of them live in rural areas." (Paul G. Bermingham, regional team leader for Europe and Eastern Africa Telecommunications and Informatics Unit, The World Bank Washington, DC).

Although the ITUs Maitland Commission, which was established in 1983 to suggest remedies for the huge telecommunications gap between developed and developing countries, called for a telephone "within an hour's walk" throughout the developing world. The observations highlighted above, indicate that not much has been achieved in terms of providing infrastructure for rural telecommunications.

Since information access is so crucial for socio-economic development, "universality" should not be assessed only in terms of the number of individuals that have access to telecommunication services, but also in terms of the community and institutions such as schools, clinics, libraries, and community centres, etc. The phrases "universal access" and "universal service" are sometimes used interchangeably. According to Hudson (1999) access is a broader concept that involves the following components:

- *infrastructure*: extension of the network to customers;
- *services*: for example Plain Old Telephone System (POTS), value-added, broadband services;
- *affordability*: pricing of installation, monthly service, local and inter-exchange calls, etc., and
- *quality*: line quality, network reliability, blockage.

2.3.2 Heterogeneous Access to Telecommunication Services

According to Mueller (1997), the old universal policy in the United States of America was based on wireline voice telephone networks. Voice service was simple, homogeneous, and uniform. Access was a binary variable: either you had a residential telephone or you did not. The question is how does one define the "new" universal service? How much bandwidth and

what functions will it involve? Will it include Internet and data communications, cable as well as telephony, wireless as well as wireline? "The whole dialogue is a futile attempt to pour the old wine of regulated monopoly telecommunications into the new bottles of a digital marketplace." (Mueller, 1997: 45). It assumes that a digital broadband network will, like the old telephone system of the past, reach into every home with a uniform grade of service, allowing the population to be neatly categorised into those who can afford this level of service (the "information haves") and those who cannot (the "information have-nots").

It is now understood that the new telecommunications infrastructure does not have to be a digitised version of the new one. Communication service is taking an ever-wider variety of forms, and there is a broad range of information transmitting and processing capabilities. Functions can be tailored to specific market segments, which now means that customisation and not uniformity is the rule. It is also possible to tailor the price and capability of service to specific user needs and socio-economic constraints. This will also apply to the provision of telecommunication services in rural areas since distance is becoming less of an issue than previously.

2.3.3 Universal Access Myths

If rural and developing regions are to enjoy the benefits of universal access, telecommunications policies need to be based on realistic premises and not wishful thinking or simplistic generalizations. It is recommended that policy-makers must rethink long-held assumptions and myths about telecommunications in rural areas. Some of the myths highlighted by Hudson (1999) are discussed below.

- **Build it and They Will Come:** This strategy assumes that investment in telecommunications alone will result in economic development. This oversimplified notion underlies many business and policy strategies. However, numerous studies have shown that telecommunications is necessary but not sufficient for development. The reality is that many other factors contribute to rural economic development, including other infrastructure (particularly electrification and transportation), a skilled workforce, and the cost of operations including facilities and labour. Rural regions with all of these advantages may well be able to attract new jobs by encouraging investment in modern and competitively priced telecommunications.

- **Rural Demand is Very Limited:** Architects of universal service policies may assume that there will be little demand for telecommunications in rural areas. Such forecasts are typically based solely on the lower population densities than are found in urban areas, coupled with the "one-size-fits-all" fallacy that assumes all rural residents are likely to have lower incomes and therefore lower demand for telecommunications than in rural areas. Income is a useful predictor, but there are also many other factors that generate demand. Villagers in Rwanda and Burundi may be very poor, but the coffee and tea plantations where they work need to communicate to order parts and supplies, check on international prices, and arrange transport of their produce to foreign markets. Egyptian farmers in poor Nile delta villages use the telephone to fill orders for vegetables from markets in Alexandria and Cairo. Tuna fishermen in poor coastal communities in the Philippines use cell phones to arrange cargo space on aircraft to get their catch to Tokyo.

  As rural and isolated people gain greater control of natural resources and demand more political autonomy, their needs for communication also increase. Organizing by indigenous peoples to obtain land claims in Alaska, northern Canada, and Outback Australia required extensive communications within their regions and with major urban centres over many years. It is hard to imagine that land claims would have been settled without reliable communications to discuss strategy, lobby political and business leaders, and build public awareness and support.

- **"One-Size-Fits-All":** Many people implicitly assume that all rural customers have the same needs. Yet not only are individuals and families likely to have different communications needs from rural businesses and organizations, but these institutional customers may differ in their service requirements and traffic patterns. Operators who adopt a "one-size-fits-all" approach may limit choices for rural customers and may inadvertently limit their own revenues.

  Planners often assume that voice service is all that developing regions will ever need. While there may never be demand for a modem in every hut, demand for Internet access is likely to grow among government offices, small businesses, cooperatives, schools, and health centres. Some operators rule out that option by installing wireless local loop technologies with very limited capacity such as Digital European Cordless

Telecommunications (DECT), which is being installed in some rural areas of South Africa. Fixed cellular also has insufficient bandwidth for accessing the Web (although the third-generation version of Global System for Mobile communications (GSM) promises more bandwidth, but at currently unspecified cost). Similar limitations apply to mobile satellite systems such as Iridium, Globalstar, and ICO, often promoted as solutions for developing countries (but also likely to be priced beyond the reach of most rural customers).

In more developed rural regions, telecommuters work from their homes. Farmers seeking price and crop management information want Internet access from home. Meanwhile, "snowbirds" in winter vacation homes and summer cottagers demand the telecommunications services they would use in the city. Yet even in industrialized countries, "basic rural service" is typically considered to be voice service, often with lower reliability, as well as higher prices than would be found in urban areas.

- **Rural Benchmarks Must be Set Lower than Urban Benchmarks:** Too often, planners approach the question of rural telecommunications policy from the viewpoint that "something is better than nothing.". They believe that providing the bare minimum of services is a technically feasible, economically justifiable goal for rural areas. However, new technologies such as terrestrial wireless, very small aperture terminals (VSATs), and digital compression, along with design and operations adapted for local conditions, can reduce costs and increase reliability of rural networks.

- **A Carrier of Last Resort is the Best Means to Ensure Rural Access:** Some countries require the dominant operator to act as a "carrier of last resort," with a Universal Service Obligation (USO) to provide rural service if no other carrier has done so. Typically the carrier with the USO is entitled to a subsidy to provide the service based on its cost estimates. However, this policy can be flawed if there is no incentive for the carrier with the USO to use the most appropriate technology and to operate it efficiently. It can also serve as a justification for the dominant carrier to be protected from competition because it has additional costs and obligations not required of new entrants. If subsidies are provided to serve high-cost areas, they should be made available to any operator willing to provide the service. Rather than

designating a single carrier of last resort, some countries are introducing bidding schemes for rural subsidies.

2.3.4 Universal Access Principles

For those Asia-Pacific Economic Cooperation (APEC) economies who believe there is a need to provide universal access to telecommunications services, the following principles provide guidance on how APEC economies can accomplish this in line with the prevailing legal and regulatory environment and government structure of each economy, within the framework of the Bogor Declaration timetable for achieving free trade and investment in the APEC region. These guidelines are also important for Non-APEC regions (APEC, 1994):

- Extension of basic telecommunications access is recognised as fundamental to economic development.
- Each economy will decide on the scope of its own universal access objectives according to its own circumstances.
- The evaluation of universal access objectives should take account of the broad economic and social benefits and the corresponding costs of limited access.
- The telecommunications regulatory framework should:
  - be administered independently from service operators in order to champion the interests of users;
  - encourage rational competition so that market-driven network development has the greatest opportunity to flourish; and
  - provide the kind of certainty in the market that encourages maximum private investment in the network.
- The policy framework for universal access should encourage:
  - the private sector to use innovative bases for generating and calculating revenues;
  - governments to consider using communications technology to deliver services both for the cost benefit to the government budget and for the intangible benefits to the people of strengthening the communications network;

- the universal service providers to minimise the costs in providing universal service without compromise on the quality of service; and
- equitable sharing of the net universal service costs among the relevant contributing parties. The obligation in supporting the provision of universal service should not affect the relative competitiveness of the operators and service providers in the telecommunications market.

- To be sustainable in the long run, universal access must be provided on a basis that is independent of implicit cross-subsidies. Therefore revenues should be arranged so that net costs are met through one or more of the following mechanisms:

  - requiring the provision of universal access as part of the conditions of the licenses of carriers;
  - mobilisation of diverse capital resources, including public, private and foreign capital;
  - transparent funding mechanisms to channel resources to universal access providers, consistent with members' international commitments and other policies; and
  - commercial arrangements negotiated against the backdrop of competition laws.

The strategies for extending universal access to telecommunications services assume a broadening of the definition of "public interest" beyond the simple assessment of connection to the network and pricing of basic services. They involve an analysis of the potential benefits of access to education and social services; the impact of geographical as well as income-related disparities; the potential economic benefits of affordable access to information for both individual and collective activities. Stakeholders including telecommunications companies, consumer organizations, business and institutional users, and policy-makers must participate in implementing this vision, in order to ensure that rural residents around the world will gain access to the tools of the "Information Age".

2.4 SOCIO-ECONOMIC IMPACT AND BENEFITS OF RURAL TELECOMMUNICATIONS

Research indicates that the introduction of sufficient quantities of modern telecommunication services in previously unserved or underserved rural and remote areas stimulate economic development, social development, and cultural development (Hudson, 1999; Barr, 1998; Richardson, 1998; Parker, 1996; Cronin *et al.*, 1991). However, the level of impact and derived benefits depend on various factors. For example, the commitment and "drive" of the rural community, non-governmental organisations (NGOs), traditional leaders in taking full advantage of the telecommunication services, the support for the technology and services, the availability of other parallel infrastructure, and level of economic activity in the region, etc.

For the purposes of this research, direct impacts and or benefits are those that are an immediate consequence of the introduction of telecommunication services in rural areas. These are relatively easy to understand and measure, such as the reduction in travelling costs. One can easily identify and quantify the reduced costs of sending or receiving fax than waiting for the normal mail. There are other direct impacts that are easily identified, but not easily quantified such as the increasing ease of some communications and improved timeliness of communications.

Some impacts are less obvious and more difficult to measure and maybe more important in the long run. For example, how do we assess the value of an individual or organization increasing international contacts and participating in activities that previously were unknown or out of reach? Indirect impacts are those that are not an immediate and exclusive result of the introduction of telecommunications in rural areas. Indirect impacts can range from increased cost effectiveness of a small nongovernmental organization (NGO) to restructuring of an economy as a result of changes in the structures of comparative advantage induced by telecommunication services.

The most important benefit of rural telecommunication systems lies in their use as tools for interpersonal communication, which is the foundation of communication for development.

The term "communication for development" is used to describe processes of two-way dialogue and expression that encourage sharing of feelings, desires, beliefs and experiences, together with problem analysis, exploration of solutions, and bottom-up communication that raises the awareness of decision-makers to those problems (Bessette, 1996). The basic tenet of communication for development is that the communication *process* is more important than the production of media products or content. Communication for development practitionersare thus people with skill and experience in facilitating social and organizational interventions, and using various media to catalyse two-way communication, dialogue and problem-solving (Richardson, 1997).

All development efforts, whether focused on technology diffusion or not, draw our attention to issues of participation, capacity building, power and control. In planning, implementing, using and evaluating telecommunication applications we must bridge the technical with the social, political, cultural and economic dimensions of development. In over five decades of development practice, communication for development practitioners have come to understand that interventions of a social or organizational nature, designed to catalyse the participation of stakeholders are of key importance in achieving development goals (Melkote, 1991). Rural telecommunication systems can add new mechanisms for enabling and enhancing stakeholder participation, and for achieving a variety of other communication, information sharing and problem-solving applications that can assist development efforts. Communication for development practitioners, of course, do not normally possess the technical expertise required to establish rural telecommunication systems and are thus dependent on the knowledge and skills of telecommunication experts to help establish these new mechanisms for enabling and enhancing participation.

Collaboration between telecommunication experts and development practitioners can do much more than establish new information and communication technologies (ICTs) for enabling and enhancing participation. When added to the technical knowledge of rural telecommunication experts, the knowledge and skills of communication for development practitioners – particularly in the areas of stakeholder participation, training and organizational capacity building – can help ensure that technologies are developed appropriately and can achieve sustainability and revenue generation. Sustainability and revenue generation tend to be key goals in the establishment of rural telecommunication systems. However, telecommunication experts may not always possess the knowledge and

skills necessary to facilitate the participatory processes that can help achieve these goals. Partnerships between our fields of knowledge and expertise are necessary.

These benefits can facilitate the process of socio-economic growth and development. What is important though is the fact that, during this process, rural telecommunications can improve the quality of life of rural inhabitants. Hudson (1984) argued that one of the indirect benefits of telecommunications is that it permits improved cost-benefits of rural social service delivery. She claims that in countries where a commitment has been made to provide or extend rural services, such as health care, education and agricultural extension services, locating highly trained professionals in the rural sectors may not be feasible. Disregarding the fact that many professionals do not wish to locate in these sectors, those who do, incur costs beyond that which is affordable to the rural sector. Furthermore, for the state there is a substantial bureaucratic overhead of managing a large, geographically dispersed organisation. However, minimally trained local rural workers can be utilised at acceptable rural rates of remuneration while being trained, managed and supervised via a telecommunications system. The consequent savings in professional training costs, relocation labour costs and transport costs may be sufficiently high to justify significant allocations for telecommunications services.

Implicit in many cost benefit analyses involving a particular telecommunications network is a "head-count" of the number of users. However, the effects of telecommunications do not accrue only to those who use the system, but accrue also to their community in general. This is so because the function of telecommunications is simply to convey information. It is not unlikely that the information conveyed may be selectively utilised to the benefit and enrichment of particular individuals or groups.

A telecommunications network, if it serves the interest of the community, could lead to improved levels in the quality of life of that community. A proviso, however, is that a certain level of organisational development and basic elementary infrastructure already exists in order to maximise the socio-economic benefits that may be realised from such a telecommunications network. Initially communication is restricted to members of extended families, spreading thereafter to include the community and then beyond. With each successive step the horizon of individuals and communities spreads, as does the organisational development of the community. The more complex the social, economic,

legal and political structures that emerge the more vital becomes the dissemination of cost effective, accurate and speedy information.

However, it is important to bear in mind that community development cannot proceed without the successful application in practice of this information. In particular, as the complexity of information flows increases, the need for a complementary accumulative public infrastructure becomes more crucial.

The role of telecommunications in the development of an economy generally, and the rural sector, in particular, will vary depending on several factors related to the socio-economic characteristics of the sector or country concerned. The demand for telecommunications services will vary in accordance with the stage of development that characterises each region. However, common to most rural regions is the fact that the implementation of a telecommunications network has been and will continue to be a potential force for the development of that society.

Moreover, the development of an intensive telecommunications network is costly and many developing countries and newly industrialised countries may consider such systems to be prohibitively expensive. However, the socio-economic benefits that may accrue, not only to particular rural communities but the countries generally, are potentially enormous. A telecommunications network, of which a telephone system is, perhaps, the most useful in underdeveloped rural sectors, is a very potent force influencing and contributing to the development of such regions. Given the satisfaction of environmental prerequisites, the potential contribution to be made by a telecommunications system to development is vast.

Several different types of telecommunications applications can help improve the economy and quality of life in rural communities (Barr, 1998; Parker, 1996):

- Networks that electronically link the parts of an organization together, including computer Local Area Networks (LANs) and Wide Area Networks (WANs), improve productivity in the businesses and other organizations so connected. External electronic networks connecting businesses to their suppliers and customers permit cost reductions and service quality improvements. This includes financial transactions (for example making bank deposits, paying bills, and obtaining cash)

and also information-type transactions (for example arranging to obtain licenses of all sorts).

The flow of information in the reverse direction also brings value. The government and other appropriate organizations can now obtain census-type and other statistical information electronically, and, as a result, can improve the quality and timeliness of decision-making and delivery of services.

- Independent retailers without electronic connections with their distributors are competitively disadvantaged. For rural manufacturers to be competitive in this age of "just in time" inventory systems, they must have network connections for electronic data interchange (EDI) with their customers.

- Flexible manufacturing networks in rural areas permit a number of smaller businesses to team together so they can collectively respond to larger orders and bigger projects than any of them could handle alone.

- Many telephone and mail order businesses have located in rural communities because of the quality of life and cost advantages, provided that the most advanced telecommunications network services were available to meet their needs.

- A variety of telemarketing businesses prefer rural locations when the telecommunications network infrastructure permits.

- Many business consultants, software developers and other people with information-intensive small businesses would prefer to live and work in rural communities if the data networking capabilities permitted.

- Distance learning networks may be an ideal way for rural schools to pool their resources and to draw on outside talents not available locally, in order to provide their students with the best education available anywhere. It is hard to offer advanced placement courses or a wide variety of math, science and foreign language courses in small rural schools. With appropriate distance learning networks, these options are all possible.

Distance learning networks may also permit lifelong continuing education for rural residents who cannot afford the relocation or the long drive time required to attend courses in distant locations. There are examples of educational programs available through telecommunications that embrace the whole range of education, from primary school to university. For many of the residents of the rural and remote areas of developing countries, this capability has the potential to open a broad spectrum of new educational possibilities. In educational applications, a variety of technologies can play a role.

- Telemedicine networks can improve the quality of rural health care by permitting medical specialists in distant urban medical centres to consult with rural patients and primary health care providers. Improved remote diagnostic and monitoring capabilities may improve home health care services for rural residents. Now, instead of having to move either the patient to the doctor or vice versa, it becomes possible to move only the relevant medical information. Good quality data service capability is necessary, so that medical readings and records and files can be transmitted reliably. Experience has demonstrated that valuable telemedicine applications include in-service coaching and training of remote-located health care staff.

- Improved computer networking may help local governments improve the quality and reduce the costs of their services while making government information more accessible to their citizens. Library networks allow rural libraries to share resources more effectively.

- The explosive growth of the Internet and its World Wide Web (www) has made a wealth of information from around the globe available to businesses and consumers everywhere. Rural residents who can access the Internet with a local phone call are privileged. Most pay long distance toll calls to get access, or do not have access at all. The "Net" is an important business opportunity for rural businesses seeking to expand their markets, but that avenue of growth is blocked for them if no local Internet provider can offer a network server on which local businesses could put up their "home pages" or give consulting help to show them how to do it.

- Personal computers have already become exciting multi-media devices for a wide variety of business and consumer applications. Current generation personal computers, when equipped with add-on hardware and software can serve as desktop videoconferencing terminals. The videoconferencing hardware and software permit voice and video communication between distant humans as well as collaborative uses of computer applications on their computers.

  This capability, like other telecommunications advances, is likely to be even more valuable in rural communities than in urban communities because of greater savings in travel costs. Unfortunately, the telecommunications networks necessary for this application, while becoming common in urban areas, are still rare in rural communities. (Most desktop videoconferencing applications require an Integrated Services Digital Network (ISDN) connection from the telephone company.)

- Finding markets for farm produce, fisheries catches and handicraft products, negotiating prices and quantities, arranging for pickup and delivery, and so on. On the input side of commercial enterprises, telecommunications facilitates such functions as arranging for the required factors of production (for example obtaining supplies of all sorts, including both raw materials and production tools) and making arrangements with and for workers.

  On both the input and the output side of commerce, telecommunications makes it much easier to follow up on contracts, and explore potential business development opportunities. Telecommunications makes it possible to obtain and to distribute information of all sorts. Databases and other information sources can be accessed, providing information, amongst many other things, on distant markets, market and consumption trends, and future markets.

- Detailed information regarding "best practices" methods and techniques can be made available, to the great advantage of agriculture, fisheries, and cottage handicraft industries. The widespread distribution of detailed, well-substantiated "best practice" methods and market information has proven to be very valuable over many years in the steady and continuing improvement of agricultural productivity in North America.

- Tourism is a commercial area that is just not feasible without adequate telecommunications, which are essential in developing and promoting the business, and in making the reservations and detailed arrangements that this industry requires. Experience indicates that potential tourism customers refuse to go to areas where "reasonable" telecommunications are not available. Tourism is a rapidly expanding industry worldwide, and offers a significant commercial opportunity for many developing countries.

- In embracing an entrepreneurial approach to the provision of telecommunication services, the promotion of services (in particular the high revenue/high margin services) is an important opportunity to be pursued. International long distance calling, which has been increasing dramatically worldwide for several years, is an important and profitable example. The experience of many developing countries indicates that there are significant numbers of expatriates who are living in other countries who want to keep in touch with the family and friends that they have left behind in the rural villages.

- Some developing countries are facilitating community access through telecentres. Typically, a telecentre includes information and communication technologies such as telephone, fax, telephone circuits, and computer with modems and Internet access installed in a community centre, library, school, post office, coffee house, or other accessible community location.

These and other specific telecommunications-intensive applications will be the way rural communities use improved telecommunications to improve their economies and their quality of life. The relationship between telecommunications investment and rural development is not some distant, abstract concept. It is the practical business of installing in rural communities the networking capabilities that will make a difference to the lives and work of rural residents.

2.5 SOCIO-ECONOMIC INDICATORS OF RURAL TELECOMMUNICATIONS

There is increasing awareness of the importance of telecommunications and the need for relevant, up-to-date and comparable statistics for analysing the industry. This includes measurements for comparing network progress and performance as well as macro-economic measurements to gauge the impact of telecommunications on social and economic development. Convergence is blurring the boundaries of the telecommunications, broadcasting, and computing industries, making it difficult to determine exactly what is to be measured. It may therefore be necessary to expand the telecommunication indicators to cover information-communication indicators (Laouyane, 1996).

In order to evaluate telecommunications infrastructure, it is necessary to identify and define the most important indicators that may be useful in analysing the telecommunications sector. International organisations have developed or proposed socio-economic indicators to measure development progress across countries. As the official agency for the collection of national statistics, Statistics South Africa has played a crucial role in the development of indictors in South Africa, including the compilation of the core set of 21 indicators within the framework of the Organisation of Economic Co-operation and Development (OECD)/World Bank/United Nations initiative (Udjo *et al.*, 2000).

2.5.1 Measuring and Monitoring Development in South Africa

Although South Africa is a member of the international development partnerships strategy, in addition to meeting international obligations there have been national initiatives to develop indicators that take into consideration, the country's specific needs with regard to the monitoring of transformation of South Africa. The goals of transformation are embodied in Government's Reconstruction and Development Programme (RDP), and the Growth, Employment and Redistribution (GEAR) strategy. The RDP, an integrated, coherent socio-economic policy framework and its programme of action was structured around its principal policy thrusts, which brought together clusters of Ministries and Departments (WPLG, 1998; IDP Report, 1998). Five major policy programmes were linked. These were designed to meet the overall goal of the RDP – *a better life for all* – namely, meeting basic needs, developing

the country's human resources, building the economy, democratizing the State and Society, and implementing the RDP (WPLG, 1998). On the other hand, GEAR is the government's macro-economic framework for rebuilding and restructuring the economy; it complements the RDP. The twin objectives of GEAR are transformation of the economy to meet the needs of the new democracy, and gearing it for the competitive world economy. The strategy in place to achieve the objectives includes infrastructure development (including housing, health care and education facilities, municipal and rural infrastructure, and recreational facilities), measures to promote competitiveness and employment, restructuring of state assets, fiscal and financial discipline and the reprioritising of spending (WPLG, 1998; IDP Report, 1998).

The development, regular compilation and reporting on indicators in these areas are essential to monitoring changes, and informing policies regarding transformation in South Africa. It is against this background that indicators have been defined or proposed in South Africa. The core indicators proposed by Statistics South Africa measure, *inter alia*, economic well being, social development, gender equality, infant and child mortality, maternal mortality, reproductive health and population, and environment (WPLG, 1998; IDP Report, 1998).

2.5.2 On the Characteristics of Indicators

There are a number of useful classifications of indicators. For example, we differentiate between quantitative and qualitative indicators. The following discussion includes quantitative indicators, such as the number of rural telephone lines provided, and qualitative indicators, such as the quality of the services.

While quantitative indicators are not necessarily more objective, their numerical value tends to lead to more agreement on interpretation of the results. However, qualitative indicators can supplement the numbers and percentages and, thereby, add a real-life perspective to the evaluation of a program. It may not always be possible to find quantitative indicators for some of the indirect impacts of the provision of telecommunication services in complex socio-economic systems, and qualitative indicators may be the only ones available that are relevant to key policy and management issues. Indicators that measure numerical values are commonly divided into such groups as ratios, intervals, ordinal values, and nominal values.

The division is important in terms of the analysis that the indicators will support. Another classification is input, output, and outcome indicators.

Given the wide variety of direct and indirect impacts of the provision of telecommunication services, there will be a large number of potential indicators related to such impacts. The indicators are intended to provide a framework for local and foreign users, service providers, and policy-makers for collecting, organizing, and analyzing information. The indicators are intended as guidance for people who will choose areas and indicators to meet their own needs. The indicators used to evaluate the impact of telecommunications on rural development will not be identical when evaluating its impact in an urban environment.

According to Jackson (1998), Objectively verifiable indicators (OVI) should meet the following criteria:

- **Measurable:** an indicator must be able to be measured in either quantitative or qualitative terms;
- **Feasible:** an indicator should be feasible in terms of finances, equipment, skills and time;
- **Relevant and Accurate:** an indicator should reflect what we are trying to measure in an accurate way;
- **Sensitive:** an indicator should be capable of picking up changes over the time period that we are interested in; and
- **Timely:** an indicator should be able to provide information in a timely manner.

2.5.3 Socio-Economic Impact Indicators of Rural Telecommunications in South Africa

This research focuses on the evaluation of the impact of rural telecommunications infrastructure. Due to the blurring of boundaries between telecommunications, broadcasting, and computing, the set of indicators referred to in this study will include information-communication indicators. However, since the impact of Information and Communication Technologies is a major focus area on its own, ICT and ICT indicators will not be dealt with in great detail. Further, it is important to note that the level or extent of the impact also depends on the presence of other parallel infrastructure needed for social and economic

development, for example supply of clean water, good transport infrastructure, supply of electricity, etc. However, a detailed discussion of the parallel infrastructure is outside the scope of this research.

Following the discussion from the previous section, the introduction of telecommunication services to rural areas can have a major impact on rural development. Socio-economic impact focuses, *inter alia*, mainly on:

- **Economic development:** business vitality in the region, level of employment, housing affordability, future business prospects;
- **Quality of life:** standard of living, contact with relatives, friends and the outside world;
- **Education:** availability of schools, level of education offered, exposure to new technologies;
- **Health:** availability of affordable primary and secondary health, proximity of health facilities.

In order to evaluate the socio-economic impact of rural telecommunications infrastructure, one needs to identify the socio-economic indicators of rural telecommunications. The most important indicators are discussed below (Indicators Handbook on Telecommunications, 1996; Stavrou, 1998; Stavrou, 1995; Udjo *et al.*, 2000; Williams and Smith, 2000).

1. **Quality of Service**: The quality of service is determined by the level of customer satisfaction, network reliability, and speed and responsiveness. The possible indicators are:

    - **Customer satisfaction**
        - Number on the waiting list for main lines
        - Number of customer fault reports
        - Number of customer out of service reports
        - Hours during which service is available
        - Transmission quality
        - Number of account queries per 100 inhabitants
        - Accuracy of directory services

- Global access

- **Network Reliability**
  - Operator service: Percentage of calls for operator service answered within . . . seconds
  - Call failure rates: Percentage of unsuccessful calls
  - Fault repair time: Percentage of telephone service faults cleared by the next working day or within . . . days

- **Speed and Responsiveness**
  - Average wait time for installation of business and residential service
  - Average length of time for roll out of new services
  - Percentage of sales from new services

2. **Usage:** Possible indicators of usage are:

- Frequency of calls: Number of calls per week, month, and year?
- Number of calls per household
- Duration of calls (Number less than 3 minutes/number more than 3 minutes)
- Reason for using telephone:
  - Social: friend, relative, neighbour
  - Domestic: neighbour, shop
  - Emergency: hospital, police
  - Commercial: business associates

- Types of calls
  - Number of local calls of ≤ 50km distance
  - Number of national calls >50 km
  - Number of international calls.

- Type of telephone most frequently used
- Call booth, store, neighbours, work, etc.
- Type of phone preferred: Individual, communal/party line

3. **Tariff:** Possible indicators are:

   - Telephone service installation charge in rural areas
   - Telephone service subscription charge in rural areas

4. **Network Size:** The network size is influenced by the demand for telecommunication services; population of the region; level of economic activity; area (km^2); organisational support; location, terrain, future prospects, etc. Possible indicators include:

   - Number of telephone main lines in operation
   - Total line capacity of local exchanges
   - Main lines for residential use
   - Main lines for other use
   - Public pay phones:
     - Number of coin operated telephones
     - Number of card operated telephones
     - Number of public call offices

Derived Indicators:

   - Number of main telephone lines per 100 inhabitants
   - Number of telephone sets per 100 inhabitants

5. **Other Services:** Possible indicators are:

   - Number of cellular mobile telephone subscribers
   - Number of ISDN subscribers
   - Number of Internet subscribers
   - Number of personal computers

The diverse nature of these indicators, that is quality of service, usage, tariff, network size, etc. requires one to gather both quantitative and qualitative data. The service providers experience difficulty in gathering hard objective data on these indicators using existing assessment methods. There is therefore a need for a holistic treatment of both quantitative and qualitative data implying the involvement of stakeholders in an inclusive and transparent evaluation process. All these needs contribute to the complexity associated with the evaluation of rural telecommunications infrastructure.

For operational purposes, some of these indicators needed to be aggregated for the purposes of this research or to be left out as not very important. The simplified list of the indicators that was used in the evaluation of rural telecommunications infrastructure is more suited to the nature of the rural area under evaluation here. It is listed in Chapter 7.

2.6 TELECOMMUNICATIONS IN SOUTH AFRICA

There are five major actors in the communications industry in South Africa that deals with the policy and regulatory environment:

- The Minister of Communications
- The Standing Parliamentary Committee on Communications
- The Department of Communications
- The South African Regulatory Authority
- The Universal Service Agency (USA)

The advent of democracy in South Africa gave rise to national policies to give effect to the Reconstruction and Development Programme (RDP). Currently the Information and Communication Technologies (ICTs) is receiving increased National Government attention. In March 1998, the Government took its first step in transforming South Africa into an information society, when the Cabinet approved a framework proposal for the development of a national information and communications technology strategy. Recently, President Thabo Mbeki set up an advisory body comprising international experts to advise government on ICT in South Africa and also on the African continent.

2.6.1 The Provision of Telecommunication Services Prior to 1994

Apartheid fundamentally skewed the manner in which the telecommunication infrastructure (and other state provided services) was allocated in both the urban and rural areas in South Africa. The white urban and rural areas, in marked contrast to the non-white areas, were well provided. In black formal townships the telephone infrastructure did exist but was inadequately provided, whilst in the shanty-towns surrounding the urban areas and in the black rural areas there was a near absence of a telecommunications network. It is therefore difficult to discuss the provision of telecommunications in South Africa without locating the issue in a political and socio-economic framework (Morris and Stavrou, 1991).

White Rural Areas

The racially skewed character of the telecommunications network was not only due to the greater economic prosperity of the white community. It was also a historical consequence of the political power of whites and the role that the state played in ensuring that adequate provision was made by using criteria that were based on social desirability rather than economic efficiency. This was most clear in the case of the white rural areas. In the past the white commercial farming community wielded immense economic and political power and used it to ensure a markedly skewed distribution of land and state provided in the rural areas services on a racially discriminatory basis. The average white farmer had access to health, education, electricity, transport networks, and a telephone as a result of a commitment from the state to provide whites with such services through public sector provision. Since most of these areas were remote the services were costly. However, the farmer did not bear the full cost of such provision. The farmer was allowed to pay the average cost rather than the marginal cost of providing the service provided telephones, on a party line system. Installation costs and maintenance charges (rents) were subsidised by higher telephone charges. There was thus an extensive system of cross subsidisation – between services and between rural and urban areas (Morris and Stavrou, 1991).

Black Rural Areas

This is in marked contrast to the situation prevailing in black rural areas. In the rural areas telephone provision has been near to zero. There has been no corresponding commitment to the provision of a telecommunications network through state subsidisation. Income levels were extremely low and economic activity was often at standstill, so it was highly unlikely that the general population could acquire conventional telephone services in the black rural areas without some form of state intervention to ensure a redistribution of both a private and public telecommunications infrastructure (Morris and Stavrou, 1991).

Formal Black Townships

In the formal black townships income levels were significantly higher than in the black rural areas but the level of telephone penetration in private households were not commensurate with either demand or affordability. Furthermore the public telecommunication network in these areas was totally inadequate. In the Greater Durban Metropolitan Region – an area with a population of just under 4 000 000 of which 1 000 000 blacks lived in formal settlements and nearly 2 000 000 in shantytowns – only 29%of households in the formal black townships possessed a telephone. One of the major problems is the legacy of apartheid within the public sector, for there is no overarching state commitment to providing and maintaining telephones to this market (Morris and Stavrou, 1991).

Shantytowns

There was no telecommunications infrastructure in most shantytowns. Inhabitants had to travel to a formal area, or to a local shop in order to gain access to telephones. There existed a widespread belief in the government and private circles that shantytown dwellers are primarily unemployed, poverty-stricken and in a fundamentally different economic position from formal township dwellers. It was therefore argued that their economic position rendered it economically unprofitable for the state to consider creative ways of installing a telephone network in these areas. However, the research carried out by Morris and Stavrou (1991) on the social and economic structure of shantytowns (notwithstanding higher levels of unemployment) revealed major similarities to many formal working class townships, and hence a neglected potential market exists.

The underlying problem was political. There have been two axes – racial and urban/rural - along which resources have been differentially distributed. State-controlled resources have been allocated towards whites rather than blacks, and insofar as blacks share in the distribution of resources the urban areas have substantially benefited at the expense of the rural areas. The role of the state in providing telecommunications to stimulate development and satisfy social needs in black shantytowns and rural areas has either been absent from discussion, or has been allocated a very low priority. Instead assessments have been made in purely economic terms based on narrow cost criteria. Issues of economic affordability and privatisation have been prioritised way above longer-term social and economic policy.

However, with the demise of apartheid a more global conception which locates the provision of telecommunications in a development framework was adopted. Redistribution of infra-structural resources was clearly on the agenda, and the issue that is dominating economic policy questions for a post-apartheid South Africa is how to achieve the correct relationship between growth, development and redistribution.

The general neglect of telecommunications issues as inputs into development planning stems partly from the fact that, until very recently, social scientists have not really come to grips with the role that communication plays in the development process. Moreover, they have also failed to consider the impact that access to a means of conveying information, or the lack of it, will have on development performance. There is an increasing literature available linking the growth of a telecommunications network in a region with corresponding economic development. Furthermore, increased access to telephones in underdeveloped areas leads to improved levels in the quality of life of that community. In our view, the value of a telecommunications network to a community is reflected in the ability that it affords that community to transmit information both speedily and cost effectively within the area and outside. Efficient information flows are not only a necessary element for the productive functioning of the economy of an area but, in addition, they are crucial for the solution of a number of other social and development issues. Moreover, not only can the successful transmission of information via an effective telecommunications network significantly improve the quality of life of people at the micro or community level, but it can also stimulate and facilitate the macro-development process generally. However, and this must be seriously underlined, the development of an appropriate system of telecommunications

requires not only technical choices but also political and social ones. Unless the socio-economic dynamics are understood, the technical choices that are made may well prove to be wholly inappropriate (Stavrou, 1997; Hudson, 1984).

2.6.2 Provision of Telecommunication Services between 1994 and 1999

Three events after the elections in 1994 began to move the telecommunications policy forward (Gerber and Braun, 1998:108):

- The establishment of the National Telecommunications Forum (NTF);
- The establishment of the Reconstruction and Development Programme (RDP);
- The appointment of the new Minister of Posts, Telecommunications, and Broadcasting.

The NTF engaged government, business, labour, civic organisations and other stakeholders in a consultative process. The RDP set the specific goal that telephones should be provided to all existing schools and clinics within two years.

2.6.2.1 Infrastructure Rollout by Telkom SA

Telkom South Africa Limited officially came into being on 1 October 1991 when it was incorporated as a company with the state as sole shareholder. In May 1997, 30% of Telkom was sold to a strategic equity partner, Thintana Communications, a consortium comprising United States (US)-based SBC Communications and Telekom Malaysia Berhad. Some R4.4 billion of the R5.6 billion equity sale proceeds was injected into Telkom to help fund its network expansion and modernization programme.

Telkom SA Ltd has been given the mandate as the sole provider of fixed wire telephony. There exists no competitor regarding fixed wire telephony at the moment. At the end of Telkom's exclusivity period (which began in 1997) in 2002, this sector will be open for new entrants. Should Telkom achieve its rollout targets by the year 2002, its exclusivity period may be extended by a further year.

In November 1995, Telkom SA unveiled a broad expansion plan, called Vision 2 000. It scheduled an ambitious plan over the next 5 years, increasing the network by 75%, implying (Gerber and Braun, 1998):

- the addition of 2 million lines in rural areas;
- the addition of 1 million lines in areas that have developed telecommunications infrastructure;
- another 1.2 million lines to replace obsolete ones, aiming to complete the digitisation of the network.

South Africa has a large transmission infrastructure, necessitated by the country's vast geographical area of 1,2 million km². Covering about 156 million circuit-kilometres, the transmission network constitutes the backbone of all telecommunications services. The network is almost wholly digital. Digital microwave and optical fibre serve as the main transmission media for the interprimary network interconnecting all major centres (GCIS, 2000/2001).

Telkom has met and exceeded its rollout targets (within three years), over 1,6 million lines, 175 488 more than the cumulative target. Since 1998, about 14 000 lines have been installed for priority groups such as schools, clinics and hospitals. In fact, South Africa ranks 23rd in telecommunications development and 17th in Internet use in the world. It is the telecommunications leader on the African continent with approximately 5,3 million installed telephones and 4,3 million installed exchange lines. This represents 39% of the total lines installed in Africa (GCIS, 2000/2001).

Penetration amongst white households generally exceeds 85%, among Indian households it stands at 74%, in coloured households 37%, and in African households 14%. Across all races, household penetration of private telephones in rural areas is approximately 1%, whilst in urban areas it is 32%. Among the reasons given by Telkom for the continued differences in coverage is the high cost of providing services in rural areas. These costs have been found to be as much as five times that of an urban area. It should also be noted that 61% of all schools, 22% of all libraries, 19% of all hospitals and clinics have no telephone at all.

National pay phone penetration currently stands at 1,14 pay phones per 1,000 persons, with a total of 71,000 public telephones installed throughout the country. The penetration is highly skewed by province, with Gauteng and the Western Cape, which comprise only one-quarter of the entire population of South Africa and only 16% of the African population, having over half of all pay phones (Stavrou, 1997).

2.6.2.2 The South African Government's Vision for Telecommunications in South Africa

The new South Africa has, unfortunately, inherited many of the socio-economic and political problems of the past. The enormous backlog of basic needs and services must be met in a sustainable manner, which does not limit future growth possibilities. In order for any service provision programme to be successful as well as economically viable, it is vital that socio-economic factors be taken into account.

The state's vision for telecommunications in South Africa is one that balances the provision of basic universal service to disadvantaged rural and urban communities with the delivery of high-level services capable of meeting the needs of a growing South African economy. The economic empowerment of historically disadvantaged communities is a programme of achieving meaningful participation by all members of these communities in all aspects of productive economic activities in South Africa as consumers, workers, managers and owners. The extension of affordable and accessible universal service will enhance social and economic activities in historically disadvantaged communities by providing the necessary infrastructure as well as generating employment in the telecom sector (White Paper on Telecommunications, 1996).

The White Paper reflects the state's vision for telecommunications as one that balances the provision of basic 160 universal services to disadvantaged rural and urban communities with the delivery of high-level services to meet the needs of a growing economy. The Telecommunication Act of November 1996 granted Telkom a five-year period of monopoly over voice telephony. The reasons for such an arrangement were largely to ensure the delivery of a universal service, which in its narrowest sense means that basic telephony should be made accessible to all South Africans, and this includes:

- to roll out a network to expand residential and business telephone penetration to all who can afford it, regardless of where they reside and at uniform cost;
- to roll out the network to expand the public pay phone penetration to all parts of the country, ensuring a ratio of 3,5 telephones per 1,000 people in urban areas and 5 pay phones per 1,000 people in rural areas;
- o ensure that all priority clients (schools, hospitals/clinics, libraries and local authorities) are connected before the end of the century;
- to strategically rebalance tariffs to reduce the costs of international and long distance calls, which currently cross-subsidize local calls; and
- to prepare Telkom for competition.

2.6.2.3 The Universal Service Agency (USA)

The Universal Service Agency was launched in May 1997. It is a statutory body created in terms of the Telecommunications Act, 1996 and its objectives include advising the Minister on ways to bring about universal access and service, coordinating initiatives by service-providers such as Telkom, Vodacom and Mobile Telephone Network (MTN) and extending access to telecommunications by working with community-based organizations (CBOs), non-governmental organizations (NGOs), donor organizations and businesses.

The Agency manages the Universal Service Fund. The Fund, which holds a percentage of funds allocated from the licences of all telecommunications suppliers, supports projects that increase universal access to telecommunications service.

A "Universal Service Agency" (USA) has been established by the Telecommunications Act to:

- promote affordable and accessible universal service to historically disadvantaged communities;
- encourage, facilitate and offer guidance in respect of any scheme to provide universal service or access to telecommunications services as part of the RDP;
- foster new methods of attaining universal service; and
- stimulate public awareness of the benefits of telecommunications.

The USA, from time to time, makes recommendations to the Minister as to what constitutes universal access and provision, and is responsible for evaluating the extent to which universal service is being delivered. Furthermore, the USA will be responsible for the administration of the Universal Service Fund, which is to be set up for the purposes of:

- paying subsidies towards the cost of provision or use of telecommunications services to needy persons; and,
- paying subsidies to Telkom or any other license holder to assist with the financing of a public switched telecommunication service to areas that are not presently adequately serviced.

Other measures to promote economic empowerment include broadening equity ownership, employee share ownership schemes, creating new employment opportunities through intensive training and the promotion of African commercial enterprises (GCIS, 2000/2001).

2.6.3 Outlook for the Provision of Telecommunication Services (2000 and beyond)

The total number of households without telephones stand at almost 4 million (3,928m), and range from a high of 2,67 million rural black households, to 1,62 million black urban households, 0,32m coloured households, 0,2m white households and 0,06m Asian households. It has been estimated that, in order to provide every family with a telephone, South Africa would have to spend R120 billion, or 12 times total government gross domestic fixed investment (GCIS, 2000/2001).

In order to reduce inequalities amongst households in South Africa, everybody who can afford a residential telephone service should gain access. After accounting for the current cost of installing and maintaining a fixed telephone, the total number of households that could afford a service currently stands at 1,87 million telephones, of which 80% (1,496m households) are black homes. The distribution of this undersupply amongst black homes is almost evenly split between urban and rural areas. Telkom will, therefore, have to install approximately 805,000 telephones in black rural, 691,000 in black urban, 167,000 in coloured, 37,000 in Asian and 170,000 in white households. If the current demand for telephones is adjusted upwards by 3,7% per annum to accommodate population growth rates,

by the year 2000, the cumulative demand for one telephone per household would have reached 2,2 million (GCIS, 2000/2001).

Telkom is aware of the fact that a total of just fewer than 2 million households will remain excluded from the residential network, and is therefore placing a strong emphasis on the delivery of public telephony. The government has set Telkom an ambitious target of increasing the number of pay phones from current levels to 190,000 by the year 2001 – an additional 120,000 new pay phone installations over the next five years. Unlike their fixed telephone penetration strategy, Telkom aims to eliminate the provincial imbalances in pay phone penetration by linking future penetration rates to population densities. Their stated objective is that there be 3,5 pay phones per 1,000 people in urban areas and 5,1 pay phones per 1,000 people in rural areas. These pay phone objectives must not be seen as an end, but rather as a means to achieving more equitable penetration in the long term, to private residential service (GCIS, 2000/2001).

A recent development that Telkom is pursuing is Voicelink, a centralised message service based on voicemail technology. Through Voicelink people who do not have their own telephone service obtain a voicemail and pin number and are able to use pay phones, private telephones or cellular telephones to send and retrieve messages. An individual or family is given a com card and an address list on the public telephone network. All incoming calls are recorded and messages accessed whenever the holder of the com card calls their address. Although there is no relief on outgoing calls, this system allows those that cannot afford a fixed line at their place of residence to at least receive messages.

Three GSM cellular network operators are licensed in South Africa – Vodacom, Mobile Telephone Networks (MTN) and Cell C. Cell C became operational in November 2001. As part of their licence obligations Vodacom and MTN are obliged to install a certain number of community phones. Currently, 7 000 community phones have been installed by Vodacom and 4 900 by MTN. The intention of the licence obligation was to ensure the delivery of telephony to those areas that were either very poorly serviced or not on the grid and unlikely to be connected in the near future. Due to there being no locational spread stipulated and the absence of an ineffective regulator at the time, Vodacom and MTN simply chose the most

convenient areas possible and over-loaded these with public pay phones. This was further compounded by the lack of co-ordination between Telkom and the two network operators, resulting in the three parties duplicating services in particular areas, while neighbouring communities remain excluded (GCIS, 2000/2001).

2.6.4 The State of Telecommunications Services in KwaZulu-Natal

Relatively good progress has been made in the provision of telecommunication services in the province of KwaZulu-Natal. The average penetration is 20 telephones per 100 people compared to the national average of 9.6 telephones per 100 people (Statistics South Africa, 1996). In the urban areas of KwaZulu-Natal, the average telephone provision is 33 per 100 people and in the rural areas the provision is 17 per 100 people. Although business telephones comprise 36% of all telephones in South Africa, exact figures for KwaZulu-Natal are currently unavailable. Table 2.1 below gives a cross section of the major urban and rural areas together with the population distribution, the number of telephones available and the ratio of number of telephones to the number of people:

Table 2.1: Population distribution and the number of telephones available for the major urban and rural areas in KwaZulu-Natal.

AREAS	NUMBER OF TELEPHONES	POPULATION	RATIO
Urban-Durban	164 741	566 121	1 : 3.4
Urban-Pinetown	105 334	383 049	1 : 3.6
Urban-Pietermaritzburg	92 258	173 823	1 : 1.8
Rural-Nqutu	23 757	159 077	1 : 6.6
Rural-Umbumbulu	26 997	163 552	1 : 6.0
Rural-Mapumulo	23 896	150 168	1 : 6.2
Rural-Ubombo	17 111	125 805	1 : 7.3
Rural-Ndwedwe	19 615	144 172	1 : 7.3
Rural-Eshowe	29 888	184 702	1 : 6.1

(Source: Statistics South Africa (1998): South African Census Statistics, 1996)

The table shows that the listed rural areas (which are among the largest in the province in terms of their population and area) fall behind the urban areas considerably with respect to

the provision of telephones. Thus the Durban and Pinetown areas are approximately twice better serviced by telephones per person than the listed rural areas. A more detailed table showing the provision of telephone services in KwaZulu-Natal is given in Appendix A. This table reflects the status quo in 1996. Unfortunately up-to-date statistics on telephone penetration and usage is available, as the results of the 2001 census are not published as yet.

2.7 CONCLUSION

More than 70% of the world population live in rural areas. Over 4 billion people have never made a telephone call (see section 2.3). Rural areas, especially in developing countries, are generally underdeveloped and underserviced. This chapter highlighted the general neglect of telecommunications issues as inputs into development planning, more especially to rural development. Only recently social scientists have come to grips with the role that communication plays in the development process. There is an increasing availability of literature linking the growth of a telecommunications network in a region with corresponding economic development. Furthermore, increased access to telephones in underdeveloped areas leads to improved levels in the quality of life of that community.

One of the major differences between urban telecommunications and rural telecommunications is that the question of affordability is not the only real issue in rural areas. In rural areas it is not possible to achieve a positive return on capital in the short term because of the large areas that must be covered and which are sparsely populated. Moreover, all the factors affecting the improvement of rural telecommunications infrastructure are not quantitative. The issue in rural areas is one of social responsibility. There is a need to ensure that all the relevant stakeholders have an input into the evaluation process.

In rural telecommunications one cannot ignore the soft issues. The priority in rural areas is the supply of electricity and clean drinking water. In order for the benefits of rural telecommunications to accrue to the rural communities, the deployment of infrastructure must be a planned, inclusive, and a transparent process involving the relevant stakeholders. There is no evidence of a holistic approach to the evaluation of rural telecommunications infrastructure in South Africa. Telecommunication service providers rely on data provided by limited surveys and research carried out by Data Research Africa. The data provided is mainly

quantitative in nature. It is also evident that current research on rural telecommunications does not receive suitable theoretical treatment. A better evaluation framework for rural telecommunication infrastructure is needed which justifies the research reported in this thesis. It cannot be developed however, without first investigating the complexity of rural telecommunications systems, and its relationship to other parallel infrastructure which is the subject of the following chapter.

Chapter 3

THE NATURE AND COMPLEXITY OF SYSTEMS AND RURAL TELECOMMUNICATIONS SYSTEMS

3.1 THE NATURE AND COMPLEXITY OF SYSTEMS

Simple systems are characterized by few and similar variables whose relations are stable and simple. The interactions are limited and can be thoroughly analyzed, and the effects are predictable. This simple causal mechanics is suited for and has been very successfully applied in classic natural science, but is quite inappropriate when dealing with social systems, which are much more complex.

In complex systems many different elements can act in manifold ways and are intensely interlinked, which does not allow detailed analysis or prediction due to non-linear, unstable relations (Simon, 1962). At best, patterns of interaction can be observed and uncertainty in working with them gradually reduced. However, human cognition is not well suited to understand their dynamics, it has the tendency to reduce complex relations to simple cause-effect patterns, and to look only at what can be observed and ignore all which is not accessible to observation or easily understood (Simon, 1962). Systems theory and systems thinking can help to avoid undue simplifications and provide useful tools for practical work with complex systems.

Complexity theory shares a common vocabulary with systems theory. Terms such as emergence, complexity, and adaptation appear in both traditions. Despite the similarities, complexity theory is not a misnomer for systems theory. Several points of departure exist in complexity's research agenda and methods. Moreover, systems theory seems to have embraced interpretivist and critical philosophies; complexity theory remains firmly in the positivist camp, despite claims that it is a postmodern science (Phelan, 1999).

Rural telecommunications systems are complex socio-technical systems. In order to understand, analyse, and evaluate rural telecommunications infrastructure, it is necessary to understand complex systems and view rural telecommunications systems from different perspectives and also consider multiple criteria in the evaluation process. This chapter examines the nature and complexity of systems, socio-technical systems and rural telecommunications systems. It also examines the need for multiple perspectives and multiple criteria decision analysis in the evaluation of rural telecommunications infrastructure.

3.1.1 Systems Theory and the Nature of Systems

Systems theory is the transdisciplinary study of the abstract organization of phenomena, independent of their substance, type, or spatial or temporal scale of existence. It investigates both the principles common to all complex entities, and the (usually mathematical) models that can be used to describe them (Heylighen, 1992). Systems theory was proposed in the 1940s by the biologist von Bertalanffy (1968), and furthered by Ashby (1956), Churchman, (1971), Ackoff (1973) and others. Von Bertalanffy reacted against reductionism and attempted to revive the unity of science. The Systems Age followed the Machine Age. Although eras do not have precise beginnings and ends "the 1940s can be said to have contained the beginning of the end of the Machine Age and the beginning of the Systems Age. This new age is the product of a new intellectual framework in which the doctrines of reductionism and mechanism and the analytical mode of thought are being supplemented by the doctrines of expansionism, teleology, and a new synthetic (or systems) mode of thought." (Ackoff, 1973: 327).

Mechanistic thinking refers to the Cartesian philosophy that states that complex phenomenon can be understood only by analysing its elementary parts (Flood and Jackson, 1991). Reductionism, therefore, is committed to explanation in terms of the smallest number of the most fundamental entities or elements (Checkland, 1976). This means that all objects and events, and their properties, can be understood in terms of ultimate elements (Flood and Jackson, 1991). It leads one to believe that the Universe or organisations are made up of building blocks arranged in some form of hierarchy. According to Flood and Jackson (1991) the "rational" or "classical" view of organisations sees them as made up of parts, each of which can be optimised independently in pursuit of some goal. However, this does necessarily mean that if the parts are optimised independently, the parts as a whole will perform optimally.

Opposed to the Cartesian philosophy were the organismic biologists, who as Flood and Jackson (1991) and Capra (1996) point out, pioneered the Systems Thinking approach. The Systems Thinking approach embraces Expansionism, a doctrine maintaining that all objects and events, and all experiences of them, are parts of larger wholes. It provides another way of viewing things, a way that is different, but compatible with, reductionism. It turns attention from ultimate elements to a whole with interrelated parts, to *systems* (Ackoff, 1973). A

system is a set of interrelated parts or elements of any kind. The parts interact to co-produce the behaviour (essential properties or characteristics) of the system. The way in which each interacting part influences the behaviour of the system as a whole depends on the behaviour of at least one other part as well as the behaviour of the system itself. If a part is removed from the system or if one is added to the system, the behaviour of the system changes as well as the behaviour of the part. The set of parts or elements has the following properties (Ackoff, 1973):

1. The properties or behaviour of each part has an effect on the properties or behaviour of the set as whole.
2. The properties or behaviour of each part and the way they affect the whole depend on the properties and behaviour of at least one other part in the set. Therefore, no part has an independent effect on the whole.
3. Every possible subgroup of elements in the set has the first two properties. Each has an effect, and none can have an independent effect, on the whole.

It can be seen from the foregoing discussion that a system is more than the sum of the parts; it is an *indivisible whole* (Ackoff, 1973). It is a set of elements that work together in relationships for the overall good and objective or vision of the whole. It loses essential properties when it is taken apart. The elements of a system may themselves be systems, and every system may be part of a larger system. Preoccupation with systems brings with it the *synthetic* mode of thought. In synthetic thinking, something to be explained is viewed as part of a larger system and is explained in terms of its role in that larger system. Von Bertalanffy (1968) emphasized that real systems are open to, and interact with, their environments, and that they can acquire qualitatively new properties through emergence, resulting in continual evolution. As Capra (1996) pointed out, organismic biologists affirmed Broad's concept of emergent properties, arguing that at each level of the hierarchical structure of living organisms, the observed phenomenon exhibits properties that do not exist at the lower level. For example, there are different levels of complexity between cells and tissues, and between tissues and organs.

Rather than reducing an entity (for example the human body) to the properties of its parts or elements (for example organs or cells), systems theory focuses on the arrangement of and relations between the parts that connect them into a whole. This particular organization

determines a system, which is independent of the concrete substance of the elements (for example particles, cells, transistors, people, etc.). Thus, the same concepts and principles of organization underlie the different disciplines (physics, biology, technology, sociology, etc.), providing a basis for their unification. Systems concepts include: system-environment boundary, input, output, process, state, hierarchy, goal-directedness, and information (Heylighen, 1992).

The central concepts of a generalised conception of a system are shown in Figure 3.1. The terms used in the figure are: elements, boundary, input and output, environment and feedback. Further notions that are required to describe the complete conception are: attributes, transformation, purpose, open system, homeostatis, emergence, communication, control, identity and hierarchy.

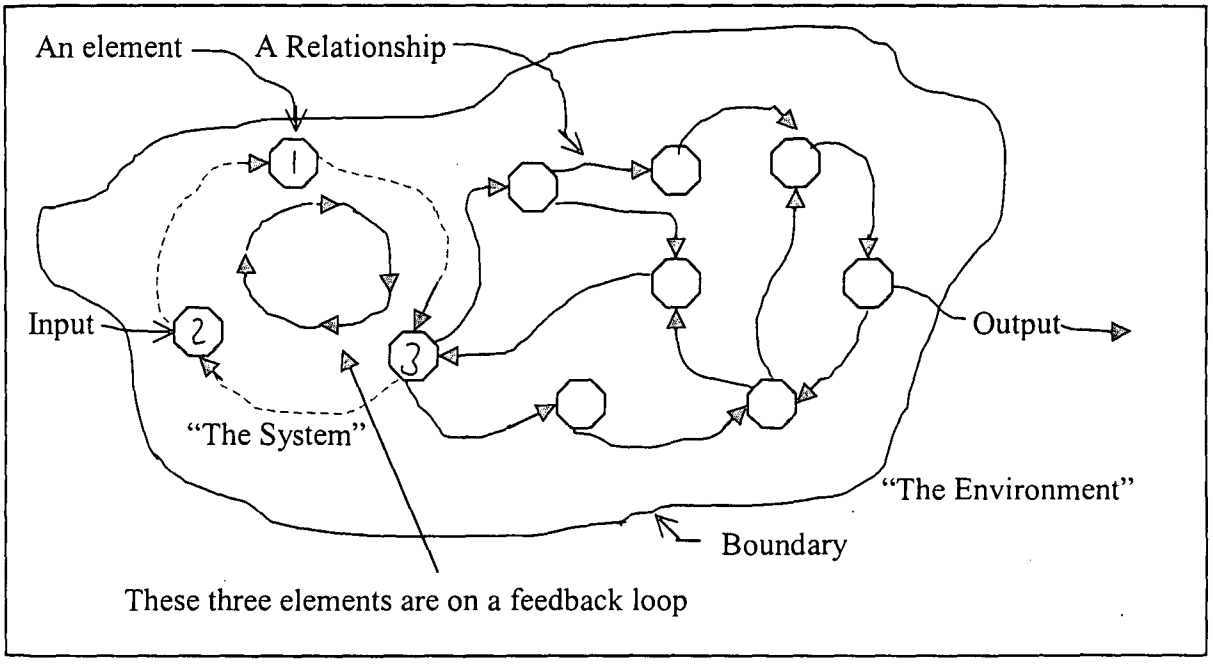


Figure 3.1: A general conception of "system" (Adapted from Flood and Jackson, 1991).

A system consists of a number of elements and relationships between the elements. There are some group of elements with high level of interactions and other groups with low level of interactions. Drawing a boundary around the richly interactive group of elements can separate these groups. The system identified by a boundary will have inputs and outputs, which may be physical or abstract. The system transforms the inputs into outputs. The processes in the system are characterised by feedback, whereby the behaviour of one element

may feed back from a series of connected elements to influence the element that initiated the behaviour. The elements and relationships are given attributes according to how one measures them (for example an element may be measured by weight and/or size and a relationship may be measured by intensity and or strength. Figure 3.1 shows that the system is separated from its environment by the boundary. This system is termed an open system if the boundary is permeable and allows inputs from and outputs to the environment. A system is said to in a homeostasis state if a system is able to maintain a dynamic steady state through communication and control within its environment.

When the parts of a system interact to achieve a particular goal, emergent properties arise which exhibits synergy and some transformation takes place (see Figure 3.2). According to Flood and Jackson (1991), the term "synergy" refers to the increased value of the parts working together as a whole. Sometimes the system under consideration may be a subsystem of a wider system. A subsystem should exhibit all the characteristics of a system in that it is separated from its environment by a boundary and that there is synergy. A system's performance depends on how it relates to its environment, the larger system of which it is part, and to other systems in that environment. For example, a car's performance depends on the weather, the road on which it is driven, and how well it and other cars are driven.

3.1.2 The Classification of Systems

According to Ackoff (1973), the Systems Age is teleology oriented ("a philosophical doctrine that developments happen as the a result of the ends served by them – rather than as a result of prior causes", Checkland, 1999), and as such it is preoccupied with systems that are goal seeking or purposeful, that is systems that can display choice of either means or ends, or both. There are three ways in which systems can be studied (Ackoff, 1973):

- the *self control* problem: Examine the effectiveness with which they serve their own purpose;
- the *humanisation* problem: Examine the effectiveness with which they serve the purposes of their parts; and
- the *environmentalisation* problem: Examine the effectiveness with which they serve the purposes of the systems of which they are part.

The Systems Age is most concerned with purposeful systems referred to as social groups. The most important class of social group is the one containing systems whose parts perform different functions referred to as an organisation. All groups and organisations, including institutions that are part of society can be conceptualised as three level purposeful systems. Systems can therefore be studied in terms of the purposeful interactions of the parts, the social setting, and its environment. Systems fall into three broad categories according to their purposes: deterministic, animated and social systems (Ackoff and Gharajedaghi, 1996). A deterministic system has no purposes of its own, but normally serves the purposes of others. Animated systems have purposes of their own. The parts have functions but no purposes of their own. Social systems on the other hand are systems which both the system and the parts have purposes of their own.

Checkland (1981, 1999) describes the world as five system types: natural systems, designed natural systems, designed abstract systems, human activity systems, and transcendental systems (Figure 3.2).

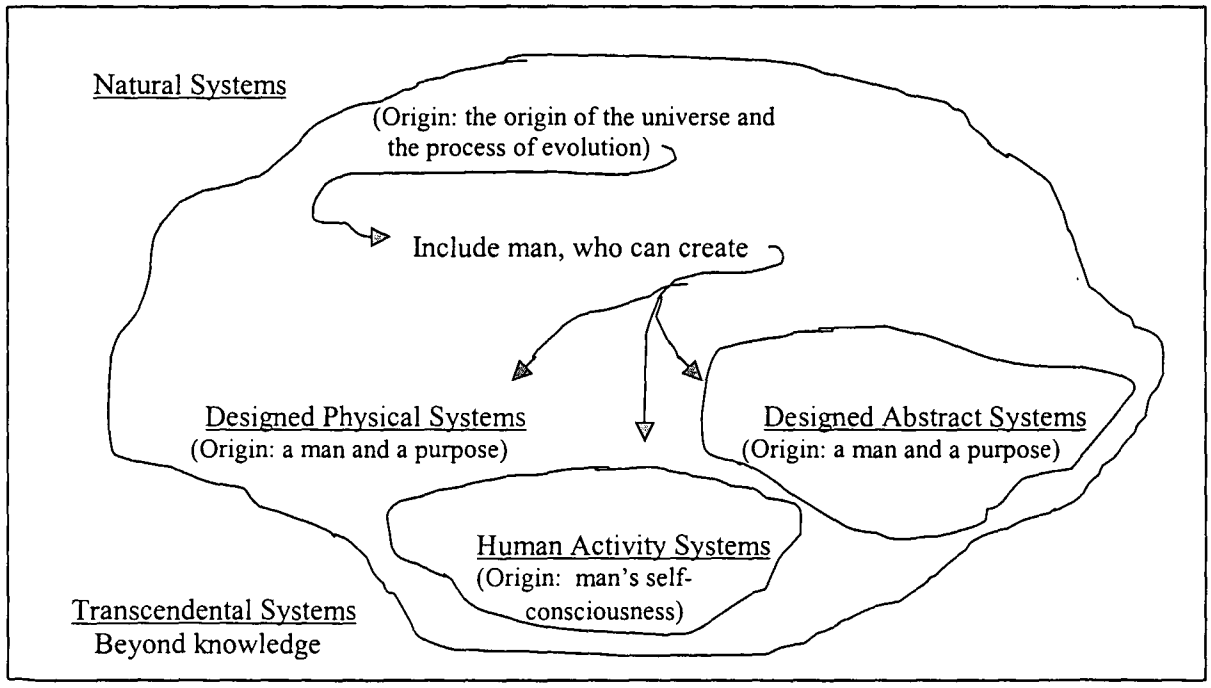


Figure 3.2: Five classes that make up a system map of the universe (Checkland, 1981).

Like the general system illustrated in Figure 3.1, these systems also consists of elements and relationships between the elements. Natural systems have much to teach us concerning "wholeness," the one being that, which have been shown to be viable through the course of evolution. One can therefore investigate, describe and learn, from natural systems. Designed

systems are available (or created) to help us, in the form of both physical artefacts and formal abstractions helpful to the thinking process. One can create and use designed systems. Human activity systems constitute the social arena in which real world problems are perceived, or appear, or disappear. Beyond natural, designed physical, designed abstract, and human activity systems there has to be a category to include systems beyond knowledge. These systems are termed transcendental systems. When systems thinking is applied to human activity systems, it is based on four basic ideas: emergence, hierarchy, communication, and control as characteristics of systems. However, when applied to natural systems or designed systems, the crucial characteristic is the emergent properties of the whole (Checkland, 1999).

3.1.3 Some Notions in Systems Thinking

Systems thinking is a scientific method of examining the world and solving problems. This approach has been developed over several decades and is employed in the physical and biological sciences, applied technology, computer sciences, game theory, management sciences and philosophy. It embraces complexity, shuns reductionism, and seeks meaning in the relationships of the systems it studies. The basic tenants of systems thinking are (Checkland, 1989):

- **Emergence:** "The whole is greater than the sum of its parts." A winning football team is not always a collection of the best players. Certain properties emerge because of the relationships and interactions between components, parts, elements or subsystems.

- **Hierarchy:** "Hierarchy" is the concept that each system consists of other subsystems and is only a component in a larger system. The human brain is an extremely complex system that consists of similarly complex cells, which consist of complex organic molecules, which consist of atoms, etc. The brain is also a subsystem of the even more complex human body, which is a subsystem of numerous human social units (family, nation, culture, etc.), which are a part of the animal kingdom, etc.

- **Control:** "Control" is the idea that a system maintains its identity (boundaries) in a changing environment by controlling its contact with other systems. Cells have

cell walls, humans have skin, buildings have walls, organizations have rules and laws, etc. If the system is unable to control its boundaries, it ceases to exist and becomes a new system. The boy scouts are the "boy" scouts because they exclude girls. If they lost the ability to exclude girls they would be a different organization, a new system.

- **Communication:** The transfer of information between systems is communication. A system is aware if it recognizes the existence of other systems, both bigger and smaller than itself.

- **Evolution:** Systems evolve (change) over time. The environment selects for the most "fit" systems when unfit systems die or fail to reproduce. This law of nature is as true for organizations as organisms – evolve or die.

Systems thinking is predicated on a philosophy that the boundaries that humans draw between systems are largely arbitrary constructs and can be redrawn to suit our needs. Changing the boundaries of a system also changes its relationships with other systems, allowing new properties to emerge. This mind-set makes systems thinkers very creative and hopeful about the ability of humans to solve their problems. A brief discussion of the aspects that characterize systems approaches as distinct from regular scientific inquiry follows.

Systems approaches concern is to aid solving problems, whether the problems concerns performance increase of production in a company, optimization of water supply in some third world country, design of new business processes, or managing the ozone whole, etc. The notion of a problem as such implies a distinction of two positions: *what is* and *what ought to be* (Simon, 1976a), therefore systems approaches occupy a fundamentally different epistemological position than the natural sciences. Science as such, and especially natural sciences, postulates production of objective, value-free knowledge that is descriptive and eventually explanative founded on the deterministic hypothesis. This is, the notion of systems approaches implies not only a description but also prescription for human affairs, whether they are business or public, technological, economical, political, or other (Ackoff, 1973, Checkland, 1976, Eriksson, 1998).

These approaches imply a mode of not only descriptive logic but also imperative logic, which generates *ought* for the systems' decision-makers. The following distinction between science and systems approaches are highlighted by Ackoff (1973), Checkland (1976) and Churchman (1979b):

- Science as such is fundamentally concerned with production of knowledge of human experiences for its own sake. Systems approaches are occupied also with prescribing how these experiences ought to be in order to help humans in managing their problems; hence designing our environments, organizations, societies, and therefore our life.

- A second observation is that systems approaches have, to a various extent, an explicit ethical position. This actualizes the importance of the particular system of values that is inherent in the various systems approaches, as well as, in the problem-solvers and decision-makers.

- A third important distinction is that science studies phenomena from a particular theoretical perspective, such as: physical, chemical, biological, psychological, social, etc., with a notorious lack of interaction with other disciplines. Systems approaches do not limit themselves to some *a priori* defined borders of disciplines. They rather seek to produce knowledge that is necessary for the faced problem, whether it requires knowledge classified as nuclear physics and psychology, software engineering and cultural anthropology, or business administration and arts. Systems approaches are not supposed to worry about the disciplinary borders since they need to be non-disciplinary; rather they need to be problem-oriented.

Churchman (1979b: 12-13) articulated the above distinction as follows: "I had come to realize that there are two 'sciences': the one represented by the collection of the disciplines, and the other by the systems approach. The first contains a collection of ideas about methodology and is essentially isolated by its disciplinary politics. The other is an attempt to engage in those areas of inquiry which are most relevant to the social good." He provides the following definition of systems approach: "On the broadest level, the systems approach belongs to a whole class of approaches to

> managing and planning our human affairs with the intent that we as a living species conduct ourselves properly in this world. Everyone adopts at least one such approach during her/his life, even if he/she is a recluse, an agnostic, a nihilist." (Churchman 1979b: 8) An approach in this context includes the theories, methodologies, methods and techniques that provide support for problem-management.

Finally, an important distinction between traditional sciences and *systems approaches* is that necessarily the latter *implies some intervention*, while the former limits itself to knowledge production. Hence, the investigation of what is and what ought to be is followed by some actual implementation of the design in order to reach the desired goals. This implies that the knowledge produced is, at least to some extent, praxis oriented.

3.1.4 The Complexity of Systems

A complex system is commonly understood as any system consisting of a large number of interacting components (agents, processes, etc.) whose aggregate activity is non-linear (not derivable from the summations of the activity of individual components), and typically exhibits hierarchical self-organization under selective pressures (Joslyn and Rocha, 2000). In such systems, the whole is more than the sum of the parts, more in a pragmatic sense than in a metaphysical sense (Simon, 1962).

Complexity frequently takes the form of a hierarchy that is a complex system is composed of subsystems and each subsystem may have their own subsystems. An authority relation to the system it belongs to subordinates each subsystem. Subsystems in each level of the hierarchy are subordinate and provide input to the level above it and finally to the root of the hierarchy, which represents the whole. In the systems sense, it may also be necessary to include subsystems in this category where there is no relation of subordination among subsystems. According to Simon (1962) hierarchical systems are frequently encountered in social systems (family, educational institutions, governments, business organisations etc.), biological systems (plants, humans, animals, etc.), physical systems (satellites, planets, galaxies, etc.), and symbolic systems (books, music, pictorial art, etc.).

In hierarchic systems it is possible to distinguish between the interactions among the subsystems, and within the subsystems. The interactions at the different levels may be of

different orders of magnitudes. The short run behaviour of each of the component subsystems is approximately independent of the short run behaviour of the other component in a nearly decomposable system. In the long run, the behaviour of any one of the components depends in only an aggregate way on the behaviour of the other components. Empirically, a large proportion of complex systems exhibit a hierarchic structure. On theoretical grounds, one could expect complex systems to be hierarchies in a world in which complexity had to evolve from simplicity (Simon, 1962). Although our brain certainly is one of the most complex devices ever invented by God, human beings strive to simplify their perception of the world – we create our individual mental maps. In fact, without simplistic models that help us navigate through the world, we would be lost, and in most cases our models do work.

3.1.5 The Use of Hierarchical Approaches in Problem Formulation of Complex Systems

Quite often, a decision problem consists of a plethora of interrelated factors and attributes. In such cases, the number of factors and their mutual relations increase beyond the ability of the decision-maker to comprehend distinct pieces of information (Saaty and Vargas, 1994). Decision-makers are able to structure a complex decision problem with the aid of the hierarchical approach thereby making decision elements and their relationships more visible (Liao, 1998). According to Saaty and Vargas (1994), a hierarchy is a particular type of system, which is based on the assumption that the elements influencing the decision problem can be grouped into disjoint sets. The elements of one group (level) influence only the elements of one other group, and are themselves affected by the elements of only one other group. The elements in each hierarchical level are assumed to be independent (Saaty and Vargas, 1994). These authors observed that the main aim of a hierarchy is to understand the goal (the highest level in a hierarchy) based on the interactions of the various levels, rather than directly from the elements of the levels. Hierarchical representations of a decision problem have several advantages (Saaty and Vargas, 1994):

- They can be used to describe how changes in the priority of higher levels affect the priority of criteria in the lower levels.

- They provide a large amount of information on the structure and function of the system in the lower levels. An overview of the actors and their objectives are provided for in the upper levels.

- Natural systems constructed as a hierarchy evolve more efficiently than those assembled as a whole.

- These systems are stable and flexible: Stable because small changes in the decision have small effects on the outcome, and flexible because any additional criteria added to a well-structured hierarchy does not affect its performance.

A method that is used to investigate "messy" and complex problems should have the ability to simulate its hierarchical nature. The multi-criteria hierarchical representation of the real - world allows the decision problem to be viewed within a larger environmental, organisational and political context. The interrelationships between the various criteria that affect the decision problem are also better represented by hierarchical multi-criteria models. According to Liao (1998), both a systems approach and a hierarchical approach have long been used in dealing with complicated decision-making problems.

3.1.6 An Analysis using Complexity Thinking

It is important to distinguish between complexity and complex systems. The notions are qualitatively different. A complex system refers to the properties of a system and how that system is different from simple systems, whereas complexity refers to a state of being complex, usually some subjective or interpretative understanding of the world which is too complicated and varied for us to understand in traditional or common ways (Phelan, 1999). Ashby (1956) stated that complex systems are so dynamic and interconnected that the alleviation of one factor immediately acts as cause to evolve alleviation of others.

Although much of the research on complexity refers to biological and physical systems, there are many making links between the behaviour of such systems and social systems (White, 2001). Gell-Mann (1994) suggests that social systems, such as organisations, can be seen as complex systems that have evolved together with its evolving component parts in order to survive or dominate. Kauffman (1991) suggests that social systems, just like other complex systems, can also behave counter-intuitively to chaos where some very disordered systems spontaneously "crystallize" into higher degree of order.

Holland (1995) identified four properties, which he considers common to all complex systems:

- **Aggregation:** Complex systems can be grouped into categories that can then be nested into larger aggregates. For example, a human being is a complex system, but also acts as an agent in a larger complex adaptive system (the organisation), which forms part of a still larger complex adaptive system (the economy), and so on.
- **Non-linearity:** A given action can lead to several possible outcomes, some of which are disproportionate in size to the action itself. Through multiple interactions, organisations are capable of many responses that are complex and unpredictable, leading to many outcomes.
- **Flows:** Networks and nodes connect the agents of complex systems in a non-linear way. Thus they can give rise to "flows" that can lead to two phenomena: "multiplier effects" which occur through the interlinked systems, and "recycling effects". The notion of a network can be used to understand complex systems.
- **Diversity:** In complex systems there are wide variations and differences in their structure and specifications.

Holland (1995) also notes three mechanisms by which complex systems operate:

- **Tagging:** This is the mechanism by which individuals/organisations can distinguish boundaries among complex systems (for example national flags among countries).
- **Internal models:** Adaptive agents learn over time to anticipate some of the results of their actions. They do this through a set of rules or guidelines they use to recognise patterns, make decisions and adapt over time.
- **Building blocks:** Individuals/organisations have the ability to decompose complex phenomena into parts, which can be assembled and reassembled in different ways to deal with everyday situations or to improve internal models. The blocks can be arranged in interconnected networks that may lead to an array of possibilities.

The success of a project or an organization is influenced by a number of factors. In each case, it is possible to identify at least a dozen such factors, but there are many others of subordinate and partially not identifiable variables, which influence each other. All processes of a system (like an organization, group, project, society, etc.) are principally dynamic and can only be

influenced in a systemic context. It is not possible to foresee all effects and relations between the factors. For example, 12 variables result in 66 linear and 220 triangular relations, as is shown in Figure 3.3 (Linstone, 1984).

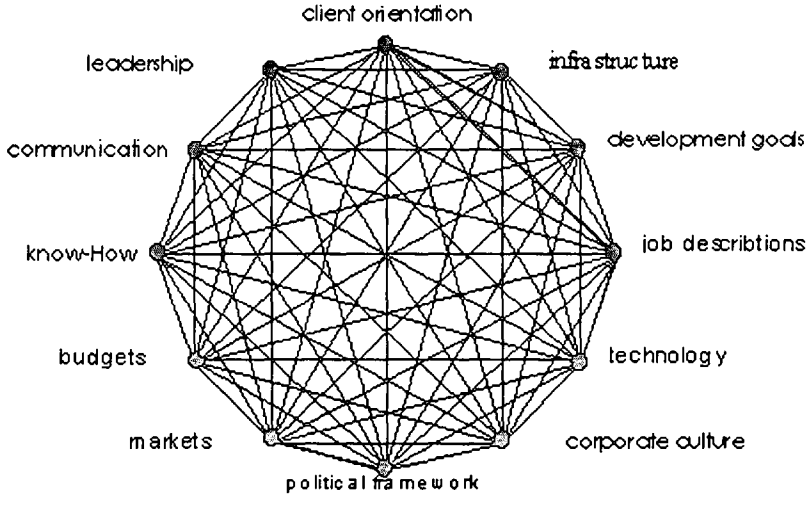


Figure 3.3: Twelve variables result in 66 linear and 220 triangular relations (Linstone, 1984).

However, there may be a number of other variables that will result in even a greater number of linear and triangular relations. To elaborate a planning base that facilitates sustainable growth the most important factors must be identified and arranged in a context that considers systemic effects. In such a complex environment, linear planning tools loose their effectiveness. The next section examines the nature and complexity of socio-technical systems.

3.2 SOCIO-TECHNICAL SYSTEMS AND THEIR COMPLEXITY

3.2.1 Socio-Technical Systems Theory

Socio-Technical Systems Theory (STST) has been widely mentioned and applied in the domain of information systems implementation (Eason, 1988; Mumford and Henshall, 1979). Dillon and Morris (1996) argue that the term STST is now generally applied to many user-centred orientations to design and implementation. Unlike the pragmatism of usability engineering which aims to support the design of technologies that are compatible with users'

abilities and needs, STST posits underlying drives and motivations to use tools that supersede concerns with effectiveness and efficiency alone (Coakes, 2000).

Leavitt (1964) claims that many organisation theories concentrate on improving performance in one aspect (usually the task) by the manipulation of a second aspect. This may be the structure (classical organisation theory), the technology (scientific management) or the people (human relations approaches). The remaining aspects are often ignored, but contribute to unforeseen and often counterproductive outcomes. The socio-technical approach emphasises simultaneous consideration of several aspects. For example, while still undertaking the same task, we may attempt to improve the welfare of the people by using an appropriate technology in a suitable organisation structure. In some cases, with a flexible technology, we may even suggest changing the task with a view to "improving" the structure and the condition of the people (Cooley, 1980).

A true socio-technical approach should attempt to consider all four aspects simultaneously. This could be rather difficult and somewhat confusing. Mumford and Weir (1979) have produced a method of computer system design based on the socio-technical concept. This method (the ETHICS method) suggests the separate generation of technical alternatives (matching the task and technology) and social alternatives (matching people and structure). These alternatives are then matched to produce "socio-technical alternatives", which are then evaluated against both social and technical objectives. This approach at least takes into account the needs of the people in the system, but still poses the problem of setting objectives and the risk that the technical objectives may remain dominant.

In a review of the theories of models that seek to predict user acceptance of new technologies, Dillon and Morris (1996) noted that the term "socio-technical" has become widely applied to a mix of theoretical positions that do not all share the original psychodynamic views of socio-technical thinkers. In current usage, STST is interpreted as referring to almost any view of user acceptance or resistance that emphasises the role of the organizational context in shaping technology use, thus blurring the historical distinctions between structuralist, human relations and open systems approaches.

3.2.2 The Nature of Socio-Technical Systems

Warfield (1994), suggests that a technological system may be partitioned into three classes:

- Members that operate on principles established in the physical sciences such as the basic radio, telephone, the internal combustion engine and telephone lines – either wire or wireless.
- Members that are referred to as "intellectual technology" such as telecommunications software, literature about the software and routing algorithms.
- A mix of elements from the above two classes. The satisfactory outputs of this system will depend on the appropriate integration of these elements into synergistic units. Examples of such systems are telecommunications network management systems, decision support systems and a telephone exchange.

Socio-technical systems are regarded as a mix of the classes of the technological system and people. The outputs of socio-technical systems largely depend on the synergistic interaction between the technological aspects and the social aspects. It is therefore concerned with the blending of the social and technical systems of an organisation (Warfield, 1994). The term socio-technical systems reflects the goal of integrating the social requirements and the technical requirements needed to keep the systems viable with regard to their environment and the organisation (Emery and Trist, 1973; Trist, 1981). Socio-technical system (STS) theorists define two dimensions in relationship to a third: the people to organisation relationship as the social dimension, and the technology to organisation relationship as the technological dimension (Figure 3.4).

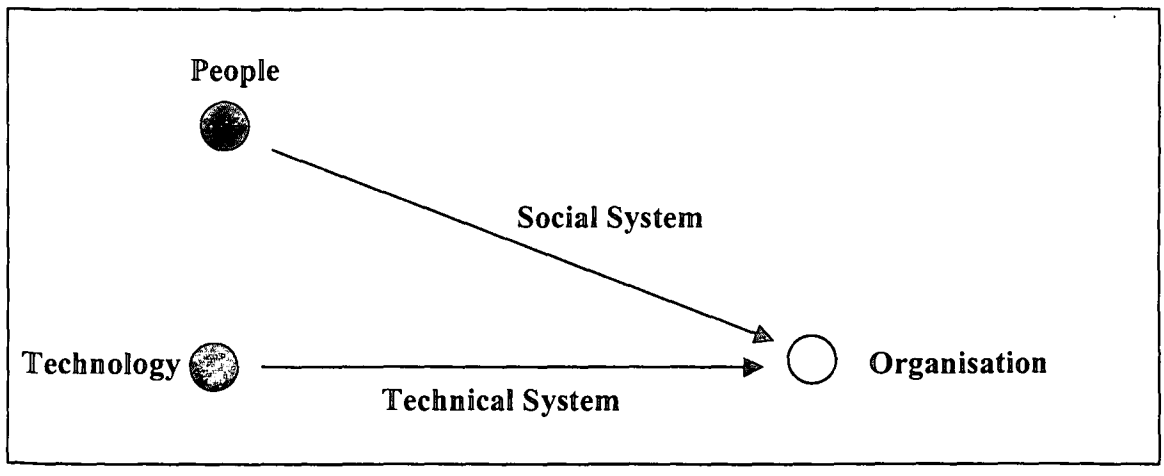


Figure 3.4: Socio-technical system (STS), the traditional model (Fox, 1995).

However, in many research areas where interdisciplinarity is a must, the systems approach is being referred to in a number of terms: human-centred, anthropocentric, balanced, work-oriented, computer and human integrated, symbiotic, techno-organizational and socio-technical design (Badham, 1995). We are concerned with the socio-technical systems approach as a rather broad term which includes Information and Communications Technology (ICT) with organizational and social concerns, as well as interdisciplinary Research and Development (R and D) aiming at the organizational and social development through telecommunications and information technology. However, the socio-technical systems (STS's) theory, being the root and the inspiration for most of the current approaches to joint technical and organizational design, has brought about a wide dissemination of the term "socio-technical". The term socio-technical is used as an "umbrella" under which a set of methods, concepts, guidelines and empirical findings are put together and applied to generate new research findings (Badham, 1995).

Pentland (1996) views the system as having three discrete, interactive components or subsystems: individuals (the human dimension, organisations (the social dimension), and technology (the technological dimension). She extended the traditional STS (Figure 3.4) so that there is a dynamic relationship between each of the three components of STS, not just two new system components in relation to the third. A third system emerged from Pentland's new system view, a new dynamic framework having three discrete, dynamic subsystems: people, organisation, and technology, each interacting with one another and all embedded in a larger system, the complex external environment (Pentland, 1996). This gives a new dimension to socio-technical systems (Figure 3.5). The third subsystem represents the relationship between technology and people, for example Information and Communication Technology (ICT), more specifically, the Internet. Rural telecommunications infrastructure is part of ICT and as such has implications for its evaluation.

Currently, broad based socio-technical approaches tend to deal with issues at one level of abstraction (the group, the organization) while usability professionals deal with another (the user, the interface). If coupled appropriately, these could offer richer insights and practices for all systems design and implementation projects (Coakes, 2000). The socio-technical approach places greater emphasis on the participation of stakeholders, and the evolution of a planned implementation strategy. The examination, therefore, of the nature of both

approaches and the practical means of utilising both appropriately is relevant when evaluating technological infrastructure.

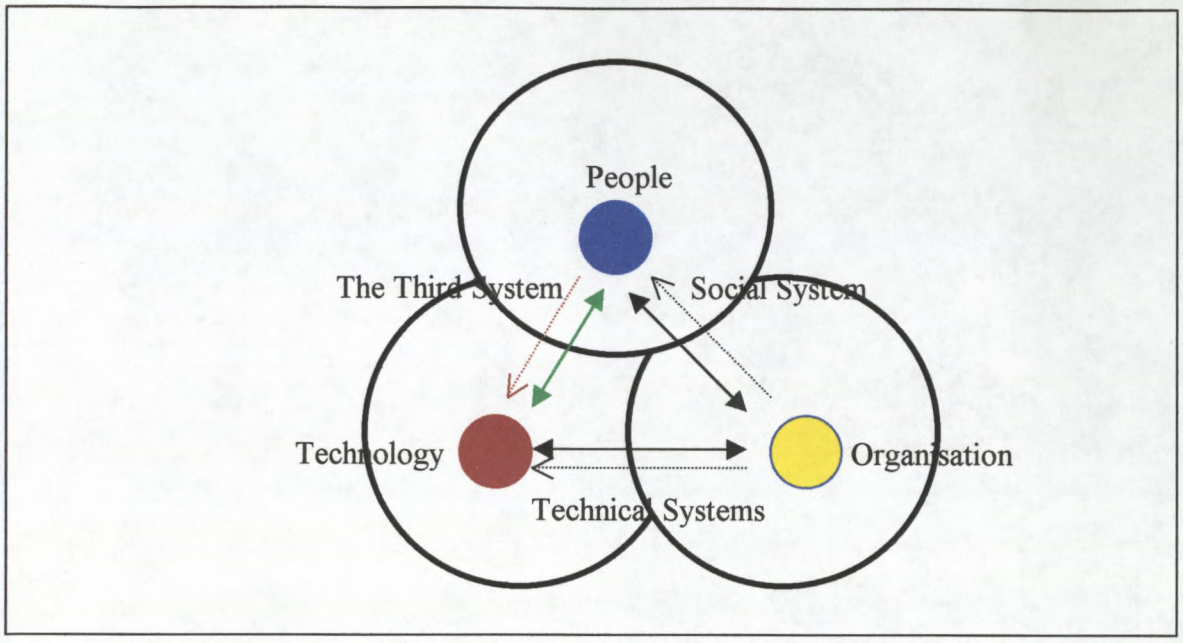


Figure 3.5: Socio-technical systems (STS), a new systems view: three systems relationships in one embedded in an environment of chaos and complexity (Pentland, 1996).

It has been often found that the best intentions in the construction of human and organizational oriented technological systems are rapidly superseded by hindering management practices, political and strategic issues and limited views and attitudes. Therefore, focused tools, whose aim is to help in the provision of technological infrastructutre, should be used in a social and organizational context calling for a socio-technical based methodology. Since a RTS is a socio-technical system, the evaluation of rural telecommunications infrastructure should also be based on socio-technical methodology. The next section examines the nature and complexity of rural telecommunication systems in the context of a socio-techical system.

3.3 THE NATURE AND COMPLEXITY OF RURAL TELECOMMUNICATIONS SYSTEMS

The complexity of the world and of social and technological systems is increasing at an indescribable speed (Bierter, 1992). Since 1984, researchers at the Santa Fé Institute tried to find common principles of chaos and order, which can be applied to economical, biological and social systems (Waldrop, 1992). Most projects of technical or financial assistance have

reached a level of complexity, which hardly can be understood or managed by traditional means. This becomes particularly evident in so-called integrated rural development projects. These are programmes that tend to influence the entire social and economic setting of the project region. They often concentrate on increasing productivity of agriculture, and by the same time provide inputs to create off-farm employment generation, improve health and social systems, education, environment.

The provision and/or improvement of rural telecommunications infrastructure is part of integrated development which operates in a complex environment. A rural telecommunications system (RTS) can be viewed as having three discrete interactive components: The technological system (the telecommunications network), the society (the rural community for whom the telecommunication service is intended), and the organisations (the telecommunications service provider, investors, regulatory body, local/provincial/national government). These systems interact with economic, environmental and other parallel infrastructures. There is need for synergistic interdependence among these interactive components (Warfield, 1994) in order to realise the emergent properties that is embedded in the complex RTS.

In order to address the "mess" in socio-technical systems in general, and rural telecommunications system in particular, a new organisation of scientific and organisational effort is required. In socio-technical systems this need was taken in the form of multidisciplinary research. The problems were decomposed into uni-disciplinary and uni-professional problems that were taken to be solvable independent of each other (Ackoff, 1973). However, with the emergence of systems thinking, it was realised that the effect of multidisciplinary research on the treatment of the whole was not necessarily the best that could be achieved. This realisation gave rise to interdisciplinary research, in which the problem was not disassembled into disciplinary parts, but was treated as a whole.

What implications does this have in terms of evaluating rural telecommunications infrastructure? Firstly, rural telecommunications infrastructure should not be examined in isolation, independent of the other subsystems. Secondly, the provision of telecommunications infrastructure is not in itself sufficient for the success of a rural telecommunication system because the emergent properties are dependent on the synergy

that exist among the different subsystems involved. It is therefore necessary to take the following into account when evaluating rural telecommunications infrastructure:

- The development and usage of telecommunications infrastructure cannot be fully understood and evaluated without understanding the interactions and relationships among the different subsystems.

- The relationship between telecommunications and rural development can only be fully understood if there is a realisation that rural telecommunications does not operate in a vacuum but in close cooperation with other parallel infrastructures and communities it serves.

- The availability or lack of basic parallel infrastructures such as, power, water, and reasonable transport infrastructure have a significant impact on socio-economic benefits of rural telecommunications.

- The evaluation of rural telecommunications infrastructure requires, *inter alia*, societal intervention, and since societies reflect a multiplicity and diversity of values and goals, the intervention should confront these realities.

- The political stability and the existing regulatory policies also have a major impact on the provision of telecommunications infrastructure.

- A rural telecommunication system is characterised by non-linearity, where a given action can lead to several possible outcomes, some of which are disproportionate in size to the action itself.

- A rural telecommunications system is a complex system and as such, the evaluation of telecommunications infrastructure in rural areas is complex and messy.

A framework for the evaluation of RTS should therefore focus on: non-linear relationships rather than linear ones, dynamic systems rather than stable ones (Begum, 1994), and since societal intervention is invariably systemic in nature, a more holistic approach should be followed. Senge (1990) suggested that systems thinking is a discipline for seeing wholes and

looking at interrelationships rather than linear cause-effect chains. Since there are a number of different stakeholders and multiple criteria involved in a RTS, it is also necessary to consider multiple perspectives of the relevant stakeholders involved and also to consider multiple criteria in the design of a framework for evaluation. The next section consider the need for multiple perspectives and the following sections considers the need for multiple criteria decision analysis in the evaluation of rural telecommunications infrastructure.

3.4 THE NEED FOR MULTIPLE PERSPECTIVES IN EVALUATION OF RURAL TELECOMMUNICATIONS INFRASTRUCTURE

Mitroff and Linstone (1993) identified three most typical perspectives in addressing complex problems: T is the Technical Perspective; O is the Organizational or Societal Perspective; and P is the Personal or Individual Perspective. According to Mitroff and Linstone (1993: 98) "each perspective reveals insights about a problem that are not obtainable in principle from the others." Given three (or more) different and potentially conflicting perspectives on a problem, one inherent concern in using the multiple viewpoints concept is the integration of different perspectives.

Using the multiple perspectives approach to formulate a "messy" or "wicked" problem, it is necessary to understand the problem from every possible participant's personal perspective (Ackoff, 1973). Personal perspectives are, however, often ignored when the problem is formulated from the organizational perspective that emerges from "dominant" perspectives of powerful individuals or groups. From the technical perspective, traditionally a problem is formulated objectively and quantitatively, often disregarding human and organizational factors. So to formulate a messy problem from the multiple perspectives approach, it is critical to minimize the gaps between perspectives (Mitroff and Linstone (1993)). This is crucial, especially in the case of rural development, where the community perspective cannot be ignored or be regarded as being less important.

The multiplicity of perspectives is vital, but how does one integrate perspectives? According to Mitroff and Linstone (1993), there is no neat scientific or technical methodology to integrate perspectives. Most executives wrestle with the initial selection of perspectives and their integration. They provide the following guidelines in applying multiple perspectives:

strive for a balance among technical, organisational, and personal perspectives; use "good" judgement in selecting perspectives; in obtaining information, it is necessary to recognise that organisational and personal perspectives require greatly different methods than technical perspectives; pay particular attention to the mutual impact, interdependencies, and integration of perspectives; and beware of thinking statically in a dynamic environment.

It is important to consider the above guidelines when developing the proposed holistic framework for the evaluation of rural telecommunications infrastructure.

3.5 THE NEED FOR MULTIPLE CRITERIA DECISION ANALYSIS IN THE EVALUATION OF RURAL TELECOMMUNICATIONS INFRASTRUCTURE

3.5.1 Multi-Criteria Decision Analysis and Multi-Criteria Decision-Making

The research into quantitative decision-making has made significant progress within recent years (Banville *et al.*, 1998). According to these authors, this stemmed from a transition in decision theory based on single criterion decisions to a decision support science which has, as its focus, more realistic situations involving several decision-makers, which makes the process much more complex. Thus, choices are often based on multiple, and often conflicting, criteria. The evaluation of rural telecommunication infrastructure also involves several decision-makers and multiple conflicting criteria.

The breakdown of traditional approaches to the study of single criterion decisions (undertaken by one person in one place and time) provided the motivation for multi-criteria approaches to decision-making (Banville *et al.*, 1998). Although an individual decision-making problem normally includes only one specific decision-making task, multiple criteria and multiple alternatives have to be considered (Liao, 1998). This author observes that a number of interrelated decision-making tasks need to be addressed simultaneously, in complex decision-making, to reach an overall objective. "Complex decision-making can therefore be structured as an integrated decision-making process which involves at least: identifying multiple tasks and chain effects, assessing environmental influences and

determining multiple criteria, and evaluating multiple alternatives" (Liao, 1998). Thus, the development of Multi-criteria Decision Making (MCDM) techniques originated from the recognition of the multi-criteria nature of managerial decision tasks as well as the increasing power and accessibility of computers (Kotteman and Davis, 1990).

Multi-criteria decision-making is a human managerial task, which cannot be automated by tools, techniques or algorithms (Stewart, 1992). The aim of MCDM techniques is to guide the decision-maker in determining the course of action that best achieves the long-term goals, by providing the decision-maker with some measure of consistency during the decision-maker's search for solutions to a problems situation (Stewart, 1992). MCDM methods may be used within two contexts namely, (1) when the decision-maker (who can be represented by a single individual or an essentially homogenous group) undertakes a decision that does not require justification to other parties; and (2) when the decision-maker (individual or group) has to make decisions on behalf of a much larger group or community (for example in government organisations). In the former scenario, the methods can be relatively informal whereas, in the latter case, the rationale for choices has to be clearly documented and the decisions justified. This necessitates the need for a more formal method of analysis, even when these may be less efficient and/or may impose structures (for example rationality), which may not be strictly justifiable (Stewart, 1992).

Thus, Stewart (1992) argues that the context of the particular decision situation needs to be considered before selecting a particular MCDM method. According to this author, a distinction between methods in this context is that between "prior" and "progressive/interactive" articulation of preferences. Methods of prior articulation of preferences require the decision-maker to specify value judgements in isolation from the particular choices available which are then translated into a particular choice/s consistent with these preferences (Stewart, 1992). This approach suits contexts where justification and rationale are prerequisites. Progressive or interactive articulation of preference methods explores the decision problem systematically, with no need for the decision-maker to specify prior preferences. Although this method is more efficient and demands less "sweeping assumptions" regarding preference structures, it is however vulnerable to manipulation by skilled users and is therefore not very defensible when solutions need to be justified or rationalised (Stewart, 1992).

3.5.2 Classification of MCDM Approaches

There are many approaches within the field of MCDM, and there is no uniform classification of them (see Henig and Buchanan, 1996; Lai and Hwang, 1994). The latter authors provide a broad classification of the field into " two categories:

- Multiple Attribute Decision Making (MADM): MADM is associated with problems whose number of alternatives has been predetermined. The decision-maker is to select/prioritise/rank a finite number of courses of action. Some authors, like Lootsma (1996), use term Multicriteria Decision Analysis (MCDA) instead of MADM, probably to indicate its links to classical decision analysis, similarly to Henig and Buchanan (1996).

- Multiple Objective Decision-Making (MODM): MODM is not associated with problems in which alternatives have been predetermined. The decision-maker's primary concern is to design a most promising alternative with respect to limited resources".

Lootsma (1996) observes that MCDA is at the stage of formation of the following schools:

- Multi Attribute Utility Theory (MAUT);
- Analytic Hierarchy Process (AHP); and the
- Outranking (French) schools

He warns that the current situation can be portrayed as a state of lack of a generally accepted paradigm in a discipline following Kuhn's theory of scientific paradigms. He therefore states that besides the signs of formation of these schools, "we still do not have a shared view on how human preference and human value judgements should be modelled" (Lootsma, 1996: 37). A brief analysis of the literature of these three schools indicates very little evidence for attempts to integrate ideas from various schools, with the possible exception of Costa *et al* (1995). These authors state that two steps are evident in any decision-making process, which is "based upon the concept of prior articulation of preferences:

- The construction of a criterion model for each fundamental point of view, that is an evaluation model that formally represents the partial preferences of some evaluator(s) according to a single point of view;
- The application and exploration of a multicriteria aggregation procedure that brings together the various criteria into an overall evaluation model, taking into consideration the available information on the nature of preferences between viewpoints" (Costa *et al.*, 1995: 266).

The same authors observe that the notion of preference is made operational by quite dissimilar mathematical representations in each approach:

- in a multi attribute value measurement framework one builds value functions based on the concept of relative strength of preference;
- in multi attribute utility measurement these strengths of preference are closely linked to the concept of risk preference;
- in the AHP these preferences are expressed as priorities;
- in the outranking approach pseudo-criteria are constructed on the basis of the credibility of statements such as "action *a* is at least as good as action *b*".

In the first two cases above, measurable value and utility functions use interval scales; in AHP a decision-maker is asked to express his judgements using a ratio scale, capturing a ratio of priorities; while in the last case absolute scales are used. The next section provides a brief overview of MCDA methods.

3.5.3 Some Comparative Remarks on MCDA Methods

When comparing various MCDA methods, Olson *et al.* (1996) state that the increase in criteria means also an increase in the comparisons required in AHP to a greater extent than in other methods. According to the same authors, AHP was considered easy to understand, with the exception of eigenvalue calculations. Olson *et al.* (1996) found in their comparative analysis of various MCDM approaches that MAUT was cognitively more difficult to understand, while SMART, which belongs to the group of MAVT approaches, was very easy to understand and use. They consider that the accuracy of all methods would be suspect with more criteria being involved in a problem.

Sarin (1992: 160) states that some empirical tests of assumptions of expected utility theory have caused some doubts about the foundational assumptions of that theory, but also a much better understanding of both normative and descriptive decision-making. However, it seems that the conclusions by Olson *et al.* (1996) have a greater direct value for the practice of decision-making. With respect to ease of use SMART and AHP seem to be more preferable. The conclusion regarding SMART is linked to the fact that there is generally a tendency these days for more wide acceptance within the Utility Theory school of Multi Attribute Value Theory, which is a simplified version of MAUT, as it does not seek the decision-maker's attitude to risk (Belton, 1999).

Keeney (1992) considers that MAUT, with some operational assumptions, is an excellent candidate for a prescriptive decision theory. However, he does not provide any evidence that users of MAUT easily understand lotteries and probabilities. Early work with MAVT software, VISA, indicated that decision-makers responded positively to the visual interactive implementation of the model (Belton, 1993). Salo and Hamalainen (1997: 309) state that the AHP has been very successful in gaining the acceptance of practitioners, possibly owing to the helpfulness of the hierarchical problem representations and the appeal of pairwise comparisons in preference elicitation. Many applications of AHP are reported in Saaty (1994) and elsewhere. Schoemaker and Waid (1982), after an experimental comparison of five different techniques for determining weights in additive utility models, have found that AHP was perceived as the easiest to use and the most trustworthy of the models tested.

The above analysis seems to show that the AHP has features which make it a better approach for MCDA from a prescriptive point of view. The next section examines the possible application of AHP in the evaluation of rural telecommunications infrastructure and provides a brief overview of AHP. The evaluation of rural telecommunication infrastructure is complex and involves multiple criteria. AHP provides a framework that supports multi-criteria decision-making. The ability to structure a complex problem and then focus attention on individual components amplifies decision-making.

The Analytic Hierarchy Process (AHP) was initially developed by Saaty as a multicriteria decision support technique in the seventies (Saaty, 1990a). AHP focuses on the choice phase of Simon's model of decision-making (Dyer and Forman, 1992: 100). Similarly, initially

MAVT also focused on the same phase. However, the past twelve years have seen some interest in the problem structuring of complex problems, though there are very few accounts of that in the literature. The Analytic Hierarchy Process has been widely applied as a multicriteria decision-making approach in industry, government and academic institutions (see Saaty, 1990a). AHP allows decision-makers to structure a complex problem that involves subjective criteria as a decision hierarchy. For more information, one may draw on the formal definitions and the richness of examples in (Saaty, 1990a). An overview of the AHP procedure is provided in Appendix B.

Theoretically, multiple criteria decision analysis (MCDA) represent progress in overcoming the single criterion barrier that often portrays the field of decision support incorrectly. In practice, however, their penetration is quite limited (Banville, *et. al.*, 1988). These authors ascribe that to the following factors: restrictions of this method in formulating the problem; the complexity of the technical aids; and the limited role the decision-maker plays with regard to responding to questions posed by the technical experts who operate the models. Kotteman and Davis (1990) further elaborate on the practical difficulties of using MCDAs. According to these authors, MCDAs often assist decision-makers in formulating an exhaustive list of objectives and alternatives. Although such a broadening of the scope of the decision problem/s may be deemed desirable at the onset, it is also possible that decision-makers' "subjective impressions of decision quality" may be adversely affected due to increases in decisional conflict (Kotteman and Davis, 1990). Thus, despite the aid's positive influence on actual quality decisions, these negative impressions may well arise.

3.6 CONCLUSION

Following from this and the preceding chapters, a rural telecommunications system is a complex system. A framework for the evaluation of rural telecommunications infrastructure should therefore focus on: non-linear relationships rather than linear ones; dynamic systems rather than stable ones; and since societal intervention is invariably systemic in nature, a more holistic approach should be followed. Systems thinking is a discipline for seeing wholes and looking at interrelationships rather than linear cause-effect chains. Since there are a number of different stakeholders and multiple criteria involved in the evaluation and improvement of infrastructure of rural telecommunications systems, it is also necessary to

consider multiple perspectives of the relevant stakeholders involved and also to consider multiple criteria in the design of a framework for evaluation. However, the evaluation of such programmes still raises a series of methodological and operational questions. In order to develop a systemic framework for the evaluation of rural telecommunications infrastructure, it is necessary to use a holistic approach that takes into account multiple perspectives and multiple criteria. The next chapter examines evaluation approaches with a view of finding an appropriate methodology for the evaluation of rural telecommunications infrastructure and its impact on rural development.

Chapter 4

EVALUATION AS A TOOL FOR DECISION-MAKING AND POLICY FORMULATION

4.1 INTRODUCTION TO EVALUATION THEORY

Evaluation is a methodological area that is closely related to, but distinguishable from more traditional social research. Evaluation utilizes many of the same methodologies used in traditional social research, but because evaluation takes place within a political and organizational context, it requires group skills, management ability, political dexterity, sensitivity to multiple stakeholders and other skills that social research in general does not rely on as much (Trochim, 1999).

At the macro level, evaluation provides standards for performance assessment, by attesting to the effectiveness of public services and public expenditures and by "enlightening" opinion-makers, it forms part of the governance framework of society. At the micro level, evaluation is nested within organizations where agents and their principals seek to achieve private or public goals. In this case also, evaluation contributes to the incentives framework that aligns agents' preference functions with broader societal goals and by providing antidotes to opportunistic behavior and inducing organizational learning. Thus, evaluation is to the public sector what accounting and auditing are to the private sector (Weiss, 1998).

Probably the most frequently given definition is: Evaluation is the systematic assessment of the worth or merit of some object (Scriven, 1991). According to Trochim (1999) there are many types of evaluations that do not *necessarily* result in an assessment of worth or merit, for example, descriptive studies, implementation analyses, and formative evaluations. He prefers a definition that emphasizes the information-processing and feedback functions of evaluation. Therefore, according to Trochim, evaluation is the systematic acquisition and assessment of information to provide useful feedback about some object (Trochim, 1999). Both definitions agree that evaluation is a *systematic* endeavour and both use the deliberately ambiguous term "object" which could refer to a program, policy, technology, person, need, activity, and so on. The latter definition emphasizes *acquiring and assessing information* rather than *assessing worth or merit* because all evaluation work involves collecting and sifting through data, making judgements about the validity of the information and of inferences we derive from it, whether or not an assessment of worth or merit results.

The generic goal of most evaluations is to provide "useful feedback" to a variety of audiences including sponsors, donors, client-groups, administrators, staff, and other relevant

constituencies. Most often, feedback is perceived as "useful" if it aids in decision-making. But the relationship between an evaluation and its impact is not a simple one – studies that seem critical sometimes fail to influence short-term decisions, and studies that initially seem to have no influence can have a delayed impact when more congenial conditions arise. Despite this, there is broad consensus that the major goal of evaluation should be to influence decision-making or policy formulation through the provision of empirically driven feedback. Though Patton (1987) has identified 100 different types of evaluations, the most basic distinction between types is still the one Scriven drew in 1967 between: Formative evaluation - focus on actual process; and Summative evaluation – focus on final product. These two types of evaluation are discussed briefly.

Formative Evaluation: Formative evaluation strengthens or improves the object (program) by examining the delivery of the program or technology, the quality of its implementation and the assessment of the organizational context, personnel procedures and inputs. In formative evaluation, information can be transferred back into the original work to both strengthen and move it forward. It is an ongoing, fluid process, used to gauge overall progress and areas needing some attention or change. This category include:

- **Needs assessment:** Who needs the program or technology, how great is the need, and what might meet the need?
- **Evaluability assessment:** Is an evaluation feasible and, if so, who should be involved?
- **Structured conceptualisation:** Defines the program or technology, the target audience, and the possible outcomes.
- **Implementation evaluation:** Is the program or technology being correctly delivered?
- **Process evaluation:** Would the program or technology benefit from possible alternative delivery procedures?

Summative Evaluation: Summative evaluation is intended to examine the effects or outcomes of some object. In summative evaluation, the information is intended to give an overall picture at the end of a stage, often measured against fixed criteria. It provides a fixed point of reference and it may provide a measure of success. This category include:

- **Outcome evaluation:** Did the program or technology create any demonstrable effects on the specified target(s)?
- **Impact evaluation:** Did the program or technology create broader or unintended effects beyond the specific target(s)?
- **Cost-effectiveness evaluation:** What is the cost-benefit ratio of the program or technology?
- **Secondary analysis:** Uses new methods to analyze or ask new questions regarding previously collected data.
- **Meta-analysis:** Integrates the outcome estimates from multiple studies to arrive at overall conclusions.

Formative and summative evaluation can employ any evaluation strategy. The next section provides here the distinction between theory-based and non theory-based evaluation.

4.2 NON-THEORY BASED EVALUATION STRATEGIES

4.2.1 A Brief Overview of Four Evaluation Strategies

Evaluation strategies mean broad, overarching perspectives on evaluation. They encompass the most general groups or "camps" of evaluators; although, at its best, evaluation work borrows eclectically from the perspectives of all these camps. Four major groups of evaluation models or strategies are discussed below (Scriven, 1991; Patton, 1987; Guba and Lincoln, 1989):

- **Scientific/Experimental Models:** Scientific-experimental models are probably the most historically dominant evaluation strategies. Taking their values and methods from the sciences (especially the social sciences) they prioritize on the desirability of impartiality, accuracy, objectivity and the validity of the information generated. Included under scientific-experimental models would be: the tradition of experimental and quasi-experimental designs; objectives-based research that comes from education; econometrically oriented perspectives including cost-effectiveness and cost-benefit analysis; and the recent articulation of theory-driven evaluation.

Problems associated with Scientific/Experimental Models: The primary problem is that this approach focuses on defining the appropriate measures of input and output, but most cognitive and behavioural processes in human beings are "black box", and intervening variables may be more important than the supposed "treatment". For instance,. why don't improved automotive safety features reduce highway fatalities more? Why have several childhood diseases, once almost eradicated, returned as a national health problem? Why are teen-age girls the fastest-growing group of new smokers? Why don't more employees welcome performance appraisal reviews?

- **Management-Oriented Models**: Two of the most common of these are **PERT**, the Program Evaluation and Review Technique, and **CPM**, the Critical Path Method. Both have been widely used in business and government in this country. It would also be legitimate to include the Logical Framework or "Logframe" model developed at U.S. Agency for International Development and general systems theory and operations research approaches in this category. Two management-oriented models were originated by evaluators: the **UTOS** model where **U** stands for Units, **T** for Treatments, **O** for Observing Observations and **S** for Settings; and the **CIPP** model where the **C** stands for Context, the **I** for Input, the first **P** for Process and the second **P** for Product. These management-oriented models emphasize comprehensiveness in evaluation, placing evaluation within a larger framework of organizational activities.

Problems associated with Management-Oriented Models include: Difficulties with these models include the fact that the formally stated goals may be less important than secondary or even latent goals, as the situation changes; external evaluators may be seen as naive outsiders who can't really understand the situation, as spies, or as hatchet men doing the dirty work of pretending to collect data to support foregone conclusions about a particular program's value; internal evaluators may be seen as lacking the expert credentials of outside evaluators or as not being impartial, having been co-opted by interest groups inside the organization; these types of models are not necessarily open: it may privilege the status quo of established management rather than seeking the feedback of possible inside and outside stakeholders in situations where it may be relevant in today's turbulent environment.

- **Qualitative/Anthropological Models**: They emphasize the importance of observation, the need to retain the phenomenological quality of the evaluation context, and the value of subjective human interpretation in the evaluation process. Included in this category are the approaches known in evaluation as naturalistic or "Fourth Generation" evaluation; the various qualitative schools; critical theory and art criticism approaches; and, the "grounded theory" approach of Glaser and Strauss among others.*Problems associated with Qualitative/Anthropological Models include*: Difficulties with these models involve the subjective nature and lack of comparability of the evaluations; fairness may also be a problem, if the evaluator can't describe and defend the criteria being used to make evaluations; models very hard to generalize to other situations, although attempts have been made to provide "quality control" through the application of outside "auditing" principles.

- **Participant-Oriented Models:** As the term suggests, they emphasize the central importance of the evaluation participants, especially clients and users of the program or technology. Client-centred and stakeholder approaches are examples of participant-oriented models, as are consumer-oriented evaluation systems. These so-called "responsive models" focus on the claims, concerns, and issues of a variety of potential stakeholders: agents (implementers, funders), beneficiaries (included target groups), and victims (excluded target groups). Major exemplars of these models include: Parlett's Illuminative Evaluation, Wolf's Adversarial Evaluation.

  Problems associated with Participant-Oriented Evaluation: Difficulties may arise due to inability to reach consensus by this wider variety of stakeholders, disagreements about appropriate evaluation criteria, and finite limitations of resources.

With all of the evaluation strategies to choose from, how does one decide? Debates that rage within the evaluation profession are generally battles between the proponents of these different strategists, with each claiming the superiority of their position. In reality, most good evaluators are familiar with all four categories and borrow from each as the need arises. There is no inherent incompatibility between these broad strategies; each of them brings something valuable to the evaluation table. In fact, in recent years attention has increasingly turned to how one might integrate results from evaluations that use different strategies,

carried out from different perspectives, and using different methods. Clearly, there are no simple answers here. The problems are complex and the methodologies needed will and should be varied (Scriven, 1991).

Fourth generation evaluation, participatory approaches to evaluation, and empowerment evaluation are examined more closely in the subsequent sections.

4.2.2 Fourth Generation Evaluation

When Guba and Lincoln published Fourth Generation Evaluation in 1989, they provided a coherent voice to the concerns of many people involved in evaluation processes. It was time, they argued, to recognise the limitations of current evaluation methods that understood the task as being to "discover the truth". It was necessary instead to give form to the complex hermeneutic process that evaluation should be, or maybe already is.

Guba and Lincoln (1989) define three historical generations of approaches to evaluation. The "first generation", they argued, was basically about measurement. The role of the evaluator was therefore that of *measurer*, and was required to have the expertise to apply the relevant measurement instruments. The "second generation" of evaluation introduced objectives into the analysis to enable factual outcomes identified by the measurement paradigm to be described against the intentions of the events. The evaluator in this context therefore added the additional task of *describer* to the measurement role. The "third generation" of evaluation was to acknowledge the need for the evaluator to make certain judgements on the basis of the available data in the light of pre-determined aims. The evaluator therefore became *judge* in addition to the existing roles of measurer and describer.

All of these conceptions of the meaning and operation of evaluation processes understood the core characteristic of good evaluation as being for a *neutral outsider* to reach a decision as to what "actually" happened in relation to what "was wanted". Guba and Lincoln argued that there were a number of serious limitations to the perspectives on evaluation offered by all of these three generations. They all failed to appreciate, in particular:

- The *real power relations* existing and pressuring the evaluator within the evaluation process. These power structures not only affected the relationships between those

being evaluated, but also limited the practical ability of the evaluator to be a neutral outsider;

- The *plurality of value-bases* existing simultaneously within the evaluation process, as well as multiple interests, agendas, and perceptions; and the consequential need to accept and cope with multiple perspectives within the evaluation process that are not mediated by resort to the assertion of facts, but to the mediation of perspectives.

Further developments in evaluation methodology, a "fourth generation", were therefore seen by Guba and Lincoln (1989) as needed to take account of these facets of actual evaluation process. They defined Fourth Generation Evaluation as a *hermeneutic dialectic negotiation*, where the evaluator is both a *facilitator* that elicits the views of different stakeholders, and a *mediator* in bringing the stakeholders to a level of consensus as to what happened in the past, and what should happen in the future. The fourth generation evaluator does not therefore seek to identify "facts", but rather to highlight and mediate between different views rooted in different interests and worldviews. Similarly, the fourth generation evaluator does not seek to determine a solution, but rather encourages the various stakeholders towards an agreement.

Evaluation is a process whereby evaluators and stakeholders *jointly and collaboratively* create (or move towards) a consensual valuing construction of some evaluand. It does *not* necessarily yield irrefutable (that is empirically confirmable) information (although that may be a side product). According to Guba and Lincoln (1989), it is also:

- a process that subsumes data collection and data valuing (interpretation) into one inseparable and simultaneous whole;
- a local process. Its outcomes depend on local contexts, local stakeholders, and local values and cannot be generalised to other settings;
- a socio-political process. Social, cultural and political aspects, far from being merely distracting or distorting nuisances, are integral to the process, at least as important as are considerations of technical adequacy;

- a teaching/learning process. Evaluators, clients, sponsors, and all stakeholders both teach and learn from one another; indeed, such teaching/learning is an absolute prerequisite to the meaningful reconstruction of systemic views;
- a continuous, recursive, and divergent process, because its "findings" are created social constructions that are subject to reconstruction. Evaluations must be continuously recycled and updated;
- an emergent process. It cannot be fully designed in advance for its focus (or foci) depends on inputs from stakeholders and its activities are serially contingent;
- a process for sharing accountability rather than assigning it;
- a process that involves evaluators and stakeholders in a hermeneutic dialectic relationship.

Certain key principles need to be adhered to in order to be able to effectively undertake Fourth Generation Evaluation (Guba and Lincoln, 1989):

- The *evaluator accepts the limitations of the previous three generations of evaluation*, and therefore understands and identifies with the new approach.
- All of the stakeholders must also *accept the limitations of a positivist approach.*
- *The evaluator must adopt a constructionist* approach. This operationalises the perspective that no assertion of truth exists independently of a particular set of values, and that this is just fine so long as one realises it and treats all information on that basis. Thus, the evaluator spends most of her or his time eliciting and mediating between constructions of the issues and events under review from different stakeholders.
- The *process is responsive* in that the aims of the processes being evaluated, the goals and approaches used to evaluate these processes, and the descriptions of the processes themselves, are all determined by stakeholders, and therefore take multiple forms.
- Evaluators play many conventional (but reinterpreted) and unconventional roles in carrying out fourth generation evaluation.

- Evaluators must possess not only technical expertise but also relevant interpersonal qualities. Perhaps chief among these are patience, humility, openness, adaptability, and a sense of humour.

Fourth Generation Evaluation suffers from several shortcomings that if left unchallenged undermine the value of the method from both theoretical and practical viewpoints (Zadek, 1994). There are two particular shortcomings:

- **Preconceptions of Preconditions:** Guba and Lincoln assert that it is only through a hermeneutic process that effective mediation between different interests and insights becomes possible. To assert the search for a " truth" can damage mediation processes, particularly in an apparently zero-sum game situation, or where stakeholders have radically differing worldviews as well as interests. Guba and Lincoln then set out what they consider to be the preconditions for such a "productive hermeneutic dialectical negotiation", which include: the need for all parties to work from a position of integrity; a willingness of all stakeholders to share power; a willingness of all stakeholders to change; and a willingness of all stakeholders to reconsider their value positions (Guba and Lincoln, 1989: 149-150).

  According to Zadek (1994) there are several problems with these conditions,. the most obvious being, whilst desirable, these conditions are unlikely to pertain except in the rarest of cases. Groups with relative power rarely want to share on any meaningful basis in practice, even those who say or actually think that they do. Similarly, very few people fulfil the condition of integrity, if by that is meant that there are no significant hidden agendas. The danger of Guba and Lincoln's severe conditions are that they *marginalize* Fourth Generation Evaluation from *practical processes*, rendering it little more than a fascinating curiosum. Secondly, the hermeneutic dialectic process proposed by Guba and Lincoln would arguably not be necessary if these conditions *did* actually prevail. That is not to say that there is no place for a process to increase mutual understanding between the most angelic of people. Rather, it is to miss the point that the hermeneutic process is necessarily political, which in itself implies that Guba and Lincoln's preconditions do not hold. Thus, Fourth Generation Evaluation has potential value

as an *emancipatory* process primarily because these preconditions do not prevail in our society. In this sense, Guba and Lincoln *undervalue* their own insight by imposing these preconditions.

- **Mediation for Action:** The manner in which Guba and Lincoln construct their argument for Fourth Generation Evaluation is in itself an interesting example of the very polarisation process that they themselves are criticising. Fourth Generation Evaluation is posited in this process as an *alternative* to a positivist approach. A different and potentially more useful interpretation is that the critical responsive and constructivist elements of the approach constitute *one aspect* of an appropriate evaluation process. In particular, without incorporating an understanding of a mediated solution that is essentially deemed a "consensual truth" by the stakeholders, *consequential actions* become almost impossible to determine. It is therefore entirely possible for different stakeholders to define diverse interpretations of a particular event. However, for a consequential action to arise from the evaluation process requires ultimately that a "fact" be determined through this process that forms the basis for agreement and further action.

  Zadek (1994) argues that if there is to be no further action, this final stage is not necessary. However, Guba and Lincoln themselves stress that evaluation is integral to a continual process, rather than an *ex-post* approach that presupposes the end of the critical process. In this sense, then, a hermeneutic process is one that creates a form of truth that Habermas would call consensual or "democratic rationality" (see Rasmussen, 1990). Critical here is that this democratic rationality is not seen as merely the point at which *some* consensus was reached. The closer to a fully ethical or democratic discourse the hermeneutic process is, the more the resolution constitutes a core form of rationality or truth (Zadek, 1994).

Strict preconditions and polarisation of conventional approaches endangers the *practical application* of their proposed method, and its internal consistency (Zadek, 1994). Although the literature on constructivist and participatory approaches in evaluation has grown considerably in these past years, *practical proposals* on working with different stakeholder opinions remains vague (Hummelbrunner, 2000).

4.2.3 Participatory Approaches to Evaluation

The area of participatory research developed and applied mainly in the context of rural development projects in the "third" world has also implicitly taken on many of the principles of Fourth Generation Evaluation (Chambers, 1993). From different disciplines and traditions within the evaluation field a wide range of related approaches have been designed which could be grouped together under the designation of participatory evaluation. These approaches tend to differ in the emphasis placed on action as compared to research and the construction of theories, on the role played by the evaluator and in their political orientations (Brown, 1995: 216). Although there are some differences between these approaches they all provide an evaluating focus committed to the development of a change or improvement that is interactive, contextualized and directed at knowledge building (Brown, 1995). Essentially, participatory evaluation starts out from a recognition that evaluation develops within a pluralistic society and allows evaluation to be built upon the ideas, values and aspirations of those taking part at all levels and throughout the whole evaluation process (Diez and Estaban, 2000).

The evaluation design is not imposed from outside, but gradually takes shape through the collaboration of all the stakeholders and their active participation in the analytical evaluation process. This focus considerably increases the probability that the results achieved by the evaluation will be used in an effective way to improve the policy, since it allows the actors in the programme to make the actual evaluation process and its results their own, transforming the evaluation into a learning process which, in a certain sense, belongs to them.

The evaluation of rural telecommunications should be understood as a participatory approach to evaluation since this approach makes it possible to convert evaluation into an exercise contributing to achieving the very goals of rural development. It is at the regional and/or local level where participatory evaluation can be easily put into action, and rural areas in most cases fall under local or regional government. Stame (1999) maintains that the evaluation of new regional policies (including those affecting rural development) should be transformed into participatory evaluation and take into consideration the viewpoints of the different actors in relation to both the methodology as well as the content of the evaluation. Kuhlmann (1998) stresses how the various interests and perceptions of the actors taking part must be explicitly taken into account.

Some of the advantages that participatory evaluation introduces into the evaluation practice of regional innovation and rural development are listed below (Diez and Estaban, 2000):

- Evaluation is understood as a learning process around the policy evaluated from the perspective of all the stakeholders. It is precisely the very participants in the policy of economic development who contribute to understanding and learning about the processes of change underlying the programme and to the development of a new awareness regarding the policy under evaluation. Evaluation ceases to be an exercise of assessment where the predominant perspective comes from only one angle, that of the objectives of the policy-designer as the only criteria for evaluation, and becomes an exercise stimulating the appearance of a learning process (Kuhlmann, 1998: 138).

- This common learning process allows the creation of a working framework where the evaluation process is used to build trust among stakeholders, managers, institutions and evaluators (Kuhlmann, 1998: 138). Participatory evaluation makes it possible to democratise the process of knowledge building. Active participation should be a practice applied throughout the entire evaluation process and be directed towards identifying and resolving problems and improving understanding of regional necessities.

- Evaluation is used to create useful knowledge for those involved in the process in order to achieve their objectives in the short and long term. The process is aimed at creating a situation where new understanding is built on the "best" from all participants. In a pluralist society where there exist a multiplicity of viewpoints and perspectives, to expect to obtain an exact objective measure of policy impact, in the sense of an unchangeable truth, is neither possible nor desirable. Furthermore, when attempting to evaluate complex policies involving broad interrelated aims, the objective of the evaluation must be to create practical knowledge, instead of mechanistic judgements concerning the results, and attention must be fixed constantly on the learning processes.

- This creation of knowledge is, at the same time, a facilitator of action and regional mobilisation; it is a practical kind of knowledge that will stimulate the capacity of regional governments, community institutions and organisations, in general, to solve the pertinent problems. In this context, participatory evaluation favours learning for action, since the evaluation process is used to propel action directed at policy improvement.

- Participatory evaluation makes it possible to strengthen the power of the participants to resolve their economic and social problems. For this reason, some researchers highlight the capacity of evaluation to prepare the regional community for action (empowerment). Evaluation is understood as a process of collaborative change that combines knowledge creation and, through learning, facilitates mobilisation for action. Participatory evaluation may be conceptualised as a way of developing awareness, facilitating learning and empower the different stakeholders to resolve the challenges confronting the region. It broadens the objectives and the agenda of the region.

Evaluation becomes, *inter alia*, an integral part of regional (including rural) development and its normal activity. It forms part of policy as one more element in its planning, implementation and development. Evaluation is understood as a tool that makes it possible to monitor the progress of the initiative, make short-term corrections and centre on regional policy objectives. Through evaluation, the meaning of social reality can be explained from different perspectives, while there is an increased likelihood both that the stakeholders will feel that the results are relevant and proper to them and that, in this way, there is a guarantee of them being put into practice.

Participatory evaluation lets evaluators, managers and social groups work together in an open interchange of information where everyone has the chance to take part in the debate. This process of collaboration creates new demands for evaluation. The aim of evaluation shifts beyond its contribution towards an understanding to take up the question of how the knowledge and learning can be used in the taking of decisions. Evaluation plays a new role in which the interchange of information, and formal and informal learning, demystify the process of evaluation itself, clarify its function and expectations of what evaluation can offer, and generate mutual trust, helping regional actors to know and understand how others

comprehend the world. Participatory evaluation as applied to a new generation of regional (including rural) policies, turns evaluation into an innovation in itself, to the degree to which it is transformed into a useful tool for mobilising the community towards regional action, empower companies and regional organisations to resolve their own problems, stimulating co-operation and the creation of mutual trust and building the capacity to learn (Diez and Estaban, 2000).

Both participatory evaluation and new regional policy for integrated development are built upon the development of a process of interactive learning. They both recognise the power of participation and they strive hard to make frameworks of work and joint action develop, directed at improving and sustaining such participation and collaboration between regional agents. In their essential make-up, both share the same conception concerning the need for collective transformation based on the generation and liberation of energy and hopes regarding the future of the region, which would be produced through collective dialogue, the construction of a common regional perspective and action. New generation regional policies are experiments for transforming regions into learning regions, participative evaluations contribute precisely to social learning and evaluation becomes an indispensable social innovation for making a region an intelligent region (Diez and Estaban, 2000).

It is vital, therefore, to create conditions of legitimacy between the scientific community and politicians, for evaluations based on focuses of participative, qualitative and contextual evaluation. It is a matter of creating opportunities for evaluators to develop and explore the latter, as well as other focuses and methodologies that are suitable for the specificities of this new generation of regional/rural policies for development. Emphasis on this participatory approach to evaluation should not make us forget the need for more innovations and experiments directed at new learning strategies.

4.2.4 Empowerment Evaluation

Empowerment evaluation is, as the name implies, a collection of evaluation techniques that promote the empowerment process (Russon, 1995). It is the use of evaluation concepts, techniques, and findings to foster improvement and self-determination. It employs both

qualitative and quantitative methodologies. Although it can be applied to individuals, organizations, communities, and societies or cultures, the focus is usually on programs.

Empowerment evaluation is defined as a method, which helps (program) participants and employees to evaluate themselves and their implementation in order to improve practice and to foster self-determination (Fetterman *et al.* 1996: 4). The most interesting point in the empowerment evaluation is that the participants conduct their own evaluations and usually act as facilitators. This method aims to increase the rights of self-determination by using different research methods. The role of the researcher is to teach the target organization the principles of evaluation. Consequently, the role of the evaluator is to act as a trainer and a teacher in the evaluation process, not as an objective researcher. The most important point in the empowerment evaluation is that its aim is not merely to evaluate the quality of the implementation but more importantly to develop the existing execution process of the organization or program.

Empowerment evaluation has its roots in community psychology. Community psychology focuses on people, organizations, and communities working to establish a control over their own affairs. Therefore, the literature on citizen participation and community development can be seen as a part of empowerment evaluation's development. On the other hand, empowerment evaluation also derives from collaborative and participatory evaluation (for example Whyte, 1991) One of the goals in the empowerment evaluation is to decrease the mystique connected with evaluation and to make it easier for the organizations to start more versatile evaluation processes and practices. This goal is supposed to be achieved with the help of five theses, which are as follows: training, facilitation, advocacy, illumination, and liberation (Fetterman *et al.* 1996: 9-11).

The process of the empowerment evaluation consists of four stages or steps. The aim of the first step, taking the stock, is to chart the present situation of the evaluation object by collecting all the essential factors connected with the activity. On the grounds of these factors one can create a base line from which future progress can be measured.

The second stage of the empowerment evaluation is setting the goals. What is essential in this part of the evaluation process is that the setting of goals is proportioned to the present condition of the evaluation object. In this way, the goals will show the direction in which the function should go in the future. In other words, the goals are proportioned to the activity.

The third stage is developing the strategies. Program participants are responsible for selecting and developing strategies to accomplish program objectives. In this work one has to be aware that the two previous steps will not be ignored in the strategies.

The fourth stage is documenting the progress. All those involved in the evaluation process have an opportunity to influence the way the information produced by the function and evaluation – and the possible development – will be documented. (Fetterman *et al.*, 1996: 18-20).

Empowerment evaluation is fundamentally a democratic process. The entire group is responsible for conducting the evaluation. The group can thus serve as a check on its own members, moderating the various biases and agendas of individual members. The evaluator is a co-equal in this endeavour, not a superior and not a servant; as a critical friend, the evaluator can question shared biases or "group think". As is the case in traditional evaluation, everyone is accountable in one fashion or another and thus has an interest or agenda to protect (Fetterman, 2000).

Empowerment evaluation also empowers external evaluators. Specifically, the external evaluator's role and productivity is enhanced by the presence of an empowerment or internal evaluation process. Most evaluators operate significantly below their capacity in an evaluation because the program lacks even rudimentary evaluation mechanisms and processes. The external evaluator routinely devotes time to the development and maintenance of elementary evaluation systems. Programs that already have a basic self-evaluation process in place enable external evaluators to begin operating at a much more sophisticated level (Fetterman, 2000).

4.2.5 Socio-Technical Approaches to Evaluation

According to Land (1999) socio-technical evaluation should take two forms:

- *Ex-ante* to demonstrate that the expected outcome of a socio-technical inspired change programme meets the instrumental expectations of the business and does so with less risk and more certainty than alternative approaches.

- *Ex-post* to provide evidence acceptable to the financial management that the desired outcomes have been achieved.

The evaluation method has to prove acceptable to the decision-makers within the organisation. In typical organisations evaluation is regarded as a purely technical process, carried out according to rules that make it possible to compare evaluations of very different projects on a single scale. Hence the introduction of methods of evaluation deemed suitable for socio-technical designs, which attempt to define the value of other sets of variables previously neglected, face severe difficulties. The problem is perhaps exacerbated by the socio-technical premise that the evaluation process itself should be a socio-technical process and not merely a technical exercise (Land, 1999).

Conventional evaluation methods provide limited possibilities for including social elements in cost/benefit assessments. These require the evaluation of the second order impacts of social changes. For example, if a socio-technical design reorganises the work situation to provide, as a direct outcome (first order impact) an increase in job satisfaction, the expected second order consequence might be a reduction in absenteeism, an improvement in health, and hopefully an increase in productivity. Each of these has a measurable impact on the cost/benefit equation. But the ex-ante assessment of the scale of these effects is difficult and tends to rely on an act of faith by the evaluator rather than a rational calculation (Land, 1999). Relying on the usual statistical standby of prior experience does not work well because the impact of the changes is highly situational. In principle it should be possible to check ex post the extent to which predictions of second order effects have been realised. But few organisations carry out rigorous ex post studies (Kumar, 1990).

A promising approach to socio-technical evaluation should be based on the following:

- First, on the recognition that organisational change, and in particular large scale change, addresses a range of problems and targets a number of objectives (Kenney and Raiffa, 1976; Land, 1976).

- Secondly, it is recognised that different stakeholders can attach quite different values to the objectives even though the objectives themselves may be shared. But there are objectives that are not shared and some stakeholders attach a negative value to them whilst others may regard them as beneficial (Land, 1999).

- Thirdly, values are measured in the natural units of the goals. Thus a measure of improved responsiveness will be the expected change of response time (ex-ante) or the achieved change of response time (ex-post). This is also one of the major drawbacks of this type of evaluation. Instead of reducing all values to the commonly accepted money value, multi-objective, multi-criteria methods reduce all values to a common utility function (Land, 1999).

- Fourthly, the evaluation process should ideally be a socio-technical one, that is, it is an iterative process of discovery involving all classes of stakeholders. Technical and social considerations are equally acceptable. Evaluation is regarded as a mutual exploration of the issues, not as a mere recording of technical data. It is recognised that evaluation is a political process (Hawgood and Land, 1988), and is seen as an arena for fighting for cherished objectives or alternatively for denying other's objectives which are seen as harmful to one's own interests. Potential conflicts are exposed and steps can be taken to resolve difficulties arising from the conflict.

A number of evaluation methods are based on the articulation of the multiplicity of objectives that lie behind the designed change and the multiplicity of values that are attached to each objective by different stakeholders. The generic term for such methods is Multi-Objective Multi-Criteria (MOMC) methods (Land, 1999). Information Economics (Parker

and Benson, 1987) and the Balanced Score Card (Kaplan and Norton, 1992) are variations of the MOMC concept.

There are many examples of apparently successful socio-technical interventions (Mumford and Henshall, 1979; Mumford and MacDonald, 1989; Land *et al.*, 1983). Nevertheless, socio-technical methods *failed* to get imbedded in those organisations as part of standard practice because without the presence of the research team the new methods were seen as outside the accepted norms of accepted (or acceptable) practice in the business (Land, 1999).

4.3 THEORY-BASED EVALUATION APPROACHES

4.3.1 Evaluation Based on Organisational Theory

According to Francescato (1992), Bruscaglioni suggested that there were three stages to the development of organisational theory: isolation of approaches, mechanical complementarism and integration of the various approaches. Although these referred to organisational theory, they may also be applied to evaluation theory (Gregory, 1996).

According to Gregory (1996), traditionally, there are three forms of evaluation: goal-based methodology, resource-based methodology and multiactor-based methodology:

- **The goal model:** This model was dominant during the early part of 20th century till the late 1950s. It concentrates on monitoring outputs and comparing the actual outputs with the targets. In this model, appropriate objectives are developed, and then performance indicators are selected. It is assumed that if the individual levels of achievement are summed, an overall indicator of organisational effectiveness is achieved. The best example of goal-based evaluation is the practice of Management By Objectives (MBO).

- **The system resource model:** The 1960s saw the emergence of the system resource model that was far more process orientated. It was founded on the assumption that if operational processes are of a high standard, any targets (which might be set for outputs) will be met as a matter of course. This model focuses on the organisational

allocation of resources. The question to be answered is: How close does the organisational allocation of resources approach an optimum distribution and, is there a balanced distribution of resources among the various organisational needs. The answers to these questions will indicate the level of effectiveness of the organisation from a system resource perspective (Etzioni, 1960).

- **The multi-actor model:** The 1970s saw the emergence of the multi-actor form of evaluation. This model also examined the level of effectiveness but from a multi-actor perspective. According to Pfeffer (1977), the study of effectiveness involves:

    - the process by which various groups and interests both within and outside the organisation develop and articulate preferences;
    - the process by which the organisation comes to perceive the various demands confronting it; and
    - the process by which actions and decisions are finally taken in the environment of frequently conflicting interests and demands.

  This model emphasised value pluralism and was popular among the not-for-profit sector. According to Gregory (1994), the pluralistic principles of the multi-actor approach are also reflected in the work of several management theorists, who promote the role that management is focused on the balancing and co-ordinating member's interests so that they can work together within the constraints of the organisation's abstract and often divergent, and superficially unifying, formal goals.

It is evident that the methodologies are sometimes based upon different, sometimes opposing, assumptions about the nature of the organisations, which are reflected in the definition of effectiveness that they advance and, correspondingly, the evaluation activities that they imply. Evaluation theorists have largely ignored the effects of power and evaluation practice in coercive contexts. Gregory (1996) recommends that emancipatory methods should be used in parallel with other methods to enable assessment of the impact of power upon organisational effectiveness and to prevent such forces having a covert effect upon the evaluation process. This approach might be termed "multidimensional evaluation" and should represent an integration of methodologies from a practical point of view and the use of methodologies in parallel from a theoretical point of view.

4.3.2 Evaluation based on Program Theory

4.3.2.1 Theory-Based evaluation – US approach

Theory-based/driven program evaluation in the United States has been elaborated and advocated especially by Chen and collaborators as an reaction to the "black-box" evaluation only focusing on input and output in a program (Chen and Rossi, 1983; 1987; Chen, 1989; 1990). A theory-based evaluation of a program is one in which the selection of program features to evaluate, is determined by an explicit conceptualisation of the program in terms of a theory – a theory which attempts to explain how the program produces the desired effects. The term "theory-based" evaluation, therefore, means an evaluation based on a model, theory, or philosophy about how the program works; a model, theory, or philosophy which indicates the causal relationships supposedly operating in the program (Fitz-Gibbon and Morris, 1975; 1996). Smith (1994) lists three purposes of theory-driven evaluation: To answer causal questions about a program; to explain how it works; and to provide recommendations for improvement.

According to Weiss (1972) the mere construction of such a model can be a useful exercise for program developers. The evaluation model can be a learning tool long before the evaluation begins. A model is not the only way to go about the delineation of necessary measures, but it is one way to clarify and systematize the factors that are worth examining. However, Weiss (1996) expressed some reservations about the character of scientific models and theories: Even with the best and most supportive data models are never "proved". At best, they are not "disconfirmed" by the data. There may be alternative models that would provide equally plausible or better interpretations of the available facts. Scientific generalizations are built up by, developing hypotheses and submitting them to successive tests in an effort to disapprove them or find the limits of their applicability (Weiss, 1998).

Fitz-Gibbon and Morris (1996) advocated that theory-based evaluation should be used ". . . when the program to be evaluated is itself based upon a theory, model, or philosophy". Stromdahl *et al.* (2001) suggest that *theory* is reserved to elaborated theories for example learning/teaching theories (behaviourism, social constructivism, etc.). Theory-based or theory-driven evaluation by its connection to social science theories offers the potential to increase general knowledge about how effective programs work. In that sense *evaluation*

becomes *evaluation research* aiming at the generation of knowledge for theory improvement and extension (Stromdahl *et al.*, 2001).

According to Smith (1994), the program theory-driven approach is not a method of evaluation, but a method of applied research, which is useful in conducting evaluations. Evaluation methods necessarily result in claims about the value of something, "X has a value", while the program theory-driven approach results in causal or causal-comparative claims, "X produces Y" or "X produces more of Y than Z produces of Y". These are research claims.

However, Smith (1994) addresses the fact that many previous and current theory-driven evaluations are often presented within a linear confirmatory approach and not used as a platform for wider explanatory approaches. Patton (1989) also views realized theory-driven evaluations as too narrowly focusing the generalizations of causal links.

4.3.2.2 Theory-based evaluation: Swedish Approach

In Sweden the theory-based evaluation originated in Dahllöf's educational research about differentiations in the Swedish comprehensive schools system which was explained by *frame factors* (Dahllöf, 1967). The frame factor approach was then further developed by Lundgren (1972) and exerted a great influence in the scientific field and the pedagogical debate both in Sweden and internationally.

Franke-Wikberg and Lundgren (1980: 145) state that a pedagogical theory-based evaluation should take its point of departure in a theory and/or scientifically underpinned assumptions and knowledge about the phenomena under investigation. Thus, the arguments for theory-based evaluation were grounded in the need for scientific rigour. Franke-Wikberg and Lundgren are, however, critical to the stress of measurement of productivity and effectiveness of the object under investigation in Fitz-Gibbons and Morris' approach, and look upon it as a variant within the classical evaluation models.

In Franke-Wikberg and Lundgren's approach, the researcher is assumed explicitly to choose the theoretical perspective for the evaluative investigation. Initially, the researchers choice of

approach does not need to be a fixed or conclusive theory. A theory could be developed, improved and amended during the investigation (an approach that is close to empirical data; where the theory formation growths in the interchange between preliminary theory (theoretical reference-frame) and gathered empirical data). They even put the label *theory generating* on their approach and refer to the ideas of *grounded theory* (Glaser and Strauss, 1967).

Franke-Wikberg (1992: 12) advocates that the main point in the theory-based approach is the formulation of a *reference-frame* for the object under investigation. The reference-frame is simply the researcher's explicit ideas of the object or phenomenon under study. The reference-frame hence serves as a tool for design and interpretation and bringing opportunities for analyses into a higher level of abstraction and generalization than otherwise in a-theoretical evaluation studies. In practice, this means that areas of possible pedagogical problem(s) or innovation(s) can be compared across different fields and/or student populations.

The researcher is situated in a pluralistic environment due to different *knowledge interests* expressed by the diversity of audience of the evaluation objectives and results, for example, on the one hand stakeholders different concerns and on the other hand the scholarly, academic audience's considerations. According to Stromdahl *et al.* (2001), Habermas' (1972) general categorization of knowledge interests is applicable here. The *technical* (instrumental) knowledge interests focus on for instance laws, rules, prediction and control of behaviour. The *practical* knowledge interests emphasize understanding, clarifying and interpretation of human communication. The *emancipatory* knowledge subsumes the previous two paradigms and is concerned with action aiming for a reflective practice.

4.3.2.3 An Integrated Framework to Theory-Based Evaluation

Stromdahl *et al.* (2001) propose an integrated framework, *theory-anchored evaluation research,* where the two approaches to theory-based evaluation could be expressed accounting for a spectrum of knowledge interests. Within the actors suggested in the experiment the focus of the evaluation is delineated by creating a preliminary *evaluand model*, a model of *the evaluand*, and the discerned part of the experiment that is going to be evaluated (see Stromdahl *et al.* (2001) for further details on this approach). The evaluand

includes for example the actual experiment, an educational program (or parts of it), a product, a teaching strategy, a specific learning environment, or a policy. The discernment of the evaluand is steered by the established evaluation questions and is accompanied by a negotiation process between the evaluation researcher(s) and the actors in the program. The aim of this process being to focus on *what is going to be evaluated.* This is clarified by Greene (1994: 533) "*What importantly distinguish one evaluation methodology from another is not methods, but rather whose questions are addressed and which values are promoted*".

In accordance with Cole (1999: 455) the theory-anchored approach is independent on restricting limitations of "stages" (Provous, 1971) and "program theory domains" (Chen, 1990) and thereby sensitive to the specific interests of the individual investigation. This is also in agreement with Smith (1994) who argues for more investigative forms, explanatory approaches and methods of the theory-based approach. Besides, theory-driven evaluation is not connected to any specific research method (Chen, 1990; Chen and Rossi, 1992; Chen 1994).

In conclusion, the US approach to theory-based evaluation described above is based on an established theory ("program theory") underlying the phenomenon (program) under investigation. A general *technical knowledge interest* is at hand. The aim of such studies being to answer the question: Are the goals reached in agreement with the "program theory"? The Swedish approach presented here is based on the researcher's choice of theoretical reference-frame (perspective) in reciprocal relation to the specific phenomenon under evaluative investigation. A general *practical and emancipatory knowledge interest* is at hand.

4.3.2.4 Possible drawbacks of Theory-Based Program Evaluation

Bickman (1989) has raised some questions of barriers to the use of theory-based evaluation. One of these is the cost connected to the requirement of specific expertise in the subject matter. However, as suggested above, if the evaluation research is conducted in close cooperation (co-ownership) with the program designers, project-leaders and those directly involved in the realization of the project (program) within the proposed theory-anchored evaluation research framework, this barrier will vanish.

The suggested close cooperation however does not mean that the evaluator shall give up his/her position as an independent critical researcher. The situation for the evaluation researcher in the suggested type of enterprise is in a sense comparable to those researchers who are involved in Participatory Action Research (PAR). This approach recognizes the need for persons being studied to participate in the design and conduct of all phases (for example design, execution, dissemination) of the research that affects them. There has been a lot of discourse (see for example Cizek, 1995) regarding the feasibility of PAR as an integral part of the research process. It can be argued that with the involvement of the actors (non-researchers) the study becomes biased and unreliable. However, by allowing actors input into the research process, issues of foundational ideas of the experiment, relevancy and applicability can be addressed in depth. It is, however, crucial to maintain the awareness of research integrity and recognize the difference between the roles of the persons involved.

4.4 CONCLUSION

In local, regional, national, and global development, the implementation of multi-objective multi-sectoral programmes is becoming more and more widespread. However, the evaluation of such programmes still raises a series of methodological and operational questions. Although the literature on constructivist and participatory approaches in evaluation has grown considerably in the last decades, practical proposals on working with different stakeholder opinions remain vague (Hummelbrunner, 2000). All of these approaches are usually confronted with the challenge of dealing appropriately with complex social systems, where a wide and often changing variety of actors with different values, interests and motives are inter-acting. Evaluation findings often reveal a diverse picture of the reality in a programme or project, particularly when viewed through the eyes of various stakeholders. Any attempt at reducing this complex picture, in an inappropriate manner, will not only harm the credibility of the evaluation, but also brings forth resistance from those who feel that they are not properly represented (Hummelbrunner, 2000).

All evaluation approaches are usually confronted with the challenge of dealing appropriately with complex social systems, where a wide (and often ever changing) variety of actors with different values, interest and motives are interacting. Evaluation findings often reveal a diverse picture of the reality of a programme/project, particularly when viewed through the

eyes of various stakeholders. And any attempt at reducing this complex picture in an inappropriate manner will not only harm the credibility of the evaluation, but also bring forth resistance from those which feel not properly represented.

Systems theory and systems thinking can be of great help to avoid undue simplification and provide useful tools for practical work with complex systems. A systems approach can also contribute towards improved use of evaluation because raising awareness for the crucial linkages and patterns at work is a prerequisite for any serious and sustainable learning effect, which is so often expected from evaluations (Hummelbrunner, 2000). The next chapter presents key elements of systems thinking approaches that are suitable for possible inclusion in a framework for evaluation of rural telecommunications infrastructure.

Chapter 5

SYSTEMS THINKING AND SYSTEMS APPROACHES THAT ARE SUITABLE FOR EVALUATION

5.1 INTRODUCTORY REMARKS

Systemic methods were first developed and applied in science and engineering. System ideas have found ready applications in these disciplines, due in part to the ease in delineating the components, boundaries, and objectives of "hard" physical systems. Applying systems concepts to "soft" social systems has proved more of a problem. Analysts and participants working in soft systems often fail to reach agreement on systems definition or on the problems to be solved (Checkland, 1991).

According to Checkland (1991), differences in perspectives arise from different weltanschauung (world-views). Soft Systems Methodology (SSM) promotes a process that aims to encourage facilitators and system participants to learn more about the perspectives and constructs of others in the system (its clients, actors, and owners). These insights provide the possibility for shared understanding and consensual action (Checkland, 1991). There are two main *modes* within SSM, real world activities, and systems thinking about the real world. Initial work involves interviews and meetings to gain an understanding of the problem situation, which is represented by the use of "rich pictures". Systems thinking using concepts of hierarchy, communication, control, and emergent properties are used to identify "relevant systems" which may provide useful insights.

Critical Systems Theory draws heavily on the philosophy of Habermas in seeking to move beyond the insights of Soft Systems Methodology. Both Soft Systems Methodology and Critical Systems Theory move away from the positivist epistemology of "hard" systems science. This chapter highlights the differences between the nature of hard and soft systems and examines Soft Systems Methodology and Critical Systems Thinking with a view to finding a suitable philosophical and theoretical foundation and a dominant methodology for the evaluation of rural telecommunications infrastructure.

The next section examines the essence of sociological paradigms and the nature of soft and hard systems and then explores Soft Systems Methodology, Critical Systems Thinking, both UK type and Critical Systems Heuristics, in more detail.

5.2 THE ESSENCE OF SOCIOLOGICAL PARADIGMS AND THE NATURE OF SOFT AND HARD SYSTEMS

The systems thinking community articulates the various systems approaches in terms of paradigms. Reference here is made to Kuhn's (1970) conception of paradigm: "A paradigm is something like a theoretical framework that a given scientific community shares. Although paradigms are associated with particular scientific theories, a paradigm is not simply a theory. It involves a whole way of viewing the world, and also a whole basis for research, problem solving and discovery." The paradigms that may be easily identified are the Hard Systems Thinking (HST), Soft Systems Thinking (SST), Critical Systems Thinking (CST), and Multimodal Systems Thinking (MST) (Eriksson, 1998). According to Eriksson (1998), these paradigms consist of three meta-paradigms, that is Machine Thinking (MT), Biological Thinking (BT) and Social Thinking (ST), and include the following:

- Machine Thinking consists of Hard Systems Thinking, that is, Operations Research and Management Science, Systems Analysis, Systems Engineering and Systems Dynamics together with first order Cybernetics.

- Biological Thinking consists of General Systems Theory, Autopoietic Systems Theory, Living Systems Theory, Viable System Model, and first and second order Cybernetics.

- Social Thinking may be articulated in the paradigms of Soft Systems Thinking, Critical Systems Thinking and Multimodal Systems Thinking. Soft Systems Thinking, in turn, contains Soft Systems Methodology, Interactive Planning, and Strategic Assumptions Surfacing and Planning. The Critical Systems Thinking paradigm contains Critical Systems Heuristics, and the Multimodal Systems Thinking paradigm contains Living Social System model.

The historical-paradigmatic discrimination illustrates the approximate order of development of systems thinking in the Twentieth Century. It started with the Hard Systems Thinking of Machine Thinking (before and just after World War 2), proceeded almost simultaneously to Biological Thinking (in post World War 2) with its various systems approaches and then to

Social Thinking. The latter gave rise first to Soft Systems Thinking (1960s and 1970s) followed by Critical Systems Thinking (1980s and 1990s) and then Multimodal Systems Thinking (1990s).

Hard Systems Thinking represents normally the systems methodologies that are labeled as Operations Research and Management Science, Systems Analysis, Systems Engineering, and Systems Dynamics. They all seem to have some common theoretical features that justify their classification into this paradigm. Hence, onto-epistemologically considered they are all founded on some dialect of realist-positivist positions. This implies, among others, that the mentioned systems approaches all focus rationality of the investigated objects by means of quantification. They assume that the problem to be solved or managed is given and well defined, and the issue is to find some alternative solutions and then choose the optimal one. Therefore, they do not provide any support for problem identification and justification. They do not provide any explicit normative framework for problem management either (Eriksson, 1998).

Soft Systems Thinking (SST) represents, *inter alia*, Churchman's Theory of Inquiring Systems, Soft Systems Methodology (SSM), Interactive Planning (IP), Strategic Assumption Surfacing and Testing, and others. Its onto-epistemological foundation is the set of theories known as nominalism, hermeneutics or interpretativism, pragmatism, constructivism, etc. (Eriksson, 1998). This implies, among others, that these systems approaches do recognize the problematic of conceiving the very problem to be managed. They provide various modeling instruments, like SSM's Rich Pictures and CATWOE analysis, for accommodating different perceptions and conceptions of seemingly similar situations that may have origin due to different cultural, knowledge and experience backgrounds. Accepting different positions, it accepts seemingly non-rational opinions, which it aspires to accommodate with each other through a process of communication and learning. It does not hope to control human reality by identifying the optimal solutions, but rather to manage with it in a suitable way that is feasible at the moment of problem management (Eriksson, 1998).

Lewis (1994) highlighted the philosophical differences between the hard and soft systems approaches, and the differences between objectivist and subjectivist approaches (Figure 5.1). Ontology regards how the philosophy defines the nature and form of reality (that is, what can be known). Each philosophy, paradigm, approach, etc., defines reality differently. In critical

race theory, the nature of reality is interpreted as something that has been shaped over time and history by a series of social, political, cultural, economic, ethnic, and gender factors and then crystallized into a series of structures that are now inappropriately taken as "real". Epistemology looks at how one knows reality, the method for knowing the nature of reality, or how one comes to know reality. It is the relationship between the knower and the known. For scientists, the way of knowing reality is via the scientific method (Guba and Lincoln, 1994). The epistemology of early operational research, out of which systems analysis was born, was positivistic and this paradigm has since dominated. These are explored further in Burrell and Morgan's 1989 model.

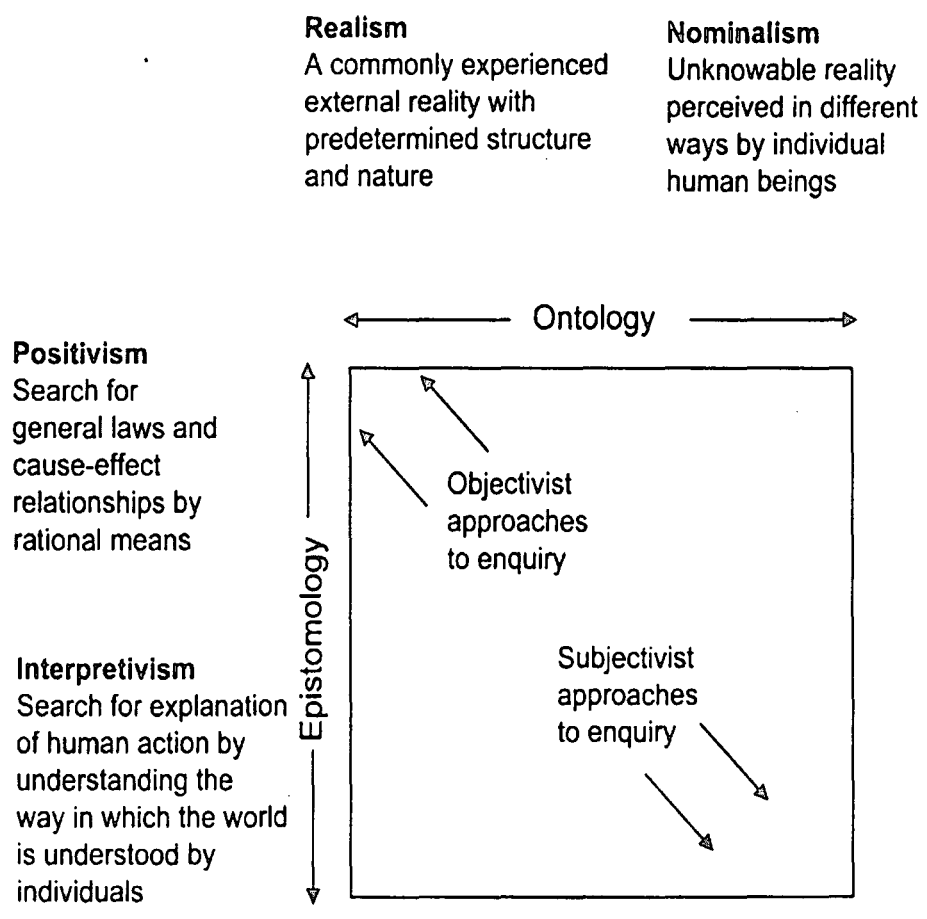


Figure 5.1: Differences between objective and subjective approaches (Lewis, 1994).

Burrell and Morgan's model of sociological paradigms also represents the various assumptions about how one should learn about reality, and about the nature of that reality. Hence in systems terms, it can provide an instrument for illuminating the assumptions about the various systems approach methodologies of investigations, as well as about the social systems that are to be investigated with the support of these systems approaches.

The model states that the social world and its investigations can be conceived in terms of four main paradigms. This distinction is founded on two aspects, first the nature of social science, that can be considered as either subjective or objective, and second about the nature of society that can be considered emphasizing either regulation or radical change. Returning to the first aspect, the nature of social science, there are four characteristics that together determine its position. These are four domains of inquiry: ontological, epistemological, anthropological and methodological.

The following distinction between objectivist and subjectivist assumptions about the nature of social science (Figure 5.2) makes up the first dimension of Burrell and Morgan's (1979) model.

1. If a theory is labeled as objective, it has the realist ontology, positivist epistemology, determinist anthropology, and nomothetic methodology positions.
2. If a theory is found to be subjective it has nominalist ontology, anti-positivist epistemology, voluntarist anthropology and ideographic methodology positions.

The second dimension considers the assumptions about the nature of society. Sociology of regulation is concerned with understanding of the status quo. Society is thus seen as being fundamentally consensual; therefore the mechanisms by which social order is maintained are studied. Sociology of radical change, on the other hand, studies radical change in social systems. Society is thus seen as being fundamentally contradictory and manifesting structural conflicts. Combining the two dimensions gives a four-cell matrix. Radical change sociology and the subjective nature of social science imply the so-called radical humanism paradigm. Secondly, radical change sociology and objectivist nature of social science result in the so-called radical structuralism paradigm.

Thirdly, regulation sociology and subjectivist nature of social science imply the interpretative paradigm. And finally, regulation sociology and objectivist nature of social science yield functionalist paradigm.

The functionalist paradigm implies that the studied systems are easy to identify and describe, and possess existence that is independent of its observers. Their study searches for regularities and relationships between the various components. Its environment determines

human behaviour and the studied system as such is characterised by the status quo. Quantitative models are built as representations that are meant to facilitate prediction and control of the studied systems.

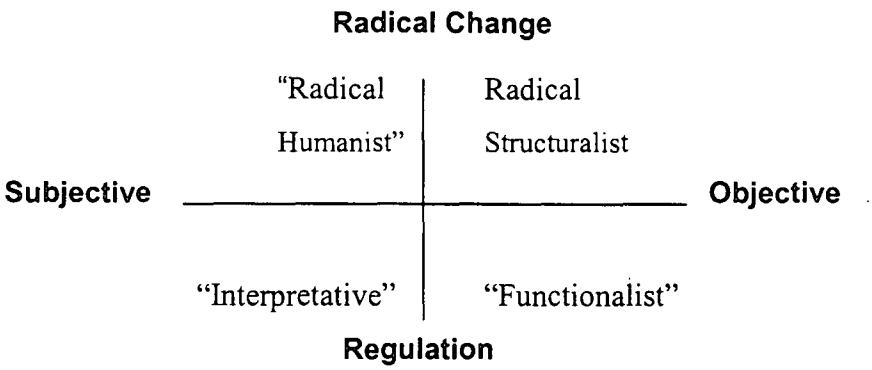


Figure 5.2: Illustration of the four sociological paradigms together with the various systems approaches (Burrell and Morgan, 1979).

The interpretative paradigm implies that there are individual interpretations of the observers, which may very well vary according to the observer. The voluntarism of humans makes it in practice very hard to construct a feasible quantitative model; the models are rather qualitative where knowledge is obtained by involved studies. Still the idea of the study is to identify some status quo, so that understanding and eventually prediction and control may be obtained.

The radical structuralist paradigm postulates an independent existence of the studied social reality. It searches for regularities of deterministic system behaviour. This implies representation with quantitative models of radical changes and conflicts. It considers the social reality to be a construction of its observer, which implies that personal involvement is necessary in order to inquiry these systems, and qualitative representation will be the result. Again there is a notion of transformation and change of the social systems. It also has much in common with the interpretive paradigm in that they both make similar assumptions about the nature of social science, as shown in Figure 5.3. The radical structuralist approach to social science is similar to that of the functionalist paradigm.

Jackson (1982, 1991) related the various systems approaches to this model of sociological paradigms as follows: Firstly, the approaches labeled as Hard Systems Thinking, that is, Operations Research, Systems Analysis, Systems Engineering, and Systems Dynamics

belong to the functionalist paradigm. Secondly, Soft Systems Thinking including Soft Systems Methodology, Interactive Planning, and Social Systems Design, is part of the interpretative paradigm. Thirdly, Critical Systems Heuristics of Critical Systems Thinking was found to be radical humanist in orientation.

ASSUMPTIONS CONCERNING	PARADIGMS			
	FUNCTIONALIST	INTERPRETIVIST	RADICAL HUMANIST	RADICAL STRUCTURALIST
ONTOLOGY	Realist	Nominalist	Nominalist	Realist
EPISTEMOLOGY	Positivist	Anti-positivist	Anti-positivist	Positivist
HUMAN NATURE	Deterministic	Violuntarist	Voluntarist	Deterministic
METHODOLOGY	Nomothetic	Ideographic	Ideographic	Nomothetic

Figure 5.3: The four paradigms as proposed by Burrel and Morgan (1979) in relation to the assumptions in their approaches to social science.

This research focuses on Soft Systems Thinking and Critical Systems Thinking. In particular, Soft Systems Methodology (SSM), Critical Systems Thinking (CST) and Critical Systems Heuristics are examined in more detail. The next section briefly discusses Soft Systems Thinking and examines Soft Systems Methodology as a possible approach to evaluating technological infrastructure.

5.3 SOFT SYSTEMS THINKING

From the researches and deployments of "hard" system methodologies to "soft" systems, it was clear to the researcher like Checkland that there is a difference between meeting a precise hardware need which is stated in a specification and defining a social need on a human activities system. Rather then striking the target directly as in those "hard" system methodologies, the "soft", system thinking advocates "a system-based means of structuring a debate, rather then as a recipe for guaranteed efficient achievement" (Checkland, 1993). Soft system thinking looks at the wider picture, the problem situation, rather than a specific problem. Checkland has recognized that such problems come from unease feelings about the existing system. These are recognizable but cannot be firmly defined. Also, these "unease feelings" might go away or become more severe from time to time. Because of these, a "soft"

system researcher must not be pressed to provide a solution to a problem, which is not explicitly defined. Instead, the researcher should alleviate the problem situation.

"Soft" system methodology is based on the concept of action research. This means that the researchers are not just observers in the process of solving the problem as in "hard" system methodologies. The "process of change" itself is the subject of the research. This is different from researches belongs to "hard" system thinking, for example, conducting research on magnetism (Checkland, 1993), where the researcher can only be an observer of a phenomenon. In problem situations like a problem involving social interactions, the researchers will be unable to be observers. They have to react to things happens in the problem situations. The researchers have to use their experiences from participating in problem situations as a source insight to improve the ill-structured "soft" system.

Techniques (such as those found in "hard" system thinking) tell the researcher how to solve problems. With the munificent variety aspect of real life problem situations, Checkland argues that improving them with techniques, precise specific procedures that produce repeatable results, is not feasible. Methodology that tells the researcher both "what" and "how" is more desirable. The methodology "should be capable of being, used in actual problem situations", "should provide a greater spur of action", and "should allow insights which precision might exclude" (Checkland, 1993). Soft Systems Methodology by Checkland is discussed in the next section.

5.3.1 Soft Systems Methodology

Soft Systems Methodology (SSM) is a systemic approach to problem solving is provided in a methodology developed by Peter Checkland and others, Professor of Systems at Lancaster University (Checkland, 1981). SSM attempts to foster learning and appreciation of the problem situation between groups of stakeholders rather than set out to solve a pre-defined problem.

There are two main *modes* within SSM, real world activities, and systems thinking about the real world. Initial work involves interviews and meetings to gain an understanding of the problem situation, which is represented by the use of "rich pictures". Systems thinking using

concepts of hierarchy, communication, control, and emergent properties are used to identify "relevant systems" which may provide useful insights.

These relevant systems are logically defined by constructing "root definitions" which are then used to generate "conceptual models" of the selected systems. Different conceptual models representing different viewpoints are then used as the basis of a debate, which through an "appreciative process" can lead to feasible and desirable change and then to action. Soft Systems Methodology is based on the following axioms:

1. Problems do not exist independent of human beings, they are constructs of the concerned mind, defined by individual world-view; therefore look not at the problem but at the situation.
2. Interrelationship of problems = "mess" (multiple problem situation).
3. Weltanschuaang or world-view – different and valid interpretations of the world by each individual.
4. (Corollary of 1) Solutions are also intellectual constructs and no "problem" exists in isolation.
5. Improvements in situations are most likely through sharing of perceptions, persuasion and debate. Analysts should be interactive/therapeutic rather than expert. Analysts cannot be divorced from the problem.

SSM addresses complex management problems: "SSM is not usually concerned with well-defined (often technical) problems in organizations – such as how to maximize the output from a manufacturing facility – but with the ill-structured problem situations with which managers of all kinds and at all levels have to face" (Checkland and Holwell, 1998).

SSM (mode 1) is represented as a seven-stage process (Checkland, 1981). The seven stages are illustrated in Figure 5.4. The learning strategy of the seven-stage model centres on iterative modeling. Unstructured modeling (rich pictures), which serves to abstract features of the problem domain is complemented by formal textual modeling (root definitions) and activity modeling. The resulting holons are used as devices for comparison with the "real

world", to stimulate constructive debate and thus, in tandem with the "cultural" stream of enquiry, to hone the researchers' understanding of the problem situation.

By 1990 this "logic stream" had been complemented by a cultural stream of inquiry (Checkland and Scholes, 1990). Analysis of the intervention itself (analysis one) is supplemented by the analysis of the roles of problem owner, problem solver and client as the situation unfolds (see Figure 5.6).

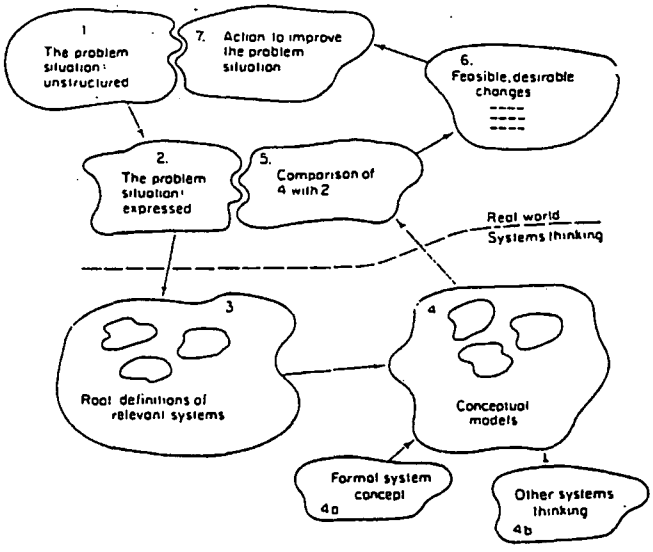


Figure 5.4: Seven-stage Model of SSM (Checkland, 1981).

Cultural analysis involves an interrelated model of roles, norms and values. Political analysis asks: "What are the commodities through which power is expressed in this situation? How are these commodities obtained, used, protected, preserved, passed on, relinquished? Through what mechanisms?" (Checkland and Scholes, 1990). The fundamental systems concepts are developed into an enquiry "language" – a set of well-defined ideas that can structure thinking. These are represented by the "epistemology of SSM" (Checkland and Scholes, 1990). The arbitrary dividing line between systems thinking and the real world has disappeared, although the idea is still encapsulated in the form and language of the model ("compare", "differences", "real situation", "real world").

In the most recent formulation of SSM (Checkland and Holwell, 1998), which is accompanied by a companion model showing the developing nature of the modeling and enquiry process during the course of a study, the distinction between systems thinking and

the real world has entirely disappeared. The focus on social and political issues is retained (see Figure 5.6).

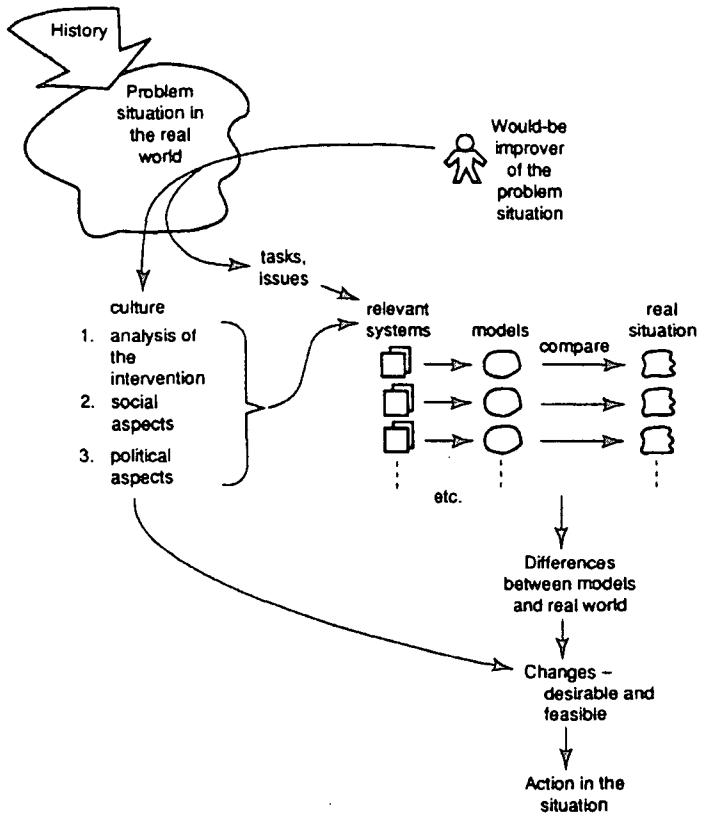


Figure 5.5: The "developed form" of SSM (Checkland and Scholes, 1990).

According to the set of constitutive rules set out by Holwell (1997), researchers undertaking SSM must:

- accept and act according to the assumption that social reality is socially constructed;
- continuously use explicit intellectual devices consciously to explore, understand and act in the situation in question; and
- include in the intellectual devices "holons" in the form of systems models of purposeful activity built on the basis of declared world-views.

The early formulation of the seven-stage model (Figure 5.4) with its postulation of a below-the-line "real world" (apparently unitary and the same for all observers), seems to assume an

objectivist ontology. However, Checkland always distinguishes his stance from that of the natural sciences: "human beings can always attach different meanings to the same social world" (Checkland, 1981); "human beings are not simply ready to attribute meanings, they cannot abide meaningless"; "an interpreted, not merely an experienced world" (Checkland and Scholes, 1990). Other exponents of SSM follow suit: "human activity systems *do not exist* . . . what do exist are *perceptions* of them in the heads of observers" (Wilson, 1984).

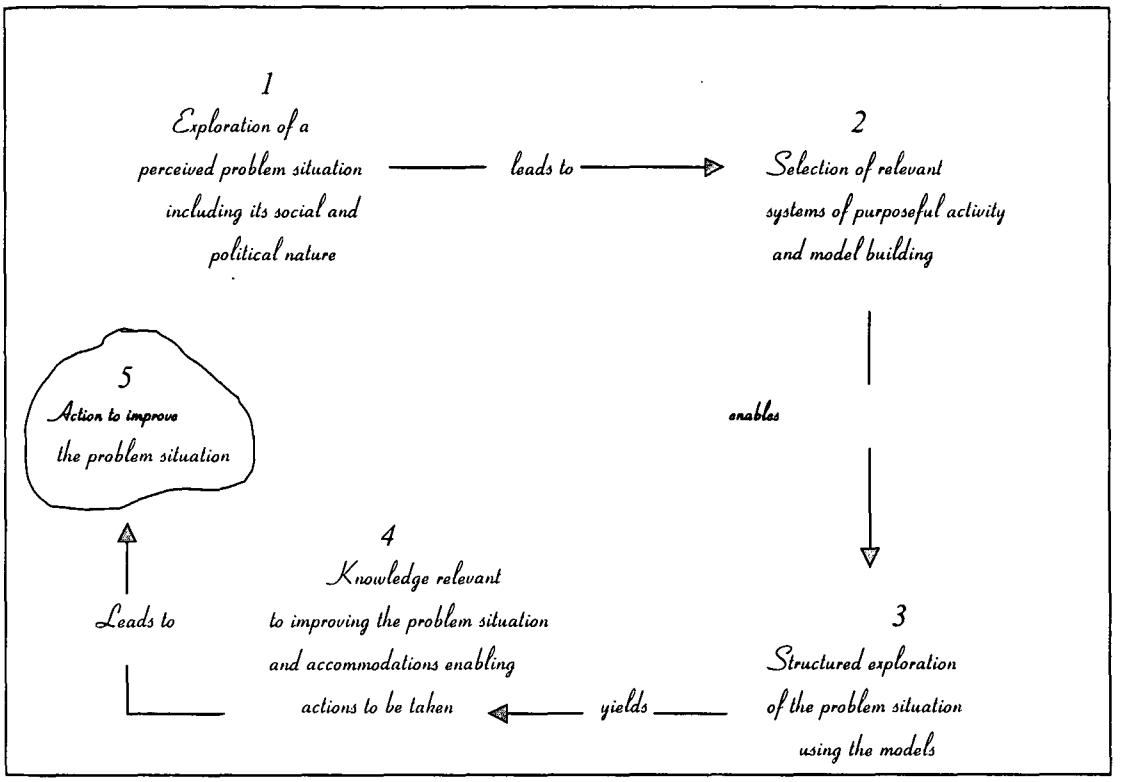


Figure 5.6: SSM version 3 (Checkland and Holwell, 1998).

Later, Checkland associates his "real world" with "the unfolding flux of events and ideas" as characterized by Vickers (Checkland and Scholes, 1990), without entirely removing the difficulty for researchers schooled to think of social reality as constructed. The central position of "Weltanschauung" in the methodology, (primarily governing a set of beliefs that validates the transformation of a holon, but also covering larger scale "world-views" (Checkland, 1986)) also predicates an interpreted or socially constructed view of reality. Even more fundamentally, the methodological device of developing "relevant systems" – different *analyst* interpretations of aspects of the problem situation – is also consistent with an interpretative stance. In this case the underlying assumption is that the analyst is

"interpreting" or allotting meanings, and that a range of those interpretations helps the analyst to a richer, broader, more useful understanding.

More recently, Checkland has accepted that the meaning of the dividing line between the "real world" and the "systems thinking world" of the seven stage model was "heuristic rather than theory-based" and that it implies a "false dualism" which soft systems practitioners need to move beyond (Tsouvalis and Checkland, 1996). Later formulations of SSM abandon the dividing line (Figure 5.5) and then erase the remaining language of the division (Figure 5.6). Checkland evolves towards a more consistent ontological stance involving a socially constructed world in which "participants continually negotiate and re-negotiate with others their perceptions and interpretations of the world outside themselves" (Checkland, 1986). Since the SSM analyst is also a participant in that process of perception and interpretation of the world we should perhaps take the "real world" of the seven-stage model to mean a prior, or non-conceptualised, perception of the problem domain, and the "systems thinking" as the epistemological set of principles which allow us access to a richer understanding, and therefore altered (richer, more insightful) perceptions of that domain (Checkland and Scholes, 1990).

The investigative force of the methodology derives not from an ontological view of a systemic world, but the epistemological power of a set of systems concepts that may structure thinking about the world. Those concepts (emergence, hierarchy, communication and control (Checkland, 1989)), in turn derive their investigative power from being good and plausible expressions of one of the ways in which we tend to structure the unassailable complexity of the world in order to derive meaning from it. The epistemological, or learning premise of his work involves the conscious movement between unstructured perceptions of the world and perceptions structured by systems principles, in order to foster debate (Tsouvalis and Checkland, 1996; Rose, 1997).

Models are simple enough to be comprehensible, without the "black box" effect where internal working of models is unapproachable without specialist understanding. In soft systems terms, then, human activity is characterized as people doing things for reasons – related sets of purposeful activities. However, representations of those human activity

systems are not thought of as descriptive or normative, merely as devices for interrogating our understandings and perceptions of the world and fostering debate (Checkland and Scholes, 1990). It follows then, that there is no one correct representation of any situation, neither in the form of a soft systems model, nor in the form of any mental model in an observer's head. Human activity is thought of as being both too complex to be adequately represented, and subjective or interpreted, and therefore not amenable to objectively *correct* observation. Our perceptions of events are coloured by the set of experiences which we have already had (our appreciative setting) each experience may alter the models we build and consequently our perceptions of subsequent events.

An outcome of an SSM study is learning, which may be gathered from many sources besides the logic stream; from social and political analyses and analysis of the intervention itself, from debate enabled by modeling and by a common systems "language" and from effecting change. There is no reason why that learning should not be expressed as theory (Rose, 1997). However, SSM offers no explicit logic of theory construction. The forms of theory generation and testing which have occurred have tended to be developments of the methodology itself. CATWOE (Smyth and Checkland, 1976) is a notable example, as is Checkland's development of mode 2 (Checkland and Scholes, 1990). This is consistent with the self-reflective nature of action research. The methodology's philosophical stance (its ontological and epistemological presuppositions) is normally allied with the interpretative quadrant of Burrell and Morgan's well-known matrix (Jackson, 1991).

The major aspects of SSM can be summarized as follows (Mordechay, 1999):

- SSM is mainly a problem-solving methodology in a systems context approach. It tries to analyze human activities as systems and subscribe a solution that will address the whole situation and not just the specific problem. As such, SSM can be described as a holistic and systemic approach.

- SSM is a participatory approach, which tries to involve the problem owners – stakeholders, decision-makers etc. – in the analysis and in finding the solution. The reason for this is that SSM evolved from "action research" – a research in which the

researcher immerses himself/herself in the analyzed organization and work, with close contact with the problem owners.

- SSM offers guidelines and a set of tools that the analyst can use. However, the analyst can and should align the methodology with the specific context that he is working on. SSM encourages the analysts to iterate and repeat stages as much as necessary.

- SSM enables the analysts to incorporate "soft knowledge" and to expose political and cultural conflicts. Moreover, because SSM puts this conflict up front, it enables a better understanding of the problem situation and the solution constructions.

However, there are a number of criticisms levelled at SSM, and an important one is the lack of support given by SSM in the Choice and Implementation stages of the decision-making process (Jayaratna, 1994). In general there are several common criticisms of Soft Systems Thinking methodologies:

- Firstly, it is argued that Soft Systems Thinking is set squarely on a consensus world-view (Jackson, 1991: 162). Its critics claim that the social world is sometimes characterised by asymmetry of power, structural conflict, and contradiction.

- Secondly, soft systems thinkers are seen as taking the possibility of participation for granted, but they ignore the obstacles to participation and free and open discussion that may occur as a result of power relationships between the stakeholders.

- Thirdly, it is alleged that the position of powerful stakeholders is not threatened by soft systems studies because significant issues can be kept off the agenda for debate. Finally, according to Jackson (1991), Soft Systems Thinking is criticised for its subjectivism or its idealism, and for its consequent failure to come to terms with structural features of social reality such as conflict and power.

The next section focuses on Critical Systems Thinking.

5.4 CRITICAL SYSTEMS THINKING

The field of systems thinking in the UK has undergone significant change during the last two decades, particularly in terms of the methods used to intervene or bring about change in organizations. There has been a move from "hard", quantitative methods (Hall, 1962) to "softer" approaches that focus on generating and managing debate (Checkland, 1981), which in turn have been augmented by critical systems approaches that help to facilitate choices between the various methods available.

Critical management science emerged in the early 1980s, in response to what CST proponents perceived as a lack of an element of self-reflection within traditional management science. Among others, Jackson (1991) criticizes traditional management sciences of being dominated by a technocratic consciousness, a consciousness that does not consider the impact of environmental, social, and human factors upon an organization. For instance, he points out that traditional management approaches do not question the existing inequalities within organizations as well as in the society in general. Furthermore, the advocates of critical management science are appalled by the lack of internal criticism within the traditional management field. In particular they criticize the traditionalists for not questioning the theoretical and methodological underpinnings of their own approach to management. Their assumptions or paradigms that they hold are fixed and taken for granted as correct.

Theoretically considered CST is founded mainly on Kantian philosophy and Habermasian critical social theory (Habermas, 1984; 1987). CST is guided by critical as well as social reflection, emancipation, and theoretical, methodological and practical complementarism. According to Jackson (1997)there are two strands in CST, Critical Systems Heuristics and Critical Systems Thinking UK type . While CST shares the critique of Hard Systems Thinking with Soft Systems Thinking, it criticizes Soft Systems Thinking for being not critically reflective and also unable to manage social power structures. The two issues are postulated to be dangerous, since they may serve the already existing interests. CST aims at democratic management by involving all affected in a systems study.

5.4.1 Critical Systems Thinking UK Type

For Jackson and other advocates of Critical Systems Thinking (CST), there is no single management theory and methodology that can address the myriad of problems faced by contemporary organizations and societies. In other words, there is no single management approach that can solve organizational or societal problems independent of other management approaches. Against the traditional or reductionist approach to management, Jackson and his colleagues propose the CST, which, *inter alia*, promotes complementarism and diversity in management science. In addition, there are two major strands in CST as indicated by Midgley (1997): CST in the British research as will be discussed here and the strand of CST promoted by Werner Ulrich.

CST is a holistic and systemic approach into problem-solving, which is based upon five pillars, namely, critical awareness, social awareness, and dedication to human emancipation, complementarism (at both the theoretical and methodological levels):

Critical Awareness: Critical awareness is an approach that integrates complementary management theories and methodologies in problem-solving; CST places emphasis on the understanding of the various theories and methodologies it integrates as well as the contexts into which it applies these theories and methodologies. This kind of an exploration is called critical awareness. There are three interlinked forms of critical awareness that system practitioners identify in the literature on CST:

- the understanding of the strengths and weaknesses and the theoretical underpinnings of available systems methods, techniques and methodologies (Jackson, 1991);

- the understanding of both the context of application and the possible consequences of employing the methodologies once the context has been defined (Flood, 1990; Jackson, 1990); and

- the close examination of the assumptions and values underlying the systems methods. To the extent that CST questions the fundamental assumptions underlying the systems method, it is similar to BPR. However, where CST departs from BPR on this

issue is on the depth of its critical examination of the systems method. Whereas BPR focuses its examination on the business processes, CST moves behind and beyond these processes, exploring the context(s) under which these processes occur and the impact of these processes on human relations and the environment.

Social Awareness: CST, unlike BPR, is premised on a theory that all of life is webbed. What happens on a factory floor has implications and dire consequences for the ecosystem. The social awareness aspect of CST compels system practitioners to think carefully about the social implications of the methodologies they employ. This way they can minimize or avert whatever social crises may arise as a result of the application of certain systems methodologies in particular contexts. CST does this because it is committed to human emancipation.

Human Emancipation: Another benchmark of CST, which separates it from BPR and other management systems, is that it is dedicated to human emancipation. It is informed by Habermasian theory of human knowledge. CST practitioners believe that all human beings have technical, practical and emancipatory interest in the functioning of the organization.

This quest for emancipation (Jackson, 1991) argues that human beings can be satisfied only by a systems method such as CST, which integrate technical, practical and emancipatory methodologies, and promotes diversity and complementarism. Jackson further posits that, "CST is dedicated to human emancipation and seek to achieve for all individuals their maximum development of their potential. This is achieved by raising the quality of life in organizations and societies in which they participate" (Jackson, 1991: 186). Given the complexity of human situation, no single theory or methodology is capable of facilitating human liberation (Jackson, 1991). This brings us to another important pillar of CST, namely, complementarism at theoretical and methodological level.

Complementarism at the methodological and theoretical level: Complementarism considers different systems approach into problem-solving, at the theoretical and methodological levels; this is also referred to as pluralism at both levels. CST promotes complementarism in messy and complex situations, which are faced by organizations and societies. Complementarism is premised on the assumption that there is no single theory and methodology that can be used to address problems that are faced by contemporary

organizations and societies independently from other methodologies. This is achieved through a process of assessing the strength and weaknesses of different systems approaches, in relations to the tasks or situation, which is faced by an organisation at that particular period. When methodological and theoretical complementarism are implemented in problem-solving, it assists in having well-informed results of the intervention. Flood and Jackson (1991) argues that "Systems of Systems Methodology sit above and co-ordinates methodological paradigms" Midgley (1993: 13), further argues that complementarism is a proposition of meta-science that respect human well-being, it co-ordinates other sciences (knowledge and methods) in an informed manner.

Human beings are considered to be playing a pivotal role in CST, their needs and contributions are continuously taken into consideration. CST is committed to critical reflection. Complementarism attempts not to suppress other systems approaches at the expense of others, hence the promotion of meta-paradigmatic through identification of strengths of other methodologies. In CST, continuous change and academic debate is encouraged.

Within management sciences some are still hooked to the traditional approaches into problem-solving namely isolationism, imperialism and pragmatism (Flood and Jackson, 1991). Isolationist methodological approaches believe that their particular approach is superior when compared to others. Isolationists' tendencies are based on consensus and are not questioned in most instances.

Proponent of this approach believes that their methodology is superior; its approach is that some of the management science disciplines can be assimilated under their umbrella. As Jackson argued that "the imperialist strategy assumes that one or another of the strands of management science is fundamentally superior and can provide suitable foundations for the development of the discipline, but at the same time is willing to incorporate aspects of other strands if they seem to be useful and add strengths in terms of favoured approach" (Jackson, 1991: 289). It is open to new ideas but they should be integrated into the dominant or favoured one.

Pragmatists based their approach into problem-solving not on a theory but purely on experience. They use any tool at their disposal when it comes into problem-solving. Jackson

(1991) argues that pragmatists do not undertake reflective inquiry but prefer to use whatever works in practice. They believe in effective action, or are very distrustful of theory and do not spend much time into understanding a problem situation. Jackson (1991) argues that, "pragmatists concentrate on building a tool kit of techniques that can be used as required in a real world situation" (Jackson, 1991: 261). For a pragmatist, there are answers and techniques that are already available and they can be used in addressing complex issues. Then the conclusion is that a pluralist approach based on CST would be more suitable to the problem of concern in this research.

5.4.1.1 System of Systems Methodology

The System of Systems Methodologies (SOSM) was proposed for the first time by Jackson and Keys (1984). The formative idea of the system of systems methodologies is that it is possible to construct an ideal-type grid of problem contexts that can be used to classify systems methodologies according to their assumptions about problem situations (Jackson 1991). SOSM considers that there are two aspects of problem contexts that are particularly pertinent to the characterisation of the very problem-managing situation. One is the system in which the problems are located, the other is the relationship between the participants, that is, those who can make decisions that affect the behaviour of the system. Systems are classified (Jackson, 1991: 28) to be either simple/mechanical or complex/systemic.

- Simple systems are characterised by having a small number of elements with few interactions between them. Such systems are likely to be governed by well-defined laws of behaviour, to be largely closed to the environment, to be static over time, to be unaffected by behavioural influences, and to have subsystems that are passive and do not pursue their own goals.

- Complex systems are characterised by having a large number of elements that are highly interrelated. Such systems are probabilistic, open to the environment, evolve over time, are subject to behavioural influences, and have purposeful parts.

The other aspect of a problem-management situation is the relationship between participants. SOSM offers three alternatives (Jackson, 1991):

1. Unitary problem context occurs when the participants associated with a particular problem context are in genuine agreement on objectives, share common interests, have compatible values and beliefs, and all participate in decision-making.
2. Pluralist problem context occurs when the participants have divergent values and beliefs and, to some extent, differing interests and objectives, but a genuine accommodation or compromise can be reached upon which all agree.
3. Coercive problem occurs when there is little common interest between the participants, there is a fundamental conflict, and the only consensus that can be achieved is through the exercise of power and through domination.

Combining the two qualities of problem-solving situations may give a six-cell matrix, with the following problem categories: simple-unitary, complex-unitary, simple-pluralist, complex-pluralist, simple-coercive, and complex-coercive (Figure 5.7).

Systems of Systems Methodologies: Six Cell matrix			
	Unitary	**Pluralist**	**Coercive**
Simple	Simple Unitary	Simple Pluralist	Simple Coercive
Complex	Complex Unitary	Complex Pluralist	Complex Coercive

Figure 5.7: Classification of problem situations as exercised by the Systems of Systems Methodologies (Flood and Jackson, 1991b).

The next step is the allocation of the contemporary systems approaches to the model described above. This implies the following (Flood and Jackson, 1991b):

1. The simple-unitary cell contains Operations Research, Systems Analysis, Systems Engineering, and Systems Dynamics.
2. The complex-unitary cell is said to contain Viable Systems Model, General Systems Theory, Socio-Technical Systems Thinking, and Contingency Theory.
3. The simple-pluralist cell has Social System Design and Strategic Assumptions Surfacing and Testing approaches.

4. The pluralist-complex cell contains Interactive Planning and Soft Systems Methodology.
5. The simple-coercive cell has only Critical Systems Heuristics.
6. The last cell, the complex-coercive, is said not to have any approach, since there are no known methodologies that can support such problem situations.

The System of Systems Methodologies is meant to enable potential users to assess the strengths and weaknesses of different methodologies for their purposes (Flood and Jackson, 1991b). In the previous section CST was explored, focusing mainly on its theoretical and philosophical underpinnings. The next section moves beyond theory, discussing how CST can be used in a real concrete situation. Towards this end, both version one and two of the Total Systems Intervention (TSI) methodology, which is regarded by most critical systems thinkers as a methodology grounded in CST, will be examined in more detail.

5.4.1.2 Total Systems Intervention version One

Total Systems Intervention (TSI) is described by Flood and Jackson (1991) as a meta-methodology that offers a mechanism to problem-solvers how to select from the different systems approaches that can be used in problem-solving. This methodology, Flood points out, has been developed to provide managers with a practical and useful system-based approach to problem-solving (Flood, 1995: 393). TSI, he further posits, offers managers with procedures to integrate all methods for problem-solving in a process which ensures that such methods are employed to tackle only issues that they are best suited to. Among the various problem-solving methodologies that are possible to use within TSI are such systems approaches as Soft Systems Methodology, Systems Dynamics, and Viable Systems Methodology, to mention a few. The underlying philosophical assumption under which TSI works is that of CST: that all problem-solving methods are complementary. TSI version one advocates that different systems approaches to problem-solving can be considered for use to solve organizational problems but once a choice of a dominant methodology is made, it is to be followed in an intervention.

Total Systems Intervention (TSI) can be considered as a "meta approach" in that it advocates use of all systems theories and methodologies in an informed and complementary manner. Spearheaded by the works of Jackson and Flood, this new orientation challenges some of the

earlier orientations and embraces a set of core commitments such as critical awareness, social awareness human emancipation and complementarity.

The Process of TSI Version One

According to Jackson (1991: 271), TSI is a system-based intervention methodology, which uses a range of systems metaphors to encourage creative thinking about organizations and their problems. These metaphors, he points out, are linked by a framework known as the *System of Systems Methodologies* (SOSM) to various systems approaches, so that once agreement is reached about which metaphors are most relevant to an organization's concern and problems, an appropriate systems-based intervention methodology (or set of methodologies) can be employed. In order to clarify what may be perceived as a complicated intervention problem-solving methodology, Flood (1995b; 1995c) describes TSI as a process in which a manager or problem-solver operates three main types of activities:

- **think creatively** about the problem one is facing;
- **choose** a method/s with which to address the problem/s; and
- **implement** the changes sought in the organization in question.

These main types of activities are regarded as the phases of TSI version one. Figure 5.8 illustrates the process of TSI version one, following Flood and Jackson (1991). Each phase is examined to see exactly what kind of task(s) is conducted during these phases.

Creativity: During this phase, the problem-solver thinks creatively about the organisation and its problem, using a set of system metaphors provided by TSI. System metaphors refer to the systems images developed by Morgan (1986) in his book *Images of Organisation.* They have been incorporated into TSI – as tools of understanding organizational structures and problems wherein he argues that systems images are crucial to organizational development. At the heart of Morgan's work is the belief that an organisation (that is, its structure and culture) can be seen as an image of a particular system, be it a machine, brain, organism, culture, domination, coalition, prison, or many other system images he suggests. Thinking about the organizations as systems, Morgan argues, enables the problem-solver or manager to see clearly various aspects of an organization, thus enabling him or her to surface the problems that must be tackled. The goal of the problem-solver during the creativity phase of TSI is to adopt a systems metaphor/s that best describes the organization in question. It is in

this process of adopting a metaphor that the problem-solver gains insight into the organization in review and begins to think about the appropriate intervention methodology to be employed.

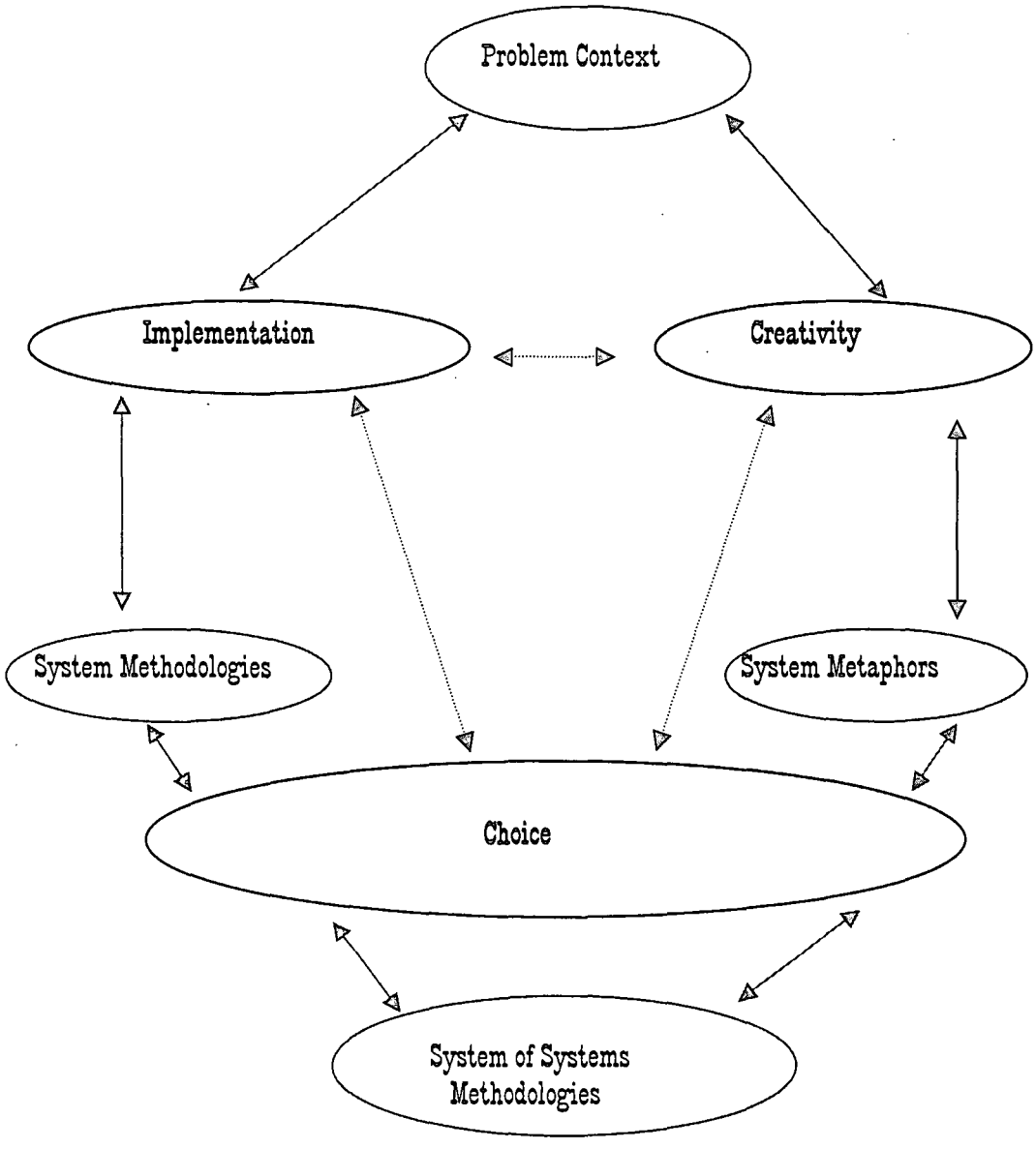


Figure 5.8: The Process of Total Systems Intervention – Version One (Flood and Jackson, 1991).

Choice: During this phase of TSI, the problem-solver chooses a systems based intervention methodology (or methodologies) related to the metaphor(s) adopted during the creativity phase. Towards this end, s/he uses the System of Systems Methodologies (SOSM) – a theoretical schema that has been constructed to classify systems methodologies on the basis

of the assumptions they make about the nature of problem situations or what is referred to as the "problem context" (Jackson, 1991: 27). By "problem context" Jackson refers to the nature of the system(s) in which the problems are located and the nature of the relationship between the participants. These two variables, Jackson argues (1991: 27-28), allow for a construction of a grid of types of problem contexts, which in turn can be used as a tool for classifying systems methodologies. For instance, Jackson (1991) argues that systems methodologies can be classified and related to each other by looking at whether they assume problems to be mechanical-unitary, mechanical-pluralist, mechanical-coercive, systemic-unitary, systemic-pluralist, or systemic-coercive.

In essence, the knowledge provided by the system of systems methodologies about the underlying assumptions of individual systems methodologies, coupled with the insight gained as a result of creative thinking (adoption of metaphor/s) enables the problem-solver to choose a systems based intervention methodology or methodologies that will tackle the organizational problems that are surfaced and yield the desired changes. The most probable outcome of the choice phase is that there will be a dominant methodology chosen – one that will tackle the most pressing or core organisational problems, while managing the less dominant interacting problems. Once the intervention systems method is chosen, it is then passed on to the implementation phase (Jackson, 1995).

Implementation: During this phase, the problem-solver implements the adopted systems methodology (or set of methodologies) to make the vision and mission of the organisation in question a material reality. The main task in this phase entails the eradication of the problems identified in the creativity phase and the introduction of systemic development or improvement within the organisation.

Limitations of TSI Version One and the Development of TSI Version Two

As with any other management theory, TSI version one is not beyond criticism. As Midgley (1996) points out, there are many criticisms that have been levelled against TSI, some methodological and others philosophical. A detailed discussion of all the criticisms is not in the scope of this research. These have been explored at length in Midgley (1996). This section highlights six important criticisms of TSI version one:

- First, the complementarism of TSI is not well conceived. TSI draws upon the various systems methodologies without showing exactly how the different and sometime conflicting assumptions and epistemologies embodied by the systems methodologies are integrated methodologically. This conceptual limitation, as Tsoukas (1992) observes, renders the use of TSI problematic.

- Second, critics of TSI version one point out that the TSI metaphorical grid prescribed by Flood and Jackson (1991) is restrictive in that it discourages problem-solvers from generating their own metaphors and conducting their own metaphorical analysis of problem situations. The six metaphors that TSI offers are limiting.

- The third methodological criticism levelled against TSI version one is that the system of systems methodologies is very difficult to follow, that it is inaccessible to the non-academic audience.

- The fourth criticism, which is also related to the second, is that the system of systems methodologies within TSI does not take into account the methodological developments in the various systems discourses. That is, it deals with the individual systems methodologies as though they are fixed or finished products. The last two criticisms are more philosophical than they are methodological.

- Fifth, post-modern critics of TSI version one note that like CST, TSI is anthropocentric, that it focuses solely on human beings and neglects the ecosystem into which human beings are linked and within which they function.

- Sixth and lastly, post-modern critiques also point out that the TSI version one methodology privileges the manager as though organisational development rests on his or her shoulders.

The above criticisms led Flood to explore further developments of TSI which resulted in the development of TSI version two or what is sometimes referred to as the Local Systemic Intervention (Flood, 1995).

5.4.1.3 Total Systems Intervention: Version Two

TSI version two is both continuous and discontinuous with the first version. Continuous in that it still emphasizes the three main phases of TSI activities in problem-solving, namely, creativity, choice, and implementation. However, TSI version two differs from TSI version one in many respects. First, responding to the criticism that TSI version one thwarts creativity, Flood (1995b; 1995c) revised TSI by, among other things, making the TSI methodology recursive. What this means is that all the phases of the TSI approach are represented at the micro-level within each of macro-level modes. Figure 5.9 below illustrates this newly revised TSI approach into problem-solving.

Second, Flood accepted the criticism that the metaphorical analysis that TSI version one prescribed was indeed restrictive. To correct this situation, he introduced three things in order to encourage TSI practitioners to generate their own metaphors: (1) "divergent" metaphorical analysis; (2) the use of creativity-enhancing techniques such as brainstorming and idea writing; and (3) an understanding of the "ergonomics of reflection" (Flood, 1995c).

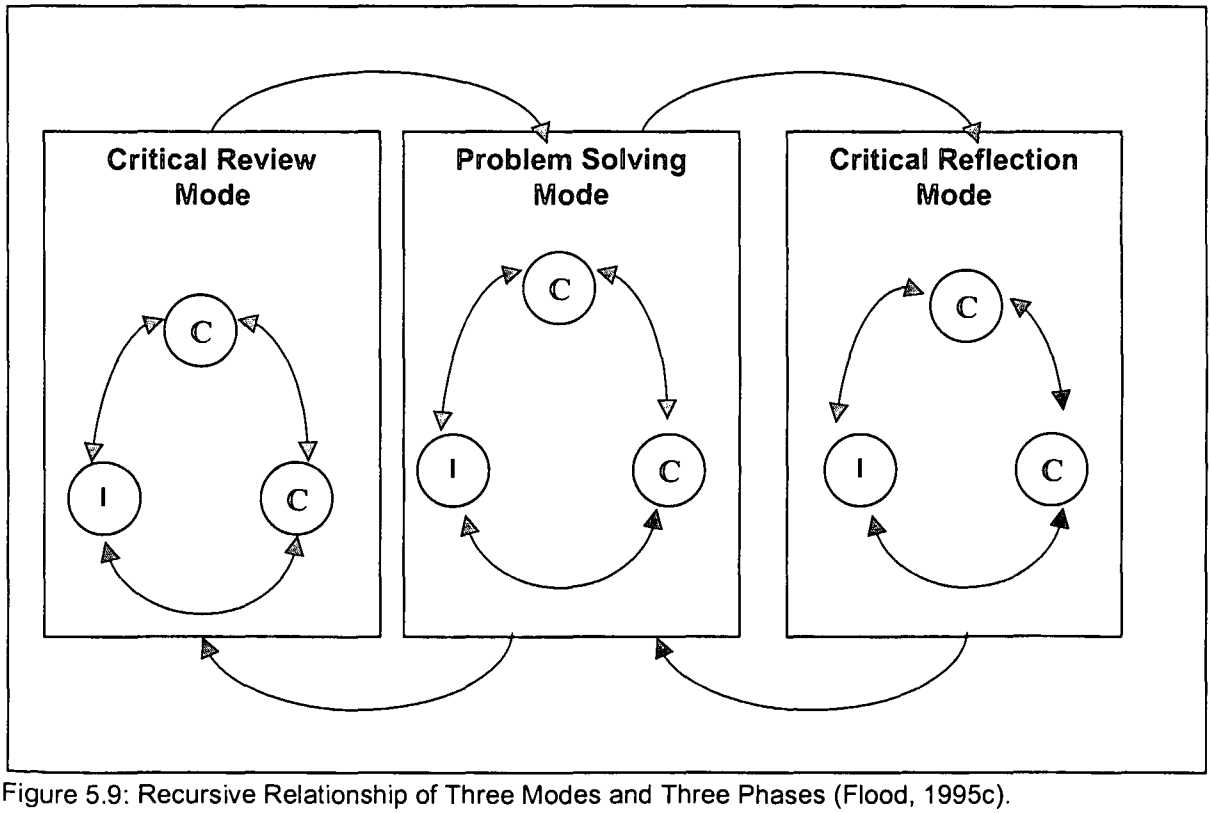


Figure 5.9: Recursive Relationship of Three Modes and Three Phases (Flood, 1995c).

According to Flood "problem solving is a mixture of creative thinking, choice of method and implementation of change proposal worked out by operating the chosen method(s)" (Flood, 1995c: 11). Moreover the manager should be cognisant of the fact that organisational problems do not exist in isolation. In other words whatever problems one faces in an organisation, is part of a whole. Likewise, the decision that will be made on a particular problem will have an impact on the entire organisation. A problem-solver or manager needs to have a holistic or systemic approach into problem-solving.

According to Flood (1995c) TSI version two provides the problem-solver with the tool with which s/he can tackle organisational problems systemically. This version of TSI, like TSI version one is premised on the notion that organisation is a system that comprises of parts and subsystems that continually interact with each other. It must be noted that methodologically, TSI version two is different from TSI version one. Whereas TSI version one methodology hinges around metaphorical analysis of problem situations, TSI version two abandons this analysis and introduces instead four key dimensions for analyzing organizations. The four dimensions that are identified by Flood (1995c: 21) are:

- **organisational processes:** flows and controls;
- **organisational designs:** structures, functions, co-ordination and control;
- **organisational culture**: mediation of behaviour in terms of people relationships, social rules and practices;
- **organisational politics:** issues of power and potency to influence flow of events.

The organisational process is mainly concerned with the main core output and sub-output of a particular organisation. It identifies the main processes that add value to the customers and processes that are mainly internal in this situation. In essence, the organisational processes have to do with the flow of events from the input through the main process and then the output.

The organisational designs are the structures within which the organisational culture takes place. The designs are functions and not people or lines of authority that co-ordinates and control processes.

Organisational culture has to do with the creation of an organisational culture that will be shared by all members of the organisation, regardless of their cultural backgrounds. TSI version two recognizes that individuals bring to the organisation distinct cultural experiences which, when mediated, may prove disastrous for decision-making and the overall performance of an organisation. TSI version two helps managers avert this disaster by enabling them to devise or develop a communication system that is pregnant with universal cultural symbol(s). Such system will promote cohesion among members, which in turn will positively impact production.

Organisational politics assist in identifying who holds power and how power is exercised. Organisational politics is associated with decision-makers; it influences the flow of events within the organisation.

Principles of TSI version two: The principles of TSI are drawn from its philosophy. The principles play a significant role in the evaluation of the effectiveness of the intervention. There are four principles that have been identified by Flood (1995b; 1995c) being systemic; achieving meaningful participation; being reflective; and enhancing human freedom.

The principle of being systemic encourages problem-solvers to be systemic when they are engaged in interventions. When they look into organizations, they must look into them from a holistic point of view; keeping in mind that, the system or subsystem they are involved with, is part of the greater whole. Organizations consist of different levels of hierarchies, that is systems, subsystems and supra-systems. These different levels of systems interact with each other.

The next principle is provision of meaningful participation promotes organisational diversity by insisting that the boundaries of organisational discourse be wide open in order to allow for the surfacing of new ideas and perceptions. As Flood observes, meaningful participation follows from the systemic principle in that "it develops an appreciation of all intervention between all parts, of technical and human sorts, at the three level at any time, then the perception of all people involved and affected must be drawn into the picture" (Flood, 1995c: 27). When boundaries are restricted, certain voices are muzzled and the organisational picture that emerges from this situation is distorted.

The next principle is being reflective. Flood (1995c) argues that organisational events are what people think they are. It is important to know what people think. This principle is crucial because people's perceptions about issues are recognized. Decisions that are taken are discussed and reasons why certain methods or approaches are preferred, are reflected. Issues that cover this principle include technical and human issues, which are faced by participation in an environment in which changes are being executed. Human freedom is inextricably linked to being reflective.

Process of TSI version two

The TSI version two process is both continuous and discontinuous with that of TSI version one. It is regarded as continuous because the three stages of that version one - creativity, choice and implementation – constitute an element of TSI version two. TSI version two is discontinuous with TSI one because of the addition of three modes of operation into its process. These are: Critical Review Mode, Problem Solving Mode, and Critical Reflection Mode (see Figure 5.9). These are discussed briefly below.

Critical Review Mode: TSI version two can incorporate a wide spread of models and methodologies. According to Flood and Romm (1996a), it does this by critically reviewing models and methodologies with a view of incorporating them in its system of approaches operated through the problem-solving mode. During this mode, system models and methodologies are identified, and critically reviewed using the three TSI version one phases. That is, each model and methodology undergoes review advocates forms of creativity, choice and implementation.

As Flood and Romm (1996) point out, the critical review mode allows people to decide on an intervention model and methodology. Critical review mode, they write, "is needed so that people can prepare for themselves a diverse system of models and methodologies, capable of tackling the complex and issues that they face today . . . the critical review process is never complete in a sense that there will always be more approaches to review and indeed, always scope for further evaluations of those already incorporated" (Flood and Romm, 1996: 103).

Following this review of models and methodologies, the evaluative process considers the following questions as proposed by Flood and Romm (1996).

1. How can we efficiently design processes?
2. How can we realize effective organizational design?
3. What options should we debate and decide upon?
4. Why should we accept any resulting design or decision, and who is likely to benefit?

Problem Solving Mode: During the Problem Solving Mode, the identified model/s and methodology/methodologies (can be one model or more than one model and also a methodology or more than one methodology depending on the problem) are used to tackle the core problem(s). In the process of intervention, each of these models and methodologies adopted undergoes the three-phase TSI evaluation process – creativity, choice and implementation. In this stage divergent ideas are discussed and debated which then lead into convergence with the purpose of reaching a consensus.

In the choice phase there is creative alignment of the models and methodologies in addressing the core issues that are facing the organization, this is followed by a choice of the models and methodologies and lastly the implementation of the models and methodologies. In this phase four-dimensional questions are asked or taken into consideration – they are organizational processes, organizational design, organizational culture and lastly organizational politics. The last step of problem-solving mode is the implementation phase.

In the implementation stage there is creative development of the change proposal, which leads to the choice of change proposal and the implementation of that proposal. There are a number of issues are addressed during this stage. These include process design, organizational design and the evaluation of design and decisions that has been taken. This then leads to the implementation of those decisions.

Critical Reflection Mode: The critical reflection mode is the last mode of TSI/LSI version two. During this mode, the three phases of TSI/LSI – creativity, choice and implementation – works in the following way: Firstly it operates in the anti clockwise manner; and secondly it raises questions about the outcome of the three stages that are in the problem-solving mode. Flood and Romm (1996) argue that this can be achieved by asking whether the intervention models and methodologies used were suitable or appropriate. The three phase of TSI evaluative process work as follows during the Critical Reflection Mode:

- **implementation phase:** receives a model or methodology reasoned during the problem-solving mode, and passes it through to the next phase.

- **choice phase:** receives details of issues to be managed from the problem-solving mode, on the basis of choosing a model and methodology for implementation.

- **creativity phase:** receives details of change of proposals or courses of action from problem-solving; judged to be relevant to manage issues surfaced through creative thinking.

In these three modes and three phases of TSI version two, there is no beginning and an end; the process is continuously recursive.

5.4.1.4 Summary of TSI Version One and Two

Having discussed Total Systems Intervention version one and two, there is a need to evaluate these two systemic methodologies. Both interventions attempt to apply CST in the real world situation. Flood and Jackson (1991) developed TSI version one. TSI version one, as mentioned above, is divided into three phases: creativity, choice and implementation. Different functions are executed during each of these three phases. During the creativity phase the focus is on the identification of a suitable metaphor. The problem with this phase is that there are only limited metaphors to choose from. TSI metaphorical analysis fails to adequately describe problem situations not characterized by the proposed metaphors; it is also so rigid that it suppresses the creativity of TSI users. Another major problem with TSI version one is that the Systems of Systems Methodologies is very difficult to understand, let alone applying it on concrete problem context. This difficulty does not only affect non-academic audience but systemic practitioners as well.

TSI version two attempts to resolve some of the problems and limitations identified in version one. It is characterized by the three modes, that is, Critical Review Mode, Problem Solving Mode and Critical Reflection Mode which were not part of version one. In each mode the three stages of TSI are applied.

TSI version two was developed as an extension to TSI version one. It is meant to simplify the TSI process – even Flood himself suggests that his book *Solving Problem Solving* (1995) on TSI version two is meant to assist both the academic and non-academic audience to be able to apply TSI in wide management contexts. However, upon critical reflection on TSI version two, one finds that it is much more complex to understand compared to TSI version one, let alone applying it in real life situations. In addition, its philosophical foundations are not clearly specified by Flood in his writings. Therefore further work is needed to investigate which version of TSI has potential for further enhancement of Critical Systems Thinking.

5.4.2 Critical Systems Heuristics (CST Swiss Type) and Boundary Critique

As indicated earlier, the research on CST is conducted not only in the UK but also elsewhere in Europe. Perhaps one of the non-British scholars whose work on CST has had enormous impact in critical management science, is Werner Ulrich. In his book *Critical Heuristics of Social Planning*, published in 1983, Ulrich levelled a strong critique against what he saw as a credibility gap in both the hard and soft systems approaches. Specifically, he noted that the systems approaches did not allow for a critical reflection either upon the goals attained and means used by hard systems thinking or upon the nature of the consensus achieved and the changes brought about by soft systems thinking. As a corrective, Ulrich proposed what he calls Critical Systems Heuristics (CSH).

CSH is a systems methodology that seeks to unravel the "normative content" of actual and proposed system designs. By "normative content" he refers to both the value assumptions that underpin intervention and the consequences such intervention impose on both participants and non-participants. CSH differs from hard and soft systems approach, in that it critically reflects upon the goals that have been attained through these systems approaches and the nature of the consensus, which has been achieved.

Flood and Jackson best described CSH as a "means of interrogating systems design to reveal the boundary judgements being made and a means of postulating alternative boundary judgements, that is of asking what the boundaries should be" (Flood and Jackson, 1991: 205). Flood and Jackson (1991) argues further that CSH sets a philosophy for emancipatory

systems approach, which planners and other stakeholders can use to reveal the normative content of actual and proposed system designs. In other words, for CSH all designs and proposals should be interrogated and should not be presented as the only objective truth. The proponents of CSH are in agreement with Churchman's view that every worldview is terribly restricted. For this reason, they insist that a proposal should not be taken as given because it might not be reflective of all the different perspectives held by different stakeholders. In short, CSH wants to ensure that the views of all stakeholders, including those who might be invisible but negatively affected by the proposed design, are taken into consideration. This way it is able to address coercive situations, questioning the true interests and motives underlining proposed design processes. CSH challenges these said proposals and constructs counter-proposals, which address concerns of stakeholders whose voices are muzzled by the process of inquiry.

CSH uses the following 12-boundary questions that allow planners and systems designers to get the normative content of proposed designed systems:

1. Who is the actual client of the system design?

2. What is the actual purpose of the systems design?

3. What is the built in measure of success?

4. Who is actually the decision-maker?

5. What conditions of successful planning and implementation of the system are really controlled by the decision-maker?

6. What conditions are riot controlled by the decision-maker (that is are in the environment)?

7. Who is actually involved as planner?

8. Who is involved as an expert, and of what kind is the expertise?

9. Where do the involved seek the guarantee that the planning will be successful?

10. Who among the involved witnesses represents the concerns of the affected? Who may be affected without being involved?

11. Are the affected given an opportunity to emancipate themselves from the experts and to take their fate into their own hands?

12. What world-view is actually underlying the design of the system? Is this the view of (some of) the involved or of (some of) the affected?

Ulrich's theory of CSH boundary critique does assist in ensuring inclusiveness during the intervention. What is not explained by Ulrich's theory, however, are his own assumptions, premises from which he is moving and his own, that are taken for granted. This makes it difficult to judge CSH. Furthermore, one ought to exercise caution when opening the boundary because he can do so without any closure. It is also a fact that in a coercive or oppressive situation not all people or groups want to disclose their views or feeling about issues for fear of reprisal or victimization. Therefore, to insist on extending the boundary in such situation may in fact promote or perpetuate oppression.

Midgley elaborated on Ulrich's notion of boundary judgements. Midgley (1996) proposes what he calls "boundary critique," which essentially entails making judgements about what must be part of and what must be excluded from the intervention. In other words, the boundaries of systems designs must be fully explored and identified. "Boundaries" here refer to social or personal constructs that define the limit of knowledge that is to be taken as pertinent in an analysis (Churchman in Midgley, 1996). According to Midgley "researchers should remain aware of the need to access a diverse variety of stakeholders views in defining problems and to sweep in relevant information" (Midgley, 1996: 1). In most instances, he posits, people tend to assume that boundaries are clearly defined whereas in actual fact this is not always the case. "What may appear to be improvement within the narrow defined boundary," Midgley observes, "may not be improvement at all if the boundaries are pushed out" (*ibid* 66). For pushing boundaries may lead into questioning on who is the legitimate decision-maker who must be taken into consideration when decisions are made, and may lead to unexpected consequences.

In this chapter, the emergence and evolution of system thinking are explored. Soft and hard systems approaches are introduced and their strengths and limitations are highlighted. If there is anything that one needs to take note of, it is the fact that systems' thinking is an ever-evolving intellectual discourse. This means the methodologies proposed are not final products. Each methodology leaves many a question unanswered, thus creating new problem areas that require research. It is also important to note that this chapter outlines only the theoretical and methodological aspects of some systems approaches that have relevance to the problem of concern here. The next section examines the opportunity to link evaluation to systems thinking.

5.5 THE OPPORTUNITY TO LINK EVALUATION TO SYSTEMS THINKING

The development of SOSM represented a shift from isolationism of the earlier period in systems research to the complementarism stage. A similar shift also took place in the evaluation field. Several different classifications which sought to fit evaluation methodologies to their most appropriate contexts for use were developed during the 1980s. The latest development in the search for a meta-methodology for evaluation was the assessment of whether Flood and Jackson's Total Systems Intervention (TSI) represents an appropriate means of facilitating the choice between evaluation methodologies (Gregory, 1994).

According to Gregory (1996), who analysed the implications for evaluation theory from the work of Bruscaglioni (1982), the meta-methodology of Flood and Jackson, TSI, can be classified as mechanical complementarism. The work on evaluation theory and practice may also be located at this stage of development (Gregory, 1996: 301). In organisational theory, the progression from the complementarism stage is the integration of approaches. This can also apply to the field of evaluation theory. Gregory (1996) says: "There has arisen an awareness that 'live' evaluation situations are far to complex too evaluate adequately with a single method."

Gregory (1996) argued that a better term for bringing together different approaches of evaluation theory might be "accommodation" used by Austin (1990), Firestone (1990) and

Skrtic (1990). Austin (1990) identifies three possible levels at which accommodation among different paradigms might take place: the philosophical, social-community, and personal levels. Based on these levels, she outlines three possible approaches to accommodation: dialogical, general respect, and personal accommodation. Dialogical accommodation operates at a philosophical level and one cannot easily shift from one paradigm to another, whereas general respect as a means of accommodation recognises the strengths and weaknesses of paradigms and one can evaluate each paradigm and determine what contribution can be made in solving without shift from one paradigm to another. Personal accommodation is characterised by the fact that paradigms can be combined to solve problems.

Firestone (1990) argued that in practice, researchers use a variety of approaches and the walls between paradigms break down. Whether paradigms can be accommodated legitimately depends on one's stance on the nature of paradigms and the relationships between philosophical principles and research practice. His accommodation is based on Austin's personal level, neglecting the other levels has attracted criticisms. If one's stance on the nature of paradigms and the relationship between philosophical principles and research practice determines whether paradigms can be accommodated or integrated, it is difficult to theoretically integrate the different methodologies. However, Gregory (1996) argues that there might be "reflective conversation" between the different paradigms and this might facilitate in practice the different methodologies.

This research aims to propose a systemic framework for the evaluation of rural telecommunications infrastructure based on a recent meta-theoretic approach called Multimethodology (Mingers and Gill, 1997). This framework combines several techniques from several paradigms in one intervention. It allows methods, models and techniques as parts of different methodologies, from different paradigms, to be brought together according to the requirements of a particular evaluation process. Following Jackson's call for a coherent pluralism within the framework of Critical Systems Practice (Jackson, 1997), this framework aims at the full realisation of the potential of the actors involved in rural telecommunications and rural development to contribute to their evaluation. This is explored further in the next chapter.

Chapter 6

TOWARDS A SYSTEMIC FRAMEWORK FOR THE EVALUATION OF RURAL TELECOMMUNICATIONS INFRASTRUCTURE

6.1 THE NATURE OF THE PROBLEM OF EVALUATION OF RURAL TELECOMMUNICATIONS INFRASTRUCTURE

It has become evident from the literature and discussions in the previous chapters that a holistic approach to the evaluation of rural telecommunications infrastructure has not been implemented. Since a rural telecommunication system is a complex system (see chapter 3) associated with "messy" problems, there is a need for a systemic pluralist methodology to address the evaluation of rural telecommunications infrastructure. Certain aspects of the analysis of systems thinking and MCDM discussed in the previous chapters indicate a possible complementarity in their strengths with respect to their use in complex situations. The goal of this chapter is to formulate a systemic pluralist framework for evaluation of rural telecommunications infrastructure, combining elements from some systems approaches and MCDM. Before formulating a framework, one has to examine the issues that need to be clarified. These issues are:

- Why does the problem related to the evaluation of rural telecommunications infrastructure require a systemic pluralist framework?
- Why is it necessary to consider the evaluation process from multiple perspectives?
- Why is there a need for a multi-method approach to address the diverse nature of rural telecommunications?
- What are the features of pluralism that should be reflected in such a framework?
- What should be the process of the systemic evaluation rural telecommunications infrastructure?
- What elements should be included in the proposed systemic framework?
- How can the framework be justified and validated from the point of view of the body of knowledge in operational research, systems thinking and rural telecommunications?

The answers to the first two questions are sought in this section. The rest of the questions are discussed in the subsequent sections.

The analysis of the current research on the evaluation of rural telecommunications infrastructure, presented in the previous chapters, leads to conclusions that can be summarised as follows:

- The development and usage of telecommunications infrastructure cannot be fully understood and evaluated without understanding the relationships between the individual communities and rural telecommunications infrastructure.

- The relationship between telecommunications and rural development can only be fully understood if there is a realisation that rural telecommunications does not operate in a vacuum but in close cooperation with other parallel infrastructures and communities it serves.

- The availability or lack of basic parallel infrastructures such as, power, water, and reasonable transport infrastructure have a significant impact on socio-economic benefits of rural telecommunications.

- The evaluation of rural telecommunications infrastructure requires, *inter alia*, societal intervention, and since societies reflect a multiplicity and diversity of values and goals, the intervention should confront these realities.

- The political stability and the existing regulatory policies also have a major impact on the provision of telecommunications infrastructure.

- A rural telecommunication system is characterised by non-linearity, where a given action can lead to several possible outcomes, some of which are disproportionate in size to the action itself.

- A rural telecommunications system is a complex system and as such, the evaluation of telecommunications infrastructure in rural areas is a complex and "messy" problem following the terminology in systems thinking.

It can therefore be concluded on the basis of the analysis of the research on Systems Thinking, the evaluation of technological infrastructure, the impact of rural telecommunications on rural development that the issue of evaluation of rural telecommunications infrastructure within a particular rural area is a complex problem. Moreover, one needs to consider the views of different stakeholders involved in the evaluation process. This underlies the need to consider the evaluation process from multiple

perspectives, explore methodologies that will facilitate participation and engagement, and include emancipation of the disadvantaged. There is therefore a need for a holistic framework for the evaluation of rural telecommunications infrastructure. Such a framework should be comprehensive and well justified regarding its origins within the body of knowledge of Complex Systems, Systems Thinking, and MCDM. In addition, the framework should be easy to use and adaptable to other rural areas.

The multiple perspectives approach to formulate a "messy" or "wicked" problem will be used here, following Mitroff and Linstone (1993). It is necessary to understand the problem from every possible participant's personal perspective (Ackoff, 1973). Personal perspectives are, however, often ignored when the problem is formulated from the organizational perspective that emerges from "dominant" perspectives of powerful individuals or groups. From the technical perspective, traditionally a problem is formulated objectively and quantitatively, often disregarding human and organizational factors. So to formulate a messy problem from the multiple perspectives approach, it is critical to minimize the gaps between perspectives (Mitroff and Linstone (1993)). This is crucial, especially in the case of rural development, where the community perspective cannot be ignored or be regarded as being less important.

The multiplicity of perspectives is vital, but how does one integrate perspectives? According to Mitroff and Linstone (1993), there is no neat scientific or technical methodology to integrate perspectives. Most executives wrestle with the initial selection of perspectives and their integration. Mitroff and Linstone (1993) provide the following guidelines in applying multiple perspectives:

- strive for a balance among technical, organisational, and personal perspectives;
- use "good" judgement in selecting perspectives;
- in obtaining information, it is necessary to recognise that organisational and personal perspectives require greatly different methods than technical perspectives;
- pay particular attention to the mutual impact, interdependencies, and integration of perspectives; and
- beware of thinking statically in a dynamic environment.

It is important to consider the above guidelines when developing the proposed holistic framework for the evaluation of rural telecommunications infrastructure. The outcome of

such a framework should lead to a better understanding of the problems associated with the evaluation of rural telecommunications and a deeper appreciation of the factors that may lead to rural development.

6.2 THE NEED FOR A MULTI-METHODOLOGY APPROACH TO ADDRESS THE EVALUATION OF RURAL TELECOMMUNICATIONS

A review of the literature has revealed that no single approach or methodology has successfully addressed the complexities associated with the evaluation of rural telecommunications infrastructure in rural areas. However, according to Rosenhead (1989), there is correlation of certain methodologies with particular types of decision/problem situations, and that certain methodologies concentrate on particular types of decision or problem situation. This also means that they examine or assume aspects of the internal structure of the particular situation, that is, the participants, the diversity in power, the possibilities of conflict and co-operation within the situation. In each case, the methodology used and its related outputs must be a response to the type of problematic situation. The analysis of the problem of evaluation of rural telecommunications infrastructure shows its similarity to the problem situations for which problem-structuring methods are suitable. Therefore, following the principles formulated by Rosenhead (1989), there is a need to incorporate approaches in an evaluation framework that:

- facilitate interaction and promote shared understanding. Soft Systems Methodology (SSM), *inter alia*, falls in this category;

- examine multiple possibilities of conflict and co-operation between at least semi-autonomous decision-makers, as well as their accompanying dimensions of emotion and irrational behaviour. Analytic Hierarchy Process (AHP), *inter alia*, falls in this category; and

- requires techniques to engage with the complex interactions between possible combinations of decisions and actions, all of which are surrounded by high levels of uncertainty. To the best knowledge of the author there is no single methodology that addresses this issue well.

Since there is a logical correlation between problem situation, methodologies and their respective outputs (Rosenhead, 1989), this research explores how different methods can be mixed in one intervention in order to provide a holistic framework for the evaluation of rural telecommunications infrastructure in rural areas. Due to the inability of a single approach to account for complexity, and to handle power-related issues in problem contexts and to bring about true emancipation for those involved in the problem context (Jackson, 1992), a pluralist approach is recommended.

Some systemic approaches have been used in evaluation of technological infrastructures but very few address all the associated complexities. Although the approaches may be systemic, each methodology usually focuses on a particular aspect of organisational complexity. Many authors also believe that their approach is superior. Consequently, not enough internal criticism has been entertained and very little cross-fertilisation has occurred. Some of these issues are addressed by a systemic approach to problem-solving known as Critical Systems Thinking (CST) that emerged in the 1980s. CST and features of pluralism that should be reflected in a framework for the evaluation of rural telecommunications infrastructure are discussed in the remaining section.

Critical Systems Thinking (CST) provides a suitable philosophical and theoretical foundation for an intervention in complex problems like evaluation of telecommunications infrastructure. CST's theoretical foundations provide justification for pluralism in management science. Pluralism seeks to respect the different strengths of the various trends in systems thinking, encouraging their theoretical development and suggesting ways in which they can be appropriately fitted to the variety of management problems that arise. What are the types of pluralism advocated here? As mentioned before, Jackson (1991) sometimes uses the term complementarism. According to Jackson (1991), complementarism is defined as seeking to respect the different strengths of the various trends in management science, encouraging their theoretical development and suggesting ways in which they can be appropriately fitted to the variety of management problems that arise. Complementarism is seen by Mingers (1997a) to be only one type of pluralism. Jackson (1991) contrasts pluralism to:

- *isolationism*, which promotes the separate development of the different strands of management science;

- *imperialism*, assuming that one or another of the strands of management science is fundamentally superior; and
- *pragmatism*, whose strategy is to develop management science by bringing together the best elements of what may appear to be opposing strands, on the criterion of what works in practice (Jackson, 1991).

The theoretical foundations of the first version of Total Systems Intervention (Flood and Jackson, 1991), a meta methodology operationalizing the ideas of CST, were based on Habermas' three fundamental interests that underpin the search for knowledge: the technical, practical and emancipatory interests (Habermas, 1972). These are supported, it is argued, by three types of systems methods: hard, soft and emancipatory, respectively. In CST, emancipation can only be achieved by addressing all three interests. In the early nineties a complementarist approach that was advocated by the authors of TSI version one was somehow not considering seriously enough the issue of paradigm incommensurability (Jackson 1997: 353). Jackson (1997, 2000; 2001) argues that pluralism would be a better term than complementarism and this encompasses ideas around the following issues: the acceptance and management, at the theoretical level, of a degree of incompatibility between paradigms; an encouragement in using diverse methodologies embodying different paradigms; an encouragement in using a maximum diversity of methods, tools and techniques without lapsing into total pragmatism.

CST's commitment to pluralism means that all methodologies have significant contributions to make as long as they are directed to areas in problem-contexts, which they can deal with successfully. This ultimately calls for a framework within which such identifications can be made. Therefore the foundation of the framework will be based partly on TSI version one (with its extensions discussed in Jackson (1997; 2000)). Following the latter two sources, TSI and its emancipatory neo-humanistic philosophy will be used in the assessment of the problem situation and the choice of a dominant systems methodology.

The above idea of Jackson (1997b) can be seen as a potential way forward. However, the interaction or "conversation" between methodologies or methods within an intervention is not specified and needs further investigation. In addition, he does not propose a resolution for the issue of paradigm incommensurability. A possible way out is suggested by Midgley (1997). According to him the paradigm problem can be tackled by complementing our thinking about

paradigms with a theory of how researchers from different backgrounds can learn from each other, but only in their own terms. The latter implies that communication between them, and hence between paradigms, is possible.

Another interesting view on the issue of paradigm incommensurability is the idea of Deetz (1996) that the four discourses defined by him are not well formed with clear boundaries, and therefore cannot be considered paradigms. Under such conditions it is natural that different discourses may be in dialogue. It can be concluded that Deetz (1996) and Midgley (1997) both support in their arguments the idea of paradigm mediation and it can be accepted as a sufficient justification of the use of techniques from different methodologies based on different paradigms. As such, no technique or paradigm may be considered as a dominant one, though, in line with Jackson (1997b), the initial stages of the intervention might predominantly use elements of an interpretivist methodology like SSM. A combination of the above three arguments provides a solution to the issue of paradigm incommensurability in the framework that is being developed here.

TSI version one deals with whole methodology management. Methodology enhancement, on the other hand, deals with the situation when different approaches from different paradigms are used in the framework of only one paradigm (see rows **G** and **H** in Table 6.1). An example would be a specific combination of SSM with AHP within the interpretivist paradigm. It stresses the importance of using AHP not only as a normative approach, but through the AHP type "what if" analysis, leading to a better understanding of the intricate internal relationships between the components of an AHP model. Without ignoring the potential of the interpretivist features of AHP for the development of a deeper insight into a problem situation, such a combination is restricted in its effectiveness by the weaknesses of the dominant chosen paradigm. According to Mingers (1997a), the main problem is the legitimacy of transferring a technique developed within one paradigm to another.

Multi-paradigm methodology shown on the last row of Table 6.1 can be viewed as the most complex and challenging from the point of view of this research. Parts of methodologies from different paradigms are brought together to construct an ad hoc multimethodology suitable for particular problematic situations (Mingers, 1997a). As the problem of evaluation of rural telecommunications infrastructure is a complex managerial problem, following the earlier

discussions, it can be expected that a combination of methodologies belonging to any of the last four options listed in Table 6.1 might be relevant for it.

Table 6.1: Different possibilities for combining methodologies (adapted from Mingers and Gill, 1997).

	One/More Methodology	One/More Paradigms	Same/ Different Intervention	Whole/ Part Methodology	Imperialist Or Mixed	Example	Name
A	One	One	----	----	----	SSM only	Methodological Isolationism
B	More	One	Different	Whole	----	SSM/ Strategic Choice	Paradigmatic Isolationism
C	More	One	Same	Whole	----	Simulation + Queueing theory	Methodology Combination
D	More	One	Same	Part	Imperialist	Cognitive mapping in SSM	Methodology Enhancement
E	More	One	Same	Part	Mixed	Cognitive mapping + Root definition	Single paradigm Multimethodology
F	More	More	Different	Whole	----	Simulation/ SSM	Methodology Selection
G	More	More	Same	Whole	----	VSM + Interactive Planning	Whole Methodology Management
H	More	More	Same	Part	Imperialist	JSD in SSM	Methodology Enhancement
I	More	More	Same	Part	Mixed	Cognitive mapping + Systems dynamics	Multi-paradigm Methodology

Mingers and Brocklesby (1996) and Mingers (1997b) distinguish four stages in an intervention: appreciation, analysis, explanation and action. These are seen always in the three dimensions of Habermas' social world, personal world and material world. Jackson (1997a: 369) claims that there is no justification for the division of the intervention into four stages. The issue of the methodology of the intervention is not clarified in detail in TSI version one apart from the general description of its three phases: creativity, choice of a method and implementation (Flood and Jackson, 1991). It is not clear, for example, why a choice of a methodology should take place each time, even in similar problem situations. It is true that each situation is somewhat unique. However, it does not prevent the analyst from identifying typical problem situations for which a particular set of methods might be appropriate.

A more tangible contribution to the theory and practice of mixing methods or the *methodology* of the intervention is made by Midgley (1997). His approach is also based on

Critical Systems Thinking, but on more recent ideas by Habermas that are different from those used as a foundation for TSI version one. Critical action can be shown as a cycle of critique, judgement and action. For Midgley there is a "smooth line running from *critique* (revealing different possibilities or knowledge and identity), through judgement (choosing between alternative knowledge and identities), and on again through action (based on judgements already made)" (Midgley, 1997: 282). These are then defined in terms of systems thinking: "Critique is about exploring different possible boundary judgements . . . If one widens the boundaries of exploration, one is likely to sweep in new forms of knowledge . . . and different social identities" (Midgley, 1997: 282). It can be concluded that Midgley's framework has certain similarities in its structure with TSI version one, though its justification is not based on the system of systems methodologies, and it replaces the metaphors of the creativity stage with boundary judgements.

Another aspect of the methodology of the intervention is to justify what the dimensions of the pluralism are that may need different approaches. Mingers (1997b) has proposed a complicated grid covering the four stages of the intervention mentioned earlier and the three worlds of Habermas. Following Mingers (1997b), a given technique or methodology is mapped to the whole area for which it is suitable, covering more than one world and more than one stage. It must be acknowledged that the multimethodology framework proposed by Mingers and Brocklesby (1996) and Mingers (1997b) is the most complete and elaborate one.

6.3 POTENTIAL TECHNIQUES/ APPROACHES FOR INCLUSION IN A FRAMEWORK FOR THE EVALUATION OF RURAL TELECOMMUNICATIONS INFRASTRUCTURE

Following Rosenhead (1989) and the preceding analysis, one can identify as potential candidates for inclusion in the required framework certain elements from Soft Systems Methodology like Rich Pictures, CATWOE analysis (Checkland, 1981), and Stakeholder analysis (Banville *et al.*, 1998); idea generation and rating from the Nominal Group Technique (Delbecq *et al.*, 1975); boundary judgements within Critical Systems Heuristics (Ulrich, 1998); and AHP (Saaty, 1990a). Although these have been contributions discussed generally in Chapter 5, the main points that apply in this particular context will be highlighted in the subsequent sections.

6.3.1 Soft Systems Thinking Techniques

The following features of SSM motivated its inclusion for stakeholder participation:

- SSM is mainly a problem-solving methodology in a systems context approach. It tries to analyze human activities as systems that will address the whole situation and not just the specific problem. As such, SSM can be described as a holistic and systemic approach.
- SSM is a participatory approach, which tries to involve the problem owners – stakeholders, decision-makers etc. – in the analysis and in finding the solution. The reason for this is that SSM evolved from "action research" – an approach in which the researcher immerses himself in the analyzed organization and work, with close contact with the problem owners.
- SSM offers guidelines and a set of tools that the analyst can use. However, the analyst can and should align the methodology with the specific context that he is working on. SSM encourages the analysts to iterate and repeat stages as much as necessary. It enables the analysts to incorporate "soft knowledge" and to expose political and cultural conflicts. Moreover, because SSM puts this conflict up front, it enables a better understanding of the problem situation and the solution constructions.

The SSM techniques that are considered for the evaluation framework are:

- rich pictures because of their expressive power and ability to represent the structure and the processes within a problem and the relationships between them;
- CATWOE analysis for its ability to reveal several dimensions of a perspective on the evaluation, like transformation process, world-view, who own the process? etc.; and
- technical, cultural, and political analysis of the evaluation problem, which is somewhat simplified as it is based on the respective classifications along these lines of the issues generated in a brainstorming session with all stakeholders.

Having identified in a rich picture the main problems and the cause and effect relationship between them, it is then important to give further consideration to *whom* these problems actually impact on most, and what the roles and interests of different stakeholders might be in addressing the problems and reaching solutions (Banville *et al.*, 1998).

The main purposes of stakeholder analysis in general are to:

- better address distributional and social impacts of projects, programs and policies associated with rural telecommunications development; and
- identify existing or potential conflicts, and factor appropriate mitigation strategies into activity design.

Stakeholder analysis is thus about asking the questions: "Whose problem?" and in an evaluation context: "Who will benefit?". The main steps in stakeholder analysis include:

- identifying the principal stakeholders (these can be at various levels, for example, local, regional, national);
- investigating their roles, interests, relative power and capacity to participate;
- identifying the extent of cooperation or conflict in the relationship between stakeholders; and
- interpreting the findings of the analysis and defining how this should be incorporated into the evaluation process.

When looking at who the stakeholders are, it is useful to distinguish between the "target group" and the broader group of stakeholders (the target group being one of the principal stakeholders). In the case of the evaluation of rural telecommunications, the target group involves the local community and the telecommunications provider while the broader group involves government, the national economy and the legislative bodies, indirectly related to the problem of concern.

6.3.2 Critical Systems Heuristics (CSH)

In order to evaluate the socio-economic impact of rural telecommunications infrastructure, one needs to identify the socio-economic indicators of rural telecommunications. The following indicators were identified during the literature survey (see Chapter 2):

1. **Quality of Service:** The level of customer satisfaction, network reliability, and speed and responsiveness determines the quality of service.

2. **Usage:** Possible indicators of usage are: frequency of calls: number of calls per week, month, and year; number of calls per household; duration of calls (number less than 3 minutes/number more than 3 minutes); types of calls.
3. **Tariff Affordability:** Telephone service installation charge in rural areas; telephone service subscription charge in rural areas.
4. **Network Size:** The network size is influenced by the demand for telecommunication services; population of the region; level of economic activity; area (km^2); organisational support; location, terrain, future prospects, etc. Possible indicators include: number of telephone main lines in operation; total line capacity of local exchanges; main lines for residential use; and main lines for other use.
5. **Derived Indicators:** Number of main telephone lines per 100 inhabitants; and number of telephone sets per 100 inhabitants.
6. **Other Service Indicators:** Number of cellular mobile telephone subscribers; Number of ISDN subscribers; Number of Internet subscribers; and number of personal computers.

Some of these indicators are reflected in the available statistical data for example, number of main lines per 100 inhabitants, number of telephone sets per 100 inhabitants, can be analysed partly using statistics and partly they were factored into the following CSH 12-boundary questions that allow for qualitative analysis:

- Who is the actual client of the evaluation of rural telecommunications?
- What is the actual purpose of the evaluation process?
- What are the possible benefits of the evaluation process?
- Who is actually the decision-maker in terms of rural telecommunications infrastructure rollout?
- What conditions of successful planning and implementation of the system are really controlled by the decision-maker?
- What conditions does the decision-maker not control?
- Who is actually involved as planners in the evaluation of rural telecommunications?
- Who is involved as an expert, and of what kind is the expertise?
- Where do the involved seek the guarantee that the planning will be successful?
- Who among the involved represents the concerns of those that are generally not heard?

- Who may be affected without being involved?
- Are the affected given an opportunity to emancipate themselves from the experts and to take their fate into their own hands in terms of the evaluation of rural telecommunications?

The boundary questions focus on people attempting to identify their respective roles and determine their boundaries. It focuses on the conditions under which the evaluation process takes place. Answers to these questions helps to build multiple perspectives of the problem situation. This can improve cooperation among the stakeholders and also allow those that are disadvantaged to be heard. A question on customer satisfaction can give the customers of the evaluation process an opportunity to provide realistic feedback on the quality of service with respect to telecommunications.

The reasons for the selection of the above candidate for this methodology, which is derived from a set of individual methods and techniques, are simple. They complement each other as SSM based analysis sometimes lacks a sense of direction in the endless sequence of iterations on a particular problem. MCDM is included in this list for its capability of enabling analytical evaluation of both qualitative and quantitative variables under several conflicting criteria. As indicated in Chapter 5, however, it is relatively weak and not formalised at the stage of problem structuring. The following section will provide further comparisons of SSM with AHP that might shed light on the way of combining different techniques in the envisaged framework for the problem under consideration.

6.3.3 Comparisons between Problem Structuring in MCDA and SSM

Before formulating the framework for evaluation of the rural telecommunications infrastructure, it might be appropriate to provide some comparisons between MCDA and Soft Systems Methodology, which might be of use when considering their potential combined application in the envisaged methodology. These comparisons are based partly on Petkova and Petkov (1997) and partly on the extensions of the ideas in that source, provided by this author. The first comparisons refer to the type of variables in both approaches. In both cases qualitative variables are considered, while in MCDA quantitative ones are also included. The second one refers to the expression of strength of association between the variables involved. While AHP is using a ratio scale to express the comparisons between the variables, SSM does not provide a means for

measuring the intensities of relationships between elements of a problem, which in this case is the evaluation of rural telecommunications infrastructure.

As stated above, MCDA allows the incorporation of subjective data in a decision problem. It has to be stressed that this is a controlled subjectivity (in AHP through the Consistency Ratio measuring deviation from the transitivity rule). The latter provides an effective feedback mechanism for the quality of decisions based on the pairwise comparisons of decision-makers. MCDA in general, and AHP in particular, also allow the incorporation of uncertainty in the decision-making process through interval judgements (Saaty, 1990a), and recently through emerging fuzzy logic extensions of AHP (Lootsma, 1996). The latter features are not available in SSM.

Further comparisons can be made on the basis of the role of goals, granularity of the components of a problem and the structuredness of the problems suitable for a particular technique. Soft Systems Methodology allows different granularities in the decomposition of the problem at different levels of system description. It seems that within a particular level of a model the granularity is the same. MCDA allows different granularities at different levels in the same model. Moving down the hierarchy it is possible to capture finer aspects of the model.

Both SSM and MCDA are more suitable in general for handling bigger rough problems. SSM has acquired a special status due to its appropriateness for ill-structured or wicked problems. Besides the fact that one may handle multiple criteria in MCDA, one can also use several hierarchies in order to reflect the various sides of a problem, for example a cost hierarchy, a benefits hierarchy, etc.

SSM does not claim to be goal-oriented. It is rather interpretive. According to Checkland (1981), organisations are studied with SSM from a hermeneutic stance. On the other hand, MCDA techniques pay special attention to goals and objectives. It can be noted that decision-makers usually get a deeper insight into their problem through the formulation and exploration of a MCDA model, and especially through "what if" analysis, which allows the claim that MCDA approaches can be used in the interpretive paradigm as well.

Finally, the last aspect of the comparison will touch on the handling of complexity in both methodologies. It was indicated earlier that MCDA represents complex problems as

hierarchies or networks. SSM's expression of a problem situation is in terms of rich pictures supported by CATWOE analysis and relevant conceptual models (Checkland, 1981). Basically SSM permits any technique that will help to express or capture the essential aspects of a problem situation. These may be graphs, text, animation, pictures, charts, tables etc. For this reason one may claim that SSM is far more flexible than MCDA in representing complexity in real world problem-solving.

The above comparisons reveal the potential benefits from combining SSM and AHP in an evaluation framework, an issue that will be discussed in the next section.

6.4 A SYSTEMIC FRAMEWORK FOR THE EVALUATION OF RURAL TELECOMMUNICATIONS INFRASTRUCTURE AND ITS JUSTIFICATION

The framework proposed is based on the theoretical foundations of Critical Systems Thinking following some ideas of Jackson, Flood, Mingers and Midgley ensuring the guaranteeing of the interests of the poor and the weak in the development of rural telecommunications. It involves on the practical side a combination of the strengths of some Soft Systems Methodology (SSM) techniques, Critical Systems Heuristics, and the Analytic Hierarchy Process (AHP).

In line with Checkland (1995), Jackson (1997) and others, this research acknowledges the social dimension of the problem situation and the multiplicity of interpretations related thereto. The framework is organised around the idea for multiple perspectives represented in Multimethodology, a recent meta-methodology suggested by Mingers (1997). The latter assumes that in a particular intervention one may use parts of given methodologies or whole methodologies depending on their strengths. Mingers (1997) provides a justification of Multimethodology on the basis of Habermas's three worlds: "the material world, our social world and my personal world" (see Habermas (1984; 1987), and also Mingers (1997a: 9-11) for a discussion of how this meta-theoretic framework can be used to provide multiple perspectives). One of the reasons for the selection of Mingers's ideas as a justification of our proposed combination of methods is that it is similar to the three-dimensional framework for multiple perspectives embracing different paradigms advocated by Mittroff and Linstone (1993). The techniques that allow the researcher to take care of the three different worlds reflecting facets of the problem in our framework are:

Social world	Stakeholder Analysis SSM (Rich pictures, CATWOE) Critical Systems Heuristics
Personal world	SSM (Rich pictures) Brainstorming (Issues generation); MCDA (AHP)
Material world	Statistical data, AHP

Figure 6.1: Mapping of Possible Techniques Suitable for the Evaluation of Rural Telecommunications Infrastructure onto the Three Worlds of Habermas (following Mingers, 1997).

The above set of techniques is a smaller and more manageable set than the one suggested by Mingers (1997b: 433). Also unlike Mingers (1997), the various methodologies and techniques are not applied here within their own original paradigms. Thus AHP is not applied within the functionalist paradigm from which it originated. Rather it is seen as a tool for gaining an insight into the problem through prioritisation of the factors affecting the telecommunications infrastructure. Using a classification suggested by Keeny (1992), it is used as a descriptive tool for decision-making as advocated often by its originator, Saaty himself. One can point out that in the proposed combination with SSM it serves the same interpretivist goals as the traditional techniques of SSM mentioned earlier. One can conclude that SSM is used as the "dominant" methodology while AHP and Statistics are seen as the "dependent" methodologies as defined in TSI version one (Jackson, 2000: 391).

The framework of mixed methods can also be grounded in Critical Systems Practice, the developed form of TSI version one (Jackson, 2000). However, as discussed earlier, it does not operate from above the paradigms but facilitates the critique between the different paradigms (Jackson, 2000: 390). The overall philosophical foundations of the framework are based on critical systems thinking not only for its commitment to pluralism, but also for its adherence to the emancipatory idea. The latter is associated with the need for improvement of rural telecommunications infrastructure through its improved evaluation.

At the same time one cannot reject the fact that AHP and Statistics provide a valuable insight as well if we consider them at a particular stage from a functionalist point of view as they help focus on the direction of decision-making in the evaluation of telecommunications

infrastructure. This fact, as well as that the dominant interpretivist paradigm is intertwined with Critical Systems Thinking, justifies the proposed type of mixing methods classified as *Methodology Enhancement* following Mingers (1997a) and Table 6.1.

The process of the intervention is the next issue that needs to be defined, apart from the philosophical foundations of the framework. The traditional framework of TSI version one (Flood and Jackson, 1991) suffers from the drawback that it places too much attention on the stage of selection of a method although the latter is not seen as a separate entity from the creativity stage or the implementation stage in problem-solving. TSI version two (Flood, 1995) just like Strategic Choice (Friend, 1988) are the only fully recursive methodologies for problem-solving (Bowen, 1998). That makes them flexible in addressing the complexities of real world interventions in which blind adherence to process is simply ineffective. However one needs to consider always the nature of the problem at hand and in our case it is evaluation of rural telecommunications infrastructure. This problem is sufficiently big to be treated on its own separately from the issues of planning and implementation of such infrastructure. Therefore, there is no need for an implementation stage of TSI version one or of the design and compare stages of Strategic Choice.

From the additional three modes introduced in TSI version two the only one that seems to provide an idea with a potential is the Critical Reflection mode according to Jackson (2000: 389). The Problem Solving mode is the traditional mode of any intervention while the Critical Review mode relates directly to the constant need for critical awareness of the existing methods that can be applied in an intervention but it is an implicitly applied principle in any intervention that claims to be based on the ideas of Critical Systems Thinking.

Another issue of importance is the fact that an evaluation of rural telecommunications infrastructure cannot take place in an independent, objectivist way. As was previously discussed, there is a need for using Critical Systems Thinking to address the need for improvement of the plight of the disadvantaged. Adding to that the fact that the problem of concern is involving heavily the human element, it becomes necessary to consider an action research process. One can then use the ideas of the process of action research as defined in Checkland and Holwell (1998: 27). The framework is shown in Figure 6.2.

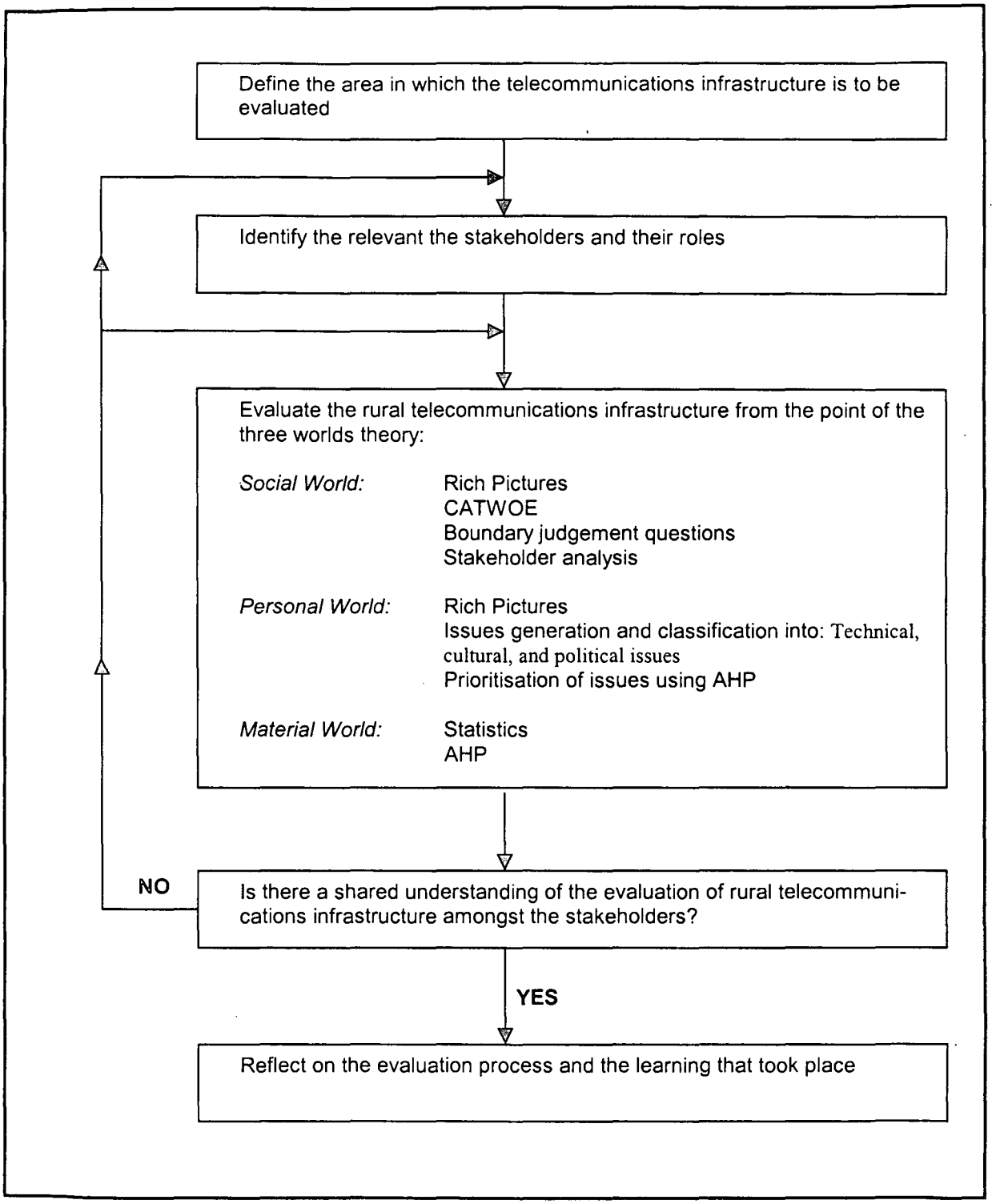


Figure 6.2: Framework for the Evaluation of Rural Telecommunications Infrastructure.

The proposed framework is an action research framework, based on Checkland and Holwell (1998). The underlying philosophy behind it is Critical Systems Thinking. The framework presents a synthesis of SSM, multicriteria decision-making, problem structuring techniques

and Critical Systems Heuristics within the Multimethodology framework of Mingers (1997a; 1997b), and enhanced by some aspects of the work of Midgley (1997). This allows methods, models and techniques as parts of different methodologies, from different paradigms, to be brought together according to the requirements of a particular intervention. Following Jackson's call for a coherent pluralism in Management Science within the framework of Critical Systems Practice (Jackson, 1997), this framework aims at the full realisation of the potential of the actors involved in rural telecommunications and rural development in a way that serves interests other than the status quo.

The overall justification of the framework as a pluralist approach to the evaluation of rural telecommunications infrastructure is presented in previous subsections of this chapter. It was done from the perspectives of the body of knowledge within Evaluation of Technological Infrastructure, Complex Systems and Systems Thinking. It was shown that the formulation of the framework could be based on a meta-theoretic approach to mixing methods and techniques from different paradigms, called Multimethodology (Mingers and Gill, 1997). The type of the methodology advocated here is Methodology Enhancement (Mingers, 1997). It is using SSM as the chosen dominant methodology. The latter is justified as SSM has a tradition in being used for evaluation purposes (Gregory and Jackson, 1992a; 1992b). However, the proposed framework for the evaluation of rural telecommunications infrastructure is significantly different from the work of Gregory, since it is using a fairly simplified form of SSM, which is enhanced by CSH and AHP making it more suitable to the problem of concern.

It is possible to use the work of Checkland (1985), quoted in Chapter 1, for the justification of the framework. Thus the nature of the problem of evaluation of rural telecommunications infrastructure determined the underlying philosophical foundations of the framework – that of Critical Systems Thinking. It was necessary for its support of pluralism and for its emancipatory nature. In the quest for a proper mix of methods in the pluralistic framework, the dominance of SSM was assumed for its support of stakeholder participation and learning of the problem situation. The emancipatory idea of improvement of rural telecommunications infrastructure was supported by one group of the critically heuristic boundary judgement questions. The other groups, as well as the CATWOE analysis and the rich picture, serve the purpose of identifying the mess through multiple perspectives. The same idea is supported also through the simple classification of relevant issues into technical, cultural, and political.

Finally the support for the framework for purposeful action in the evaluation process is supported through a MCDA approach, the Analytic Hierarchy Process. All the above features make the framework more powerful than a traditional action research approach based on SSM only.

The above considerations aim to show that the proposed evaluation framework is relevant to the problem situation of concern. Since it uses the best results in evaluation theory and critical systems thinking that have relevance to the problem, one can claim that theoretically it is competently built. Therefore it satisfies two of the most important criteria for validation of soft approaches to management interventions, as specified in Checkland (1995). However, Checkland (1995) and others stress also the importance of practice for judging the theoretical results. The following chapter presents the findings of the experimental validation of the proposed framework for the evaluation of rural telecommunications infrastructure in the Wembezi/Estcourt area of KwaZulu-Natal.

Chapter 7

A CASE STUDY ON THE IMPLEMENTATION OF THE FRAMEWORK FOR THE EVALUATION OF RURAL TELECOMMUNICATIONS INFRASTRUCTURE

7.1 Defining the Estcourt/Wembezi Rural Area for the Evaluation of Rural Telecommunications Infrastructure

7.2 Stakeholder Analysis

7.3 An Examination of the Evaluation of Rural Telecommunications Infrastructure from Multiple Perspectives

7.4 Reflection on the Approaches used in the Evaluation of Rural Telecommunications Infrastructure

This chapter focuses on providing a practical validation of the framework for the evaluation of rural telecommunication infrastructure. As discussed in the previous chapter, the framework in Figure 6.2 will be followed. In order to implement the framework it was necessary to identify a rural area in KwaZulu-Natal that had telecommunications infrastructure rolled out in the last three to five years. The following potential rural areas were identified with the assistance of the Telkom Regional Managers in Durban and Pietermaritzburg: Nqutu, Emzumbe, Mpumulanga, Ndwedwe, Ingwavuma, Ubombo, Mapumulo, Oklahlamba, Cornfields, Tembalihle, and Wembesi. The prioritised set of criteria (that is, the following in order of priority: economic activity, population, location, organisational support, future prospects and area) as derived by the prioritisation process was used for the selection process (see Appendix C1.1). A survey of the areas mentioned above revealed that the main economic activity in these areas was restricted mainly to farming (agricultural and stock). However, the rural area that showed a potential for economic development, especially in terms of tourism and other allied business opportunity was Estcourt/Wembezi. It was decided to implement the framework in this area.

In order to carry out a practical validation of the framework for the evaluation of rural telecommunications infrastructure it was necessary to set up a workshop with the relevant stakeholders. In order to set up the workshop, the author sought the assistance of the Planning Division of Telkom in Pietermaritzburg and the Maintenance Division of Telkom in Estcourt. After making contact with a traditional leader of Wembezi with the assistance of the Maintenance Division of Estcourt, it was suggested that it would be best to work through the Estcourt Municipality.

The author then contacted the Speaker of the House of the Estcourt/Wembezi Local Council. He was extremely helpful and assisted the author in setting up the workshop. Two workshops were held in the Council Chambers of the Umtshezi Municipality in Estcourt, KwaZulu-Natal on 10th and 24th October 2001. The participants included representatives from the Community (represented by the NGOs), Local Government (represented by the Mayor, Deputy Mayor, Speaker of the House, and Ward Councillors), Amakhosi Chiefs, Business; (represented by the Estcourt Farmers' Association) Health Services, Telkom (the sole fixed line public network service provider of telecommunications services), and Police Services (see Appendix C1.2 for the full list of participants). The following sections outline the process and the results of the case study.

7.1 DEFINING THE ESTCOURT/WEMBEZI RURAL AREA FOR THE EVALUATION OF RURAL TELECOMMUNICATIONS INFRASTRUCTURE

The Estcourt/Wembezi area lies at the centre of four economic clusters (Figure 7.1) and about 170km from the coastal town of Durban (see Appendix C1.10 for its location in relation to Durban). It provides services to the surrounding rural population. The town has a population of 170 000 of which more than 135 000 live in rural areas. Unemployment levels are high at 52%. The most important economic sectors in this area are agriculture, manufacturing, commerce, and tourism. The lack of basic infrastructural services and the discrepancy in economic infrastructural levels between the rural and urban areas, tend to restrict economic development.

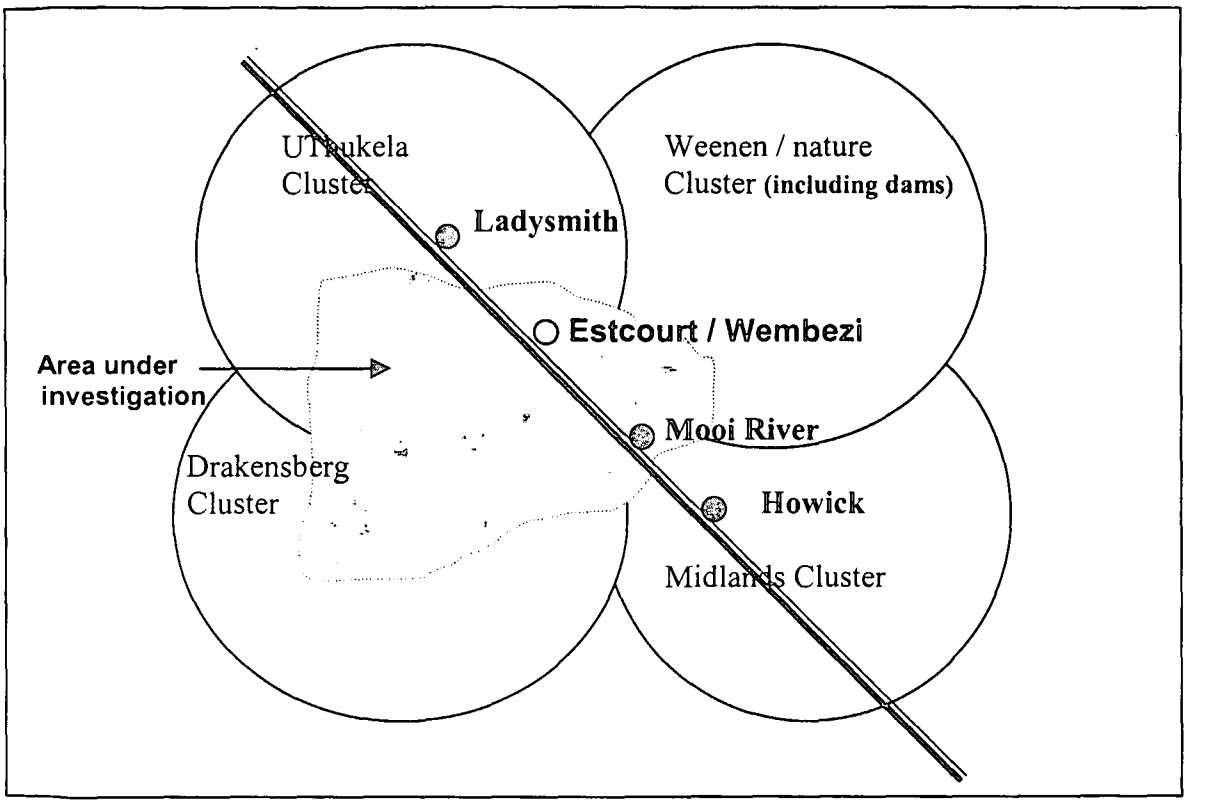


Figure 7.1: Estcourt/Wembezi lies at the centre of four economic clusters (Adapted from the Estcourt/Wembezi Regeneration Study Report, 2001) .

The areas are also influenced by national and international trends (Estcourt/Wembezi Economic Regeneration Study Report, 2001). The most important of these are:

- the new local government structure;
- the globalisation of world markets;

- the growth of the information and highway technology systems;
- the growth of the tourism industry;
- the changes in transport nodes and systems; and
- the stagnant national economy

In developing a new vision for these areas it should be realised that a town and its surrounding rural areas are a complex arrangement and concentration of human activity. This means that there is seldom, if ever, a single simplistic view of a town. Different aspects and components of the town are important to different people and different organisations (Estcourt/Wembezi Economic Regeneration Study Report, 2001). Similarly, one cannot take a single simplistic view of a Rural Telecommunications System (RTS), since a RTS is also a complex system (see Chapter 3). Rural telecommunications is one of the key ingredients in integrated economic and social development. In evaluating infrastructure, it is necessary to include all relevant stakeholders and to examine issues associated with telecommunications and rural development from different stakeholder perspectives.

7.2 STAKEHOLDER ANALYSIS

In line with the second step of the framework, this section reports on the stakeholder analysis conducted during the workshop. The evaluation of rural telecommunications infrastructure requires both quantitative and qualitative analysis. Qualitative analysis requires the active involvement of the relevant stakeholders. It was therefore necessary to identify these stakeholders. The main purposes of stakeholder analysis are to better address distributional and social impacts of projects, programs and policies; and to identify existing or potential conflicts, and factor appropriate mitigation strategies into activity design. The main steps in stakeholder analysis include:

- identifying the principal stakeholders (these can be at various levels, for example, local, regional, national government);
- investigating their roles, interests, relative power and capacity to participate;
- identifying the extent of cooperation or conflict in the relationship between stakeholders; and

- interpreting the findings of the analysis and defining how this should be incorporated into project design.

The author who acted as the facilitator, engaged the participants in identifying the relevant stakeholders that will be, either directly or indirectly, affected by the improvement of rural telecommunications infrastructure in the Estcourt/Wembezi rural area. A rich picture, Figure 7.2, was used to initiate a brainstorming session. The rich picture aimed to show the rough structure of the problem as well as the main processes within the problem under concern (Checkland and Scholes, 1990). The rich picture depicts a long road to Drakensberg's White Mountain and Giant's Castle. Although the rich picture highlights the lack of development in the area, it also highlights the interests of investors and the potential for economic development. The light at the end of the road symbolises hope for the community in terms of infrastructural support.

The participants did not experience any difficulty in identifying the stakeholders. The stakeholders identified by the participants in the workshop are listed in Table 7.1.

Table 7.1: Stakeholders identified by the participants at the workshop.

Group 1:	Local Business (Big and Small) and Farmers Associations
Group 2:	Local Council, Provincial, and National Government – sometimes referred to as government agencies
Group 3:	Telkom and Eskom
Group 4:	Health and Police Services
Group 5:	Local Community, NGOs, and Tribal Authority

Many of the stakeholders identified can be regarded as "standard stakeholders", in terms of Banville *et al.* (1998). According to these authors, standard stakeholders both affect the problem and are affected by the problem and play a crucial role in the improvement of rural infrastructure for development. Consultants can be characterised as "fiduciary stakeholders" as they may participate in the process of formulating the problem and affect the way it is solved but they are not personally affected by the solution. The future generations can be classified as "silent stakeholders" since they have no direct control over the resources or uncertainties deemed relevant for solving the problem.

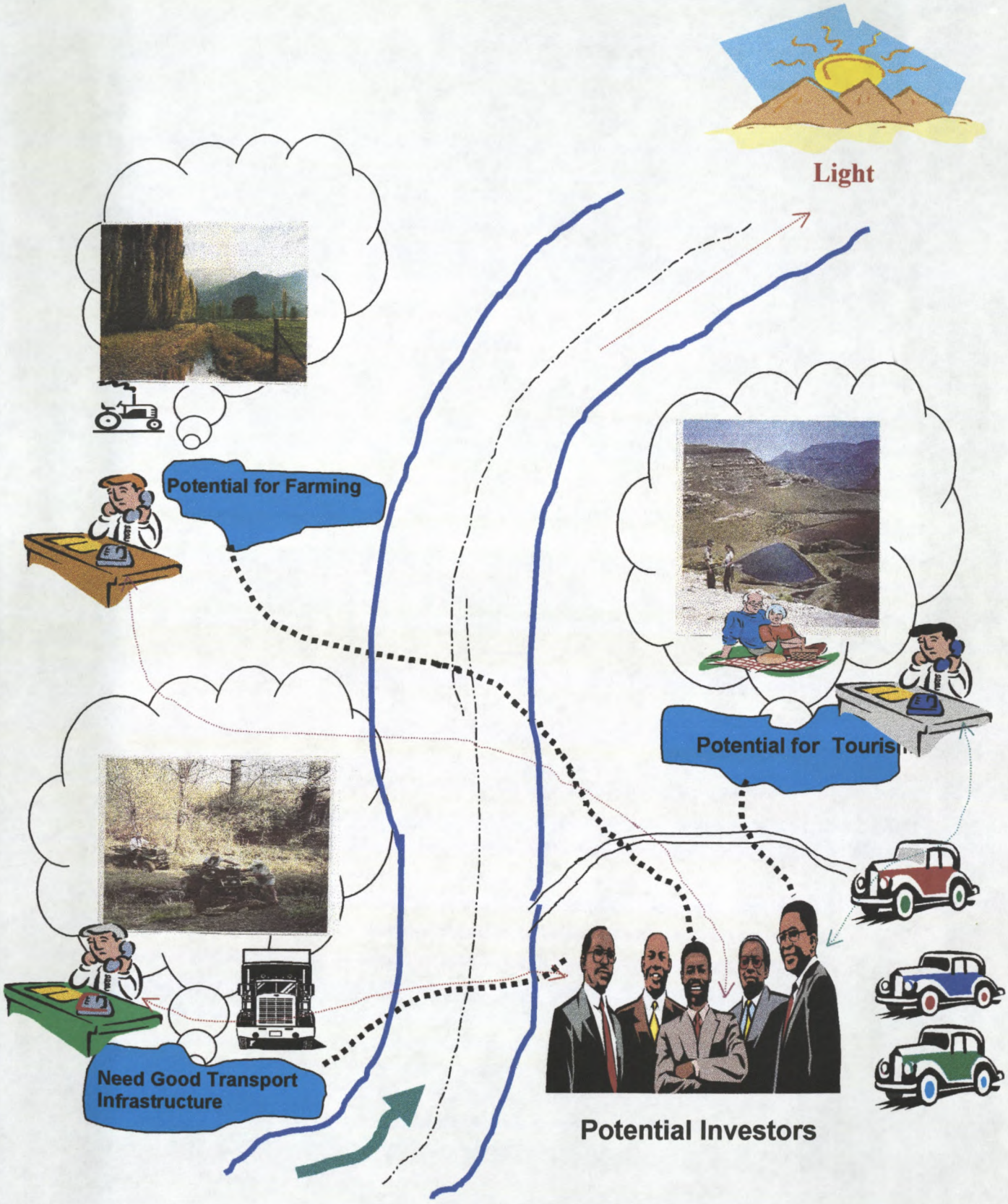


Figure 7.2: Rich Picture depicting some of the rural development issues.

7.3 AN EXAMINATION OF THE EVALUATION OF RURAL TELECOMMUNICATIONS INFRASTRUCTURE FROM MULTIPLE PERSPECTIVES

This section uses different techniques: brainstorming; rich pictures and CATWOE analysis of SSM; boundary judgement questions of CSH; prioritisation of criteria using AHP; and statistics to generate issues associated with the evaluation of rural telecommunications infrastructure, empower those that are disadvantaged to be heard, and provide an environment for learning and sufficient information to motivate for the improvement of rural telecommunications infrastructure.

7.3.1 The use of Rich Pictures, Statistics, and Brainstorming in Identifying Issues for the Evaluation of Rural Telecommunications Infrastructure

Rich Picture on the Problem

After having identified the stakeholders, the rich picture (Figure 7.2) was used to generate issues around the improvement of telecommunications infrastructure and rural development. It was agreed that it is sometimes difficult to represent all the weltanschauungs (world-views) in one rich picture. The author attempted to include the different weltanschauungs by updating the rich picture (Figure 7.2) after receiving inputs from the different stakeholders. A new rich picture (Appendix C1.5) was then presented to the participants. The rich picture depicted a long road as a metaphor for rural development. The impact that telecommunications can have on the social, economic, and political development of the region was highlighted. The road goes through a bureaucratic maze that comprises all the stakeholders in the decision process. However, there was agreement among the stakeholders that for integrated development to be sustainable it was necessary for the relevant stakeholders to be involved and/or consulted before any major decisions were taken. The workshop participants recognised the confusion and frustration service providers, developers, and the community suffer during this process, because the process is not linear and takes a long time for consensus and approval. The participants agreed that before the rolling-out of any infrastructure, there should be proper planning, which had to be transparent and inclusive.

Statistical Data to Support the Evaluation

Statistics is simply the most important tool of the sciences. Because scientists often must use large amounts of data to gain a representative sample of a population, it is not possible to simply look at the numbers and understand what is happening. Statistics allows one, especially a trained person, to see the significance of data, the relationship between seemingly unrelated phenomena, and predict what may happen in the future or determine what may have happened in the past. Similarly the statistical data on the provision of telephones in the Estcourt/Wembezi area assists one in understanding the inadequacies that exists in the provision of telecommunications infrastructure and allows one to draw conclusions on its socio-economic impact. Table 7.2 provides statistical data on the provision of telephone facilities for the Estcourt/Wembezi area in 1996.

Table 7.2: Telephone facilities for the Estcourt/Wembezi Area
(Source: Statistics South Africa, Census: 1996).

Household:	**Estcourt**	**Wembezi**	**Tribal-Estcourt**	**NU-Estcourt**	**Total**
Dwelling/cell phone	1925	564	87	364	2940
Telephone at neighbour nearby	226	497	1247	228	2198
Public telephone nearby	282	1048	5431	301	7062
At another location nearby	130	268	750	341	1489
No access to a telephone	109	224	8093	811	9237
Unspecified	9	23	121	36	189
Total	**2681**	**2624**	**15729**	**2181**	**23115**
Population	*12084*	*13683*	*115578*	*12820*	*154165*

On examining the statistical data above one can see that the provision of telecommunications infrastructure was inadequate in 1996, especially when it is compared with the population of the area. However, new infrastructure was rolled out in 1998. The Telkom High Level Planning Information Report (1997) for the Wembezi area indicated that 1200 circuits were to be provided with a backbone catering for a four-year demand figure of 1500. These services include the provision of services to all priority customers: schools, clinics, police stations, hospitals and the minimum of one service to each unserviced village. The circuit

requirements projected in 1997 (Telkom High Level Planning Information Report, 1997) were as follows:

	1 Year	4 Year
Residential Telephones	1040	1295
Business Telephones	0060	0105
Call Office (Telephone coin box)	0090	0090

Unfortunately, the current statistics are not available at present. These will be made available once the 2001 census has been finalised. It will then be possible to do an impact analysis of the state of infrastructure provision in 1996 compared to 2001. Although this falls outside the scope of this thesis the author will continue with it as an on-going project and carry out an analysis as soon as the statistical data becomes available. Recommendations can then be made to the service providers and policy-makers.

In order to evaluate the socio-economic impact of rural telecommunications infrastructure, one needs to identify the socio-economic indicators of rural telecommunications. While quantitative indicators are not necessarily more objective, their numerical value tends to lead to more agreement on interpretation of the results. However, qualitative indicators can supplement the numbers and percentages and, thereby, add a real-life perspective to the evaluation of a program. It may not always be possible to find quantitative indicators for some of the indirect impacts of the provision of telecommunication services in complex socio-economic systems, and qualitative indicators may be the only ones available that are relevant to key policy and management issues. The quantitative indicators listed below are regarded as being most important for the purposes of this research:

- The quality of service which is determined by:
  - the level of customer satisfaction;
  - network reliability;
  - speed and responsiveness; and
- The network size, which is determined by:

- number of telephone main lines in operation;
- total line capacity of local exchanges main lines for residential use; and
- the number of public pay phones.

It must be noted that the above is not an exhaustive list. See Chapter 2 for a more detailed list of indicators. The selection of the relevant indicators for an area will always depend on the characteristics of the area of concern.

Brainstorming the Issues Associated with the Evaluation

Brainstorming was used together with the statistics available, and a rich picture to generate ideas and highlight issues associated with the improvement of rural telecommunications infrastructure. The ideas that were generated during the brainstorming session were listed on a flip chart. The redundant and duplicate ideas were removed. The following are the main issues raised by the stakeholders:

- There are too many unskilled people in the rural area. There is a need to provide skills training in order in order for them to take an active part in development programmes. Local offices of the telecommunications provider also require the services of skilled personnel.

- There are about 50 schools in the area. More than half do not have telephones. There is a need to provide schools in rural areas with telecommunication services.

- Although clinics have telephone services, they are out of order. There is a need to reduce downtime on services to clinics.

- Only the telecommunications service provider makes all the decisions regarding the rollout of infrastructure. There is a need to improve decision-making on telecommunications infrastructure.

- The churn factor (number that discontinue the services) is high. Many customers do not pay for telecommunications. There is a need to create a culture of payment for services among the customers.

- In Cornfields, there is only one call box serving the entire community. There is a need for more call boxes.

- There is not sufficient information on businesses's usage of telephones. There is need to make these available to the local council in order to assist them with the Integrated Planning Programmes.

- Many people in the community are unemployed or earn very little from subsistence farming. There is a need to improve the affordability of telephones.

- Although many people apply for telephone services, only a few are successful. There is an unsatisfied demand for telephones.

- There is a high level of theft of copper wire and vandalism. There is a need to educate the community on the importance of telecommunication infrastructure in order to reduce vandalism, the theft of copper wires, and solar panels.

- Information on demand for telephones is not easily available. There is a need to provide better information on the demand for telecommunication services.

- There is insufficient knowledge on coverage of the area by the Council.

- There is long decrease delay in processing telephone applications.

- The community is not aware of all the services offered by Telkom. Telkom needs to market its services.

The participants were asked to rank the ideas above in terms of their importance to the improvement of rural development. A scale of 1 to 10 was used, 1 representing little and 10 extreme importance. The ideas/issues together with the ranking are listed in Table 7.3.

It can be noted that an issue may be classified into more than one category where: **T** = Technical; **C** = Cultural; and **P** = Political. Thus, the technical and cultural streams of SSM mode two are simulated, taking care also of the limited time the stakeholders had for this evaluation. As can be seen from the table, some issues are classified in two or more categories, example: Provide skills training to develop the community (two categories), and Decrease delay in processing applications (three categories). The classification of the issues into the three categories allows one to perform a cultural analysis of the intervention, to examine the social and political aspects of the relevant systems and to compare these to the real world. The differences between the desirable and the real world form the basis for

change and action.

Table 7.3: Ideas Generated during the brainstorming session.

	Issues	Rating	T	C	P
1	Provide skills training to develop local community	10	✓		✓
2	Provide schools in rural areas with telecommunication services	10	✓		✓
3	Reduce downtime on services to clinics	10	✓		
4	Provide better decision-making on telecommunications infrastructure	9	✓	✓	
5	Create a culture of payment for services	9		✓	
6	More call boxes required	7	✓		
7	Information on businesses usage of telephones	7	✓		✓
8	Improve the affordability of telephones	7			✓
9	Unsatisfied demand for telephones	7			✓
10	Educate on the importance of telecommunication infrastructure in order to reduce vandalism, the theft of copper wires, and solar panels	7	✓	✓	
11	Provide better information on the demand for telecommunication services	6	✓		✓
12	Insufficient knowledge on coverage of the area by the Council	6	✓		✓
13	Decrease delay in processing applications	5	✓	✓	✓
14	Telkom needs to market its services	5		✓	✓

From the rating it can be concluded that the participants considered the following issues (rating of 9 and 10) as most important:

- to provide skills training
- to provide the schools with telecommunication services
- to reduce downtime to clinics
- to provide better decision-making on telecommunications infrastructure
- to create a culture of payment for services.

An analysis of the above classification confirms the assertions made before, that is, the major issues in the improvement of rural telecommunications infrastructure are not only the technical issues but also includes the softer issues (cultural and political). These softer issues need to be examined more closely. Stakeholders sometimes consider the problems and issues from their own or limited perspective. There is therefore a need to align the stakeholders' perception in order to resolve possible conflicts and make it easier to reach consensus. The development of multiple perspectives was completed in the second workshop and is discussed in the next section.

7.3.2 The Use of CATWOE Analysis to Develop Multiple Perspectives for the Evaluation of Rural Telecommunications Infrastructure

According to Banville *et al.* (1998), it is not sufficient to identify the stakeholders, but it is also necessary to investigate their roles, interests, relative power and capacity to participate; and also to identify the extent of cooperation or conflict in the relationship between stakeholders. In line with the third step of the framework, these issues and the development of multiple perspective representations of the problems and issues associated with the evaluation of rural telecommunications infrastructure had to be explored. Mitroff and Linstone (1993) identified three most typical perspectives in addressing complex problems like the evaluation of rural telecommunications: Technical Perspective; Organizational or Societal Perspective; and Personal or Individual Perspective. Following Mitroff and Linstone (1993: 98) "each perspective reveals insights about a problem that are not obtainable in principle from the others". Given three (or more) different and potentially conflicting perspectives on a problem, one inherent concern in using the multiple viewpoints concept is the integration of different perspectives.

Personal perspectives are, however, often ignored when the problem is formulated from the organizational perspective that emerges from "dominant" perspectives of powerful individuals or groups. From the technical perspective, traditionally a problem is formulated objectively and quantitatively, often disregarding human and organizational factors. So to formulate a messy problem from the multiple perspectives approach, it is critical to minimize the gaps between perspectives (Mitroff and Linstone, 1993). This is crucial, especially in the

case of rural development, where the community perspective cannot be ignored or be regarded as being less important.

Multiple perspectives were explored through CATWOE analysis of Soft Systems Methodology (Checkland and Scholes, 1990) and the Boundary Questions of Critical Systems Heuristics (Ulrich, 1983). The first technique that was used to develop multiple perspectives was the CATWOE analysis, a technique from Soft Systems Methodology (Checkland and Scholes, 1990). The meaning of the CATWOE mnemonic is listed in Table 7.3.

Table 7.4: CATWOE and its meaning in the context of the improvement of rural telecommunications infrastructure.

- Customers: The customers, beneficiaries or victims of the improvement of rural telecommunications infrastructure.
- Actors: The people that are involved in the improvement of rural telecommunications infrastructure.
- Transformation process: The process that transforms provision of telecommunication services to economic and social development.
- World-view: What should be the viewpoint from which the transformation should take place?
- Owners: Those in the system that have decision-making authority – those who can stop the process of the improvement of infrastructure.
- Environmental constraints. The environment includes those factors that will impinge on the situation, and over which the actors and owners have no control.

Each group was given a questionnaire (Appendix C1.6). The CATWOE mnemonic was explained to the groups. The groups were then given a set of CATWOE questions. They were then requested to discuss each CATWOE and answer the questions contained in the questionnaire. The participants were reminded that their responses had to be in reference to the evaluation and improvement of telecommunications infrastructure in their area. After the completion of the questionnaire, each group was asked to discuss their answers to the CATWOE questions. Other groups were then asked to add or comment on the responses.

The responses of the different groups are given below. These responses are followed by a brief discussion.

Summary of the responses of each group of stakeholders for the **CUSTOMER** element of CATWOE

Business including Farmers	Employers and Employees, Farmers, Farm Labourers
Govt. Agencies	Clinics, Police, Community Leaders, Schools, Consumers, Business
Community Reps	Business, Schools, Clinics, Police, Churches, NGOs, Information Centres.
Health and Police	Community, Schools, Clinics, Police, Local Council, Shop Owners
Telkom	Communities, Schools, Clinics, Farmers, Police, NGOs, Business

From the responses it is clear that the Government agencies, that is, representatives from local government; community representatives; health and police services; and Telkom had a similar perspective in terms of who should be the customers of the improvement of telecommunication services. The business community, represented by a representative from the Estcourt Farmers' Association restricted his perspective just to employers and employees. During the feedback session the participant indicated that he should be looking at the issues from different perspectives. This is a very narrow perspective and justifies the need for an exercise to develop multiple perspectives.

Summary of the responses of each group of stakeholders for the **ACTOR** element of CATWOE.

Business	Chamber of Commerce and Farmers Association
Govt. Agencies	Telkom, Eskom, Dept. of Transport, Security Firms, Community Leaders, Schools
Community Reps	Customers and Beneficiaries
Health and Police	Telkom, Eskom, Community Leaders, Dept. of Transport
Telkom	Local Communities, Tribal Chiefs, Local Council, Educators, Eskom, Police, Telkom

In response to who the actors should be, the representative restricted his response to the business community while some included Eskom (Electricity provider) and the Department of Transport. One very important actor, that is, the Tribal Chiefs (Amakhosi) was excluded from most groups. Although two groups included community leaders, they did not represent the Amakhosi. It must be noted that the Amakhosi plays a very important role in decision-making especially in the areas where their tribal authority extends. The representative from Telkom explained during the feedback session that permission had to be sought from the

Amakhosi before installing any equipment in that area. All necessary documents had to be signed by the Amakhosi of that specific area.

Summary of the responses of each group of stakeholders for the **TRANSFORMATION** element of CATWOE.

Business	Reliable communication to essential services; Access to local and international markets
Govt. Agencies	Link between municipal office and satellite offices
Community Reps	Improve social life, Improve economy
Health and Police	More call boxes for the community, police and clinics
Telkom	Sustain and improve telecommunication services

The responses to the transformation process indicate the restricted perspectives of each group. During the feedback session the importance of this exercise became clear to the participants. Some mentioned that they did not see transformation from "that point of view". The involvement of different stakeholders and their input was becoming clearer to the participants during the feedback session. The representative from Telkom mentioned that although their response was to "sustain and improve telecommunication services" they did not consider all the other points that were mentioned. They mentioned that this kind of input was very important from a planning point of view.

Summary of the responses of each group of stakeholders for the **WELTANSCHUAANG (WORLD-VIEW)** element of CATWOE.

Business	Improved service by Telkom; Reduced theft
Govt. Agencies	Improvement of infrastructure; Education of customers; Communication between different municipalities; Reduction in vandalism; Improved knowledge on usage
Community Reps	Improved quality of life for the community
Health and Police	Quicker response to calls
Telkom	To meet the social obligation as a communications provider

How did each group perceive the improvement of telecommunication services? The responses indicate that this question was also answered from a very narrow perspective. The feedback session proved to be very useful in that each group realized that they left out important aspects that should really have been included, for example, the response from the health and police services only considered their world-view to be just an improvement in terms of response time. They realized that other aspects of improvement also needed to be considered.

Summary of the responses of each group of stakeholders for the **OWNER** element of CATWOE.

Business	Govt., Telkom, Local Authorities
Govt. Agencies	Service Providers; National and Provincial Govt., Community Leaders; Local Council
Community Reps	Traditional Leaders and Councilors; Civic Associations; National and Provincial Govt.
Health and Police	National and Provincial Govt., Telkom; Traditional Leaders
Telkom	Telkom

Most of the responses include the obvious: the service provider, Telkom, and government agencies but only two groups had traditional leaders, that is, the Amakhosi. The Amakhosi can stop development in "his" area. It is therefore important to include the Amakhosi in the decision-making process. The participants indicated that a community leader is not necessarily the Amakhosi.

Summary of the responses of each group of stakeholders for the **ENVIRONMENT** element of CATWOE

Business	Terrain; Weather (lightning); Fire; Road (Access)
Govt. Agencies	Terrain; Roads; Lightning; Wind; Floods
Community Reps	Poverty
Health and Police	Floods; Storms; Fire
Telkom	Fire, Snow; Flood; Lightning

There was consensus on the environmental issues that the actors had very little or no control over. The Telkom representatives were asked why they had included snow. They indicated that during heavy snow falls, power lines go down, and this affects the telecommunication services also. The response of the community representatives was also interesting. They listed poverty as an environmental issue. The facilitator asked the groups for their views on this response. After a short discussion it became clear that it was the poverty issue that was been addressed. The improvement of rural telecommunications infrastructure and integrated development aimed at alleviating poverty.

7.3.3 The Use of Boundary Judgement Questions to Develop Multiple Perspectives for the Evaluation of Rural Telecommunications Infrastructure

Apart from the CATWOE analysis, Critical Systems Heuristics (CSH) proposed by Ulrich (1983), was also used to reinforce the need for multiple perspectives and unravel the "normative content" of the actual and proposed systems designs. Flood and Jackson (1991) argues that CSH sets a philosophy for emancipatory systems approach, which planners and other stakeholders can use to reveal the normative content of actual and proposed system designs. By "normative content", Ulrich referred to both the value assumptions that underpin intervention and the consequences such intervention impose on the participants and non-participants. Flood and Jackson best described CSH as "a means of interrogating systems design to reveal the boundary judgements being made and a means of postulating alternative boundary judgements, that is of asking what the boundaries should be" (Flood and Jackson, 1991: 205).

Ulrich (1983) agrees that Churchman's desire to sweep the maximum amount of information into understandings of improvement is theoretically sound, but also acknowledges that the need to take practical action will inevitably limit the sweep-in process. Those that built on Churchman's work on CSH are in agreement with Churchman who argues that every worldview is terribly restricted. For this reason, they insist that a proposal should not be taken as given because it might not be reflective of all the different perspectives held by different stakeholders. In short, CSH wants to ensure that the views of all stakeholders, including those who might be invisibly but negatively affected by the proposed design, are taken into consideration. CSH uses the 12-boundary questions that allow planners and systems designer to get the normative content of proposed designed systems. The questions are divided into four groups comprising three questions each. Each group aims to identify the sources of motivation, power, knowledge, and legitimization (Ulrich, 1983). The questions were adapted for the evaluation and/or improvement of rural telecommunications infrastructure (Chapter 6).

After the CATWOE exercise, the groups were more comfortable in handling the boundary questions although some had difficulty in interpreting some of the questions. The first set of questions (Appendix C1.7) aimed to determine the sources of motivation for the evaluation and improvement of rural telecommunications infrastructure. There were no problems in determining who were the actual clients in the improvement of telecommunications infrastructure. Some groups had consumers and customers while others listed the clients. During feedback it was made clear that consumers referred to all those that required new services or improved services. There was general consensus on the possible positive spin-offs of the evaluation process: Identify needs; National connectivity; better payment culture; Improved services; and Feedback to the government agencies and the service provider.

The groups had a fairly good idea of how to determine whether the provision of telecommunication services constitutes an improvement or not. At this point the facilitator was asked the question "What will be the outcome of this workshop?" in other words, what is the next step? The facilitator pointed out that since Telkom and Ericsson fund this project (this was also mentioned at the beginning of the workshop), a report of the findings will be submitted to them and that it was hoped that the points raised will be taken into account in the planning of services for their area. It was also mentioned that a report would also be sent to the participants. The groups were happy that they were not involved in a futile exercise.

The second set of questions aimed to determine the basis of power for the evaluation and improvement of rural telecommunications infrastructure. The responses indicate that the groups had a very good idea of who the decision-makers should be and what resources should be under their control. There was general consensus on these two issues. The responses to what the decision-makers should not have control over were very interesting. The groups felt that the awarding of tenders and determining what was good for the community should not be left to the decision-makers only. The community and other stakeholders should also be involved in determining what was good for their area. The awarding of tenders should be a transparent process and consideration should be given to empower local business to stimulate growth.

The third set of questions aimed to determine the sources of knowledge for the evaluation and improvement of rural telecommunications infrastructure. The groups experienced problems in answering these sets of questions. The author (with hindsight) now feels that these questions should have been excluded because the participants were expected to understand the planning process. Stakeholders can lobby for resources and provide useful input into the planning process, but the actual planning ought to be done by qualified planners and other experts (for example, surveyors). However, this proved to be a useful exercise, because the participants realized that although the Amakhosi was a very important person in the area under discussion, he does not get involved in the planning process. The same applies to Councillors, NGO's, etc.

The fourth set of questions was aimed to determine the sources of legitimisation for the evaluation and improvement of rural telecommunications infrastructure. It became clear from the responses to these questions that the participants did not fully understand the role of telecommunication in the development of rural areas and the importance of integrated development. The author explained to the groups how improved telecommunications services could help to alleviate poverty in their area especially since there was such great potential for economic development. Their vision for the future was universal access of telecommunication services at affordable rates and that there should be proper planning before infrastructure rollout.

The responses of the groups to CATWOE and the boundary questions provided a deeper insight into the issues associated with the evaluation of rural telecommunications infrastructure. A number of the problems centred around the softer issues and very little on the hard technology issues. This highlighted the complexity of the problem where one needs to consider the hard and soft issues in these kinds of problem contexts.

The feedback session proved to be very successful. The participants admitted that they learned a great deal from this exercise because they viewed some of the issues from their own narrow perspectives. This exercise gave them a new insight into the different perspectives one should consider when examining a problem. One council member said "we need to keep this in mind during our council meetings". It is the author's view that there was

consensus within the group and that the development of multiple perspectives was an integral part of the learning process. The next step was to prioritize the issues raised thus far. This is discussed in the next section.

7.3.4 The Prioritization of Factors Affecting the Improvement of Rural Telecommunications Infrastructure in the Estcourt/Wembezi Area

In order to allocate resources and establish time frames, it is necessary to determine those issues that contribute more significantly to the improvement of telecommunications infrastructure. This step involves the prioritization of factors that affect the improvement of rural telecommunications infrastructure with respect to the particular area characteristics. In order to proceed with the prioritisation process, the issues were as follows:

Planning and Operational Issues

- Reduce downtime to clinics
- Decrease delays in processing applications
- Provide more call boxes
- Improve phone affordability

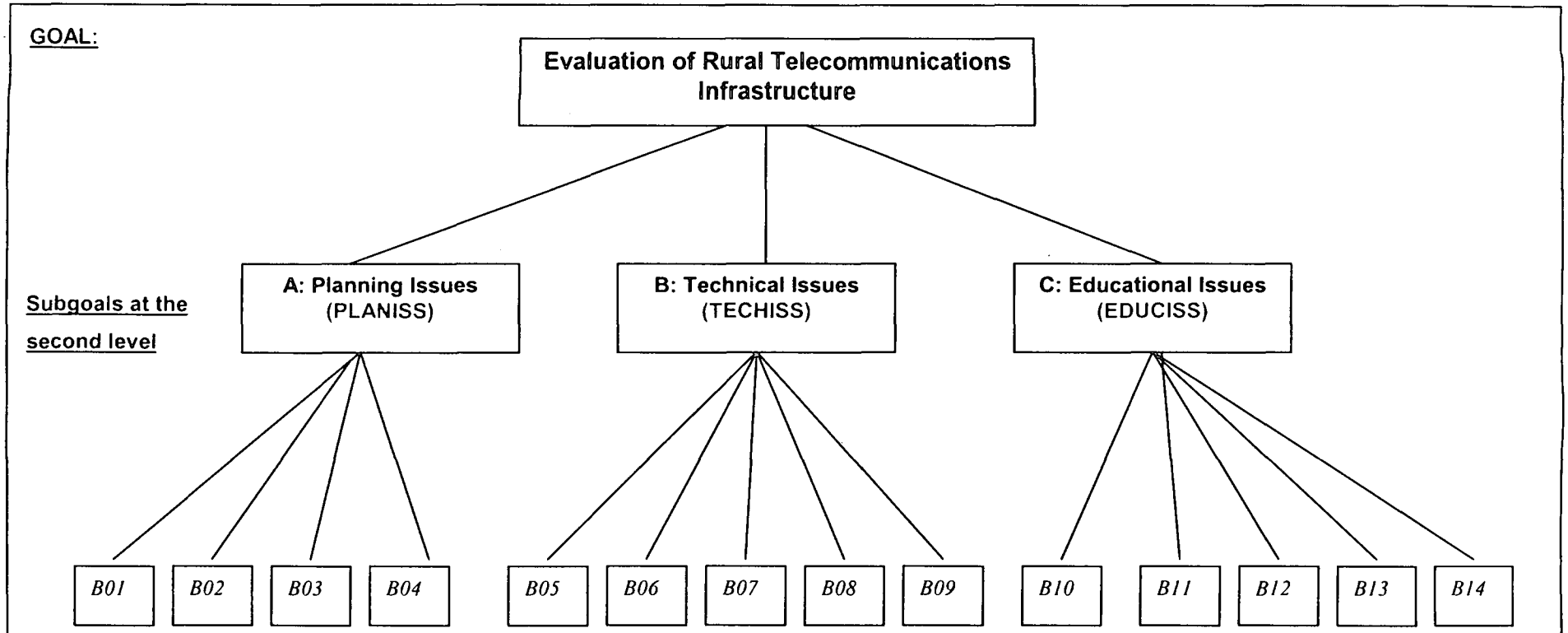
Technical and Marketing Issues

- Unsatisfied demand
- Need for more information on the demand for phones
- Insufficient knowledge on coverage of the area by the Council
- Information on businesses usage of telephones
- Provide better decision-making on telecommunications infrastructure

Educational Issues

- Need for Telkom to market its services
- Provide skills training
- Educate community to reduce vandalism and theft
- Provide telecommunication services to all rural schools
- Create a culture of payment.

A hierarchical representation of these criteria for the evaluation of rural telecommunications infrastructure is given in Figure 7.3.



Categories of Activities **at the third level, affecting the subgoals are:**

B01 **D/T CLIN** Reduce downtime for clinics **(A)**

B02 **DEL.APPL** Avoid delays in processing applications **(A)**

B03 **CALL BOX** Provide more call boxes **(A)**

B04 **PHO.AFFO** Improve phone affordability **(A)**

B05 **UN.DEMAN** Unsatisfied demand **(B)**

B06 **INF.NEED** Need for more information on demand for phones **(B)**

B07 **KNOW COV** Need for knowledge of coverage by Council **(B)**

B08 **BUS.USAG** Information on business usage of telecommunications **(B)**

B09 **IMP.DMI** Need to improve decision-making on telecoms infrastructure **(B)**

B10 **MARKETIN** Need for Telkom to market its services **(C)**

B11 **SKILL TR** Need to provide skills training **(C)**

B12 **ED.IMP.T** Educate to reduce vandalism and theft **(C)**

B13 **SER.SCHO** Provide telecoms service to schools **(C)**

B14 **CULT.PAY** Create a culture of payment **(C)**

Figure 7.3: A Hierarchical representation of the criteria for the improvement of Rural Telecommunications Infrastructure.

Figure 7.3 shows the holistic nature of this hierarchy and how it focuses the attention of the stakeholders in the evaluation process. The implicit feelings expressed during the SSM session get a specific expression through the process leading to prioritisation of the factors affecting the improvement of rural telecommunications. The implementation of the MCDA model for the evaluation of rural telecommunications infrastructure was conducted with the groups. At this stage of the workshop some of the participants left due to other commitments. However, each group had a minimum of three participants.

In order to determine the issues that are most significant to the improvement of rural telecommunications infrastructure, it is necessary to prioritise the criteria at the second and third level of the hierarchy. This is achieved by carrying out pairwise comparison (see section 7.1). The pairwise comparison was processed by software, Expert Choice. Figure 7.4 displays the results of the pairwise comparison at the second level.

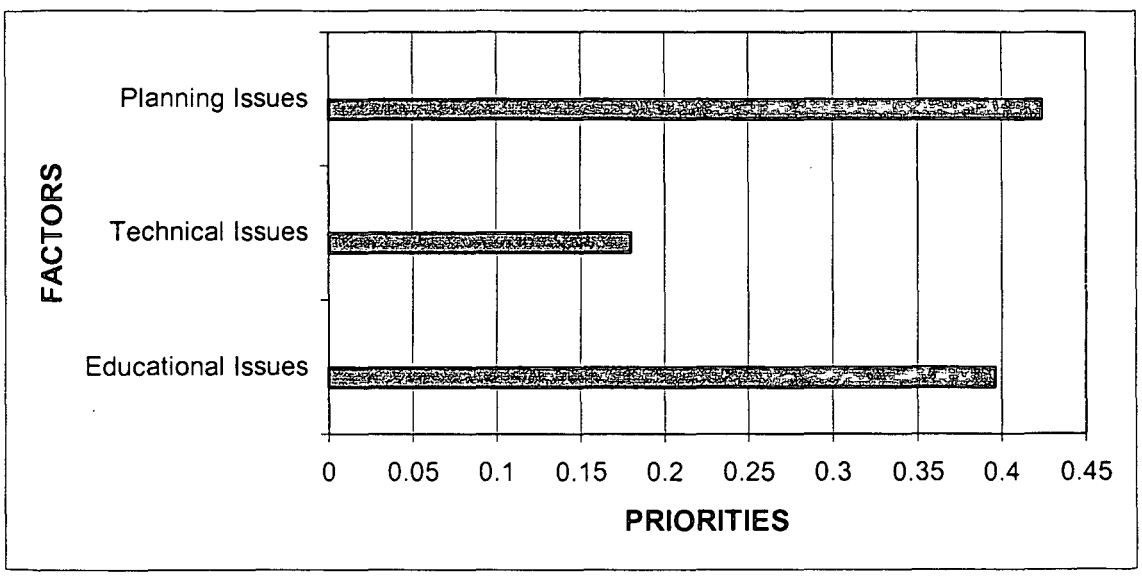


Figure 7.4: Priorities for the Following Second Level Issues: Technical and Operational Issues, Planning and Marketing Issues, and Educational Issues.

According to the participants, the planning issues were regarded as most important (0.424), with educational issues following closely as the second most important (0.396). Technical issues were not regarded as very important (0.180). This reveals that if the planning is done properly and there is awareness of the importance of telecommunications infrastructure created by suitable educational programs, the technical issues/problems would be resolved to a great extent. If the planning is not a transparent and inclusive process, the infrastructure

that is rolled out may not serve the interest of the community. Education can result in increased usage for social and business purposes and may also reduce vandalism and theft. Education will also make the community realise that they need to take ownership of the infrastructure in order to protect it.

The next section examines the prioritisation of each cluster, that is, Planning and Marketing Issues, Technical and Operational Issues, and Educational Issues. The prioritisation of the planning and marketing issues, as illustrated in Figure 7.5, is discussed first.

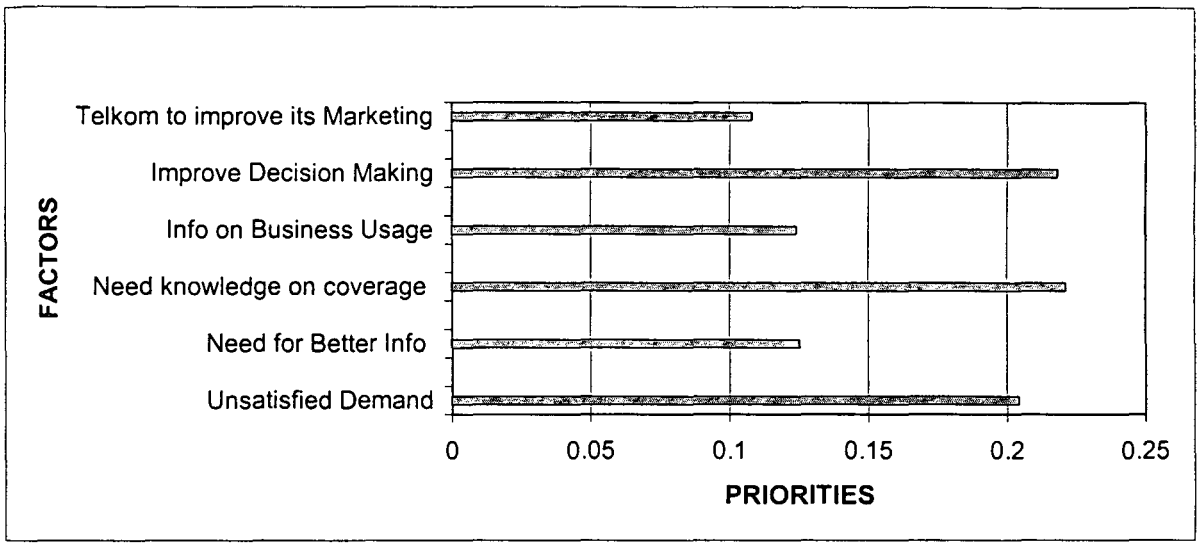


Figure 7.5: Local Priorities of the Planning and Marketing Factors in the Evaluation of Rural Telecommunications Infrastructure.

Telephone penetration statistics in the area was considered most important. During the brainstorming session, the local council representatives mentioned that they were currently involved in integrated development planning and it was felt that the statistics would provide useful input into their planning process. The importance of this information is also highlighted in the prioritisation process.

Two other important issues that were highlighted during the brainstorming session and also received high priority in the prioritisation process were: the need to improve decision-making by Telkom on the rollout of telecommunication infrastructure and the need to satisfy the large demand for telecommunication services. However, the churn out factor was high according to the Telkom representatives. They pointed out that some members of the

community were under the misconception that the services were free. The prioritisation of the technical and operational issues is illustrated in Figure 7.6.

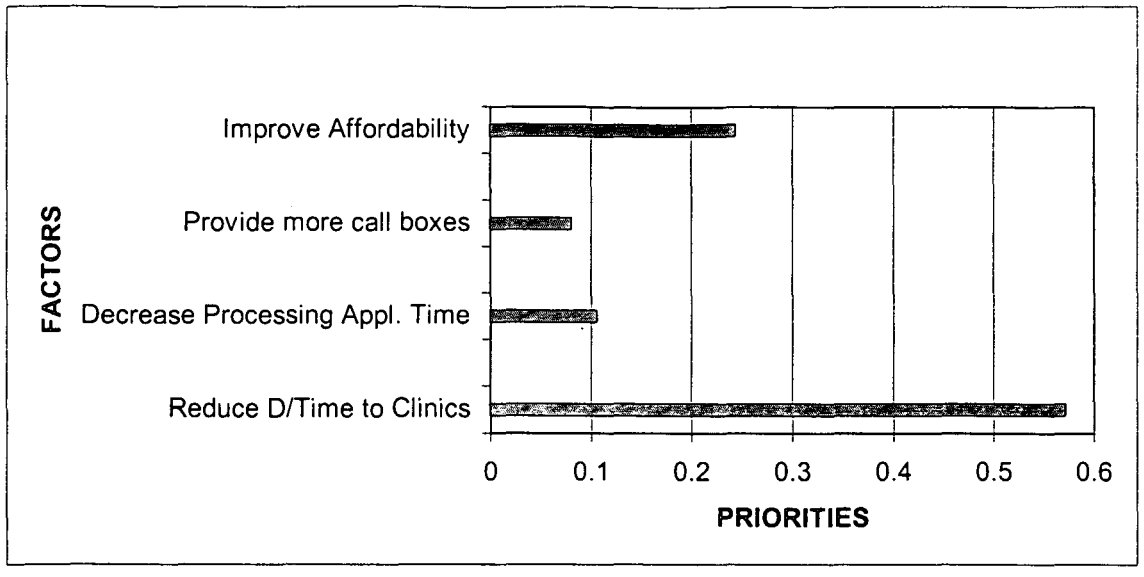


Figure 7.6: Local Priorities of the Technical and Operational Factors in the Evaluation of Rural Telecommunications Infrastructure.

The reduction of downtime to the clinics was considered most important. Although there are phones in the clinics, they are out of order most of the time. This has major implications during emergencies. It was also felt that the phone services should be made more affordable. There is a high level of poverty in this area. The community felt that since the people in the area were generally very poor, the state should subsidise the services. The educational issues were prioritised next. The results are illustrated in Figure 7.7.

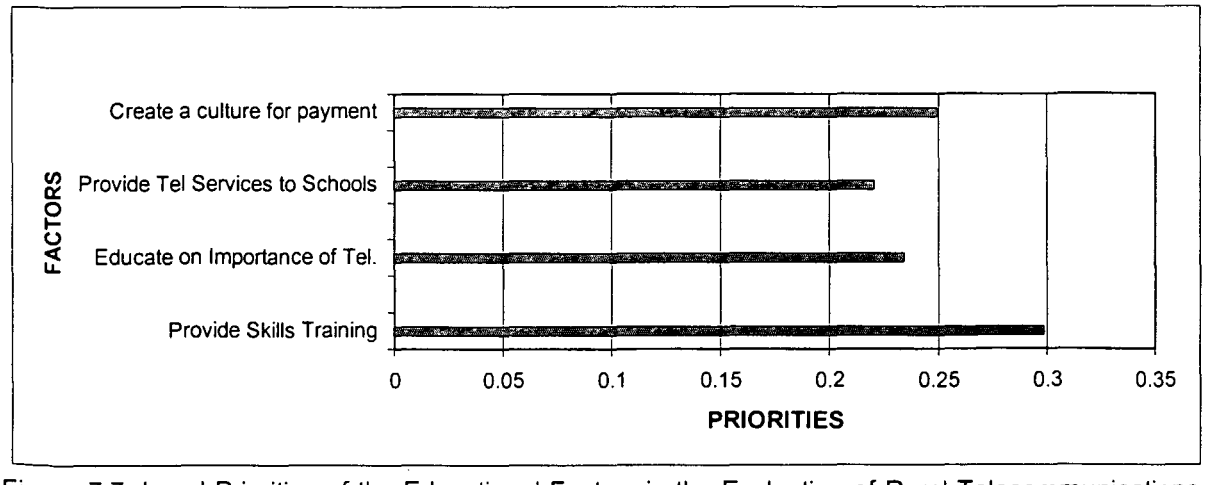


Figure 7.7: Local Priorities of the Educational Factors in the Evaluation of Rural Telecommunications Infrastructure.

All the educational issues were regarded as important. However, the need for skills training was regarded as most important. There was a strong feeling that in order to improve the employment opportunities people should possess employable skills. Skilled personnel play a very important role in economic development. The participants also felt that if there is sufficient education on the benefits of telecommunication services, people will not be reluctant to pay for services and that the level of vandalism and theft may be reduced.

The discussion so far was concerned with the local priorities of the individual factors, reflecting their contribution to the respective group of factors. However, the global priorities of all the factors showing their contribution to the evaluation and improvement of rural telecommunication infrastructure are more important (Figure 7.8).

Information regarding telephone penetration rates (knowledge of coverage 0.119) was regarded as most important. The second most important factor was the need for Telkom to improve their decision-making (0.117) with respect to the rollout of telecommunications infrastructure were regarded as most important. As mentioned above, these priorities were influenced by the discussion that took place during the workshop where the local council emphasised the importance of need for telephone penetration statistics and that stakeholders should provide input into the planning process and that stakeholders at present provide none or very little input.

There was very little difference between the need for skills training (0.111), and the need to satisfy the demand for telecommunication services (0.110). These were followed by the need to educate the community on the importance of telecommunication services in order to improve the culture of payment (0.093), reduce the amount of theft and reduce the level of vandalism (0.087), and provide telecommunication services to schools (0.082). The need for more information on the demand for telephones and information on business usage of telephones were equally important (0.067). The remaining factors had a low priority: Telkom should improve its marketing (0.052), and reduce downtime to clinics (0.050). It was surprising that the need to improve phone affordability had a very low priority (0.021). It was understandable that the delay in processing application received a very low priority of 0.09 because if the services are available, the processing of applications is an administrative issue. Also, if there is adequate access to residential telephones, there is no need to have a large number of call boxes.

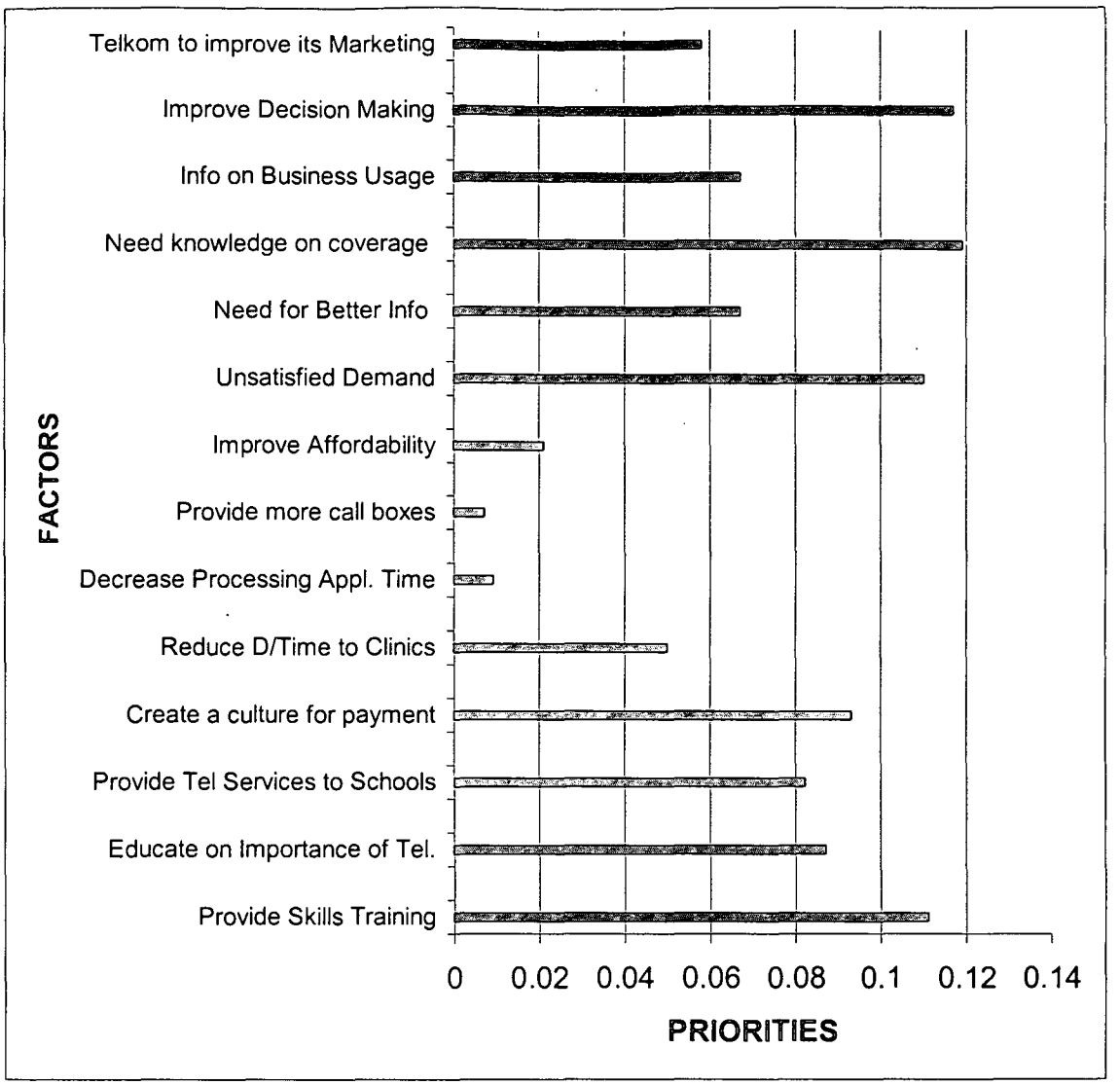


Figure 7.8: Global Priorities with respect to the main goal: Evaluation of Rural Telecommunications Infrastructure.

The prioritisation process reveals that according to the participants, the following issues: the need for knowledge, the need to improve decision-making by Telkom, the need to provide skills training, and unsatisfied demand are high priority issues that should be attended to first (intensity greater than 0.1). The set of issues that should attended to next include the need to create a culture of payment, the need to educate on the importance of telecommunications infrastructure, and the need to provide telephone to schools (0.08<intensity<0.10). The issues with the least priority include the need to provide more call boxes and the need to decrease processing application time.

Apart from prioritizing the factors affecting the improvement of rural telecommunications infrastructure, it is also necessary to examine the impact the improvement of rural telecommunications infrastructure will have on the socio-economic development of the Estcourt/Wembezi area. This is addressed in the next section.

7.3.5 The Prioritization of Impacts of Rural Telecommunications Infrastructure on Socio-Economic Development in Estcourt/Wembezi Area

The problem here was to elicit judgements from the participants in the workshop on how they viewed the impacts of telecommunications on development. They defined the possible impacts as follows: Social networking, reduction in travel time, improvement of security, improvement of education, improvement of local government, improvement of health, and creation of employment opportunities.

Pairwise comparisons were performed with respect to the main goal: Impact of Telecommunication infrastructure on socio-economic development. The priorities are given in Figure 7.9. The creation of employment opportunities was regarded as most important. This is logical since employment and or business opportunities are very important for economic upliftment. The provision of reliable telecommunication services to the health sector was also regarded important for access to medical assistance especially in the case of emergencies. The opportunity of using telemedicine services can become a reality.

Since local government is actively involved in integrated programmes, reliable services should be provided to the satellite sites. Access to information and communication technologies (ICT) was also seen as very important. Access to internet services in schools were also regarded as important in order to improve educational standards. Distance education can also become a reality. Improved security, reduction in travel time and social networking, although important, were regarded comparatively less important that those mentioned above.

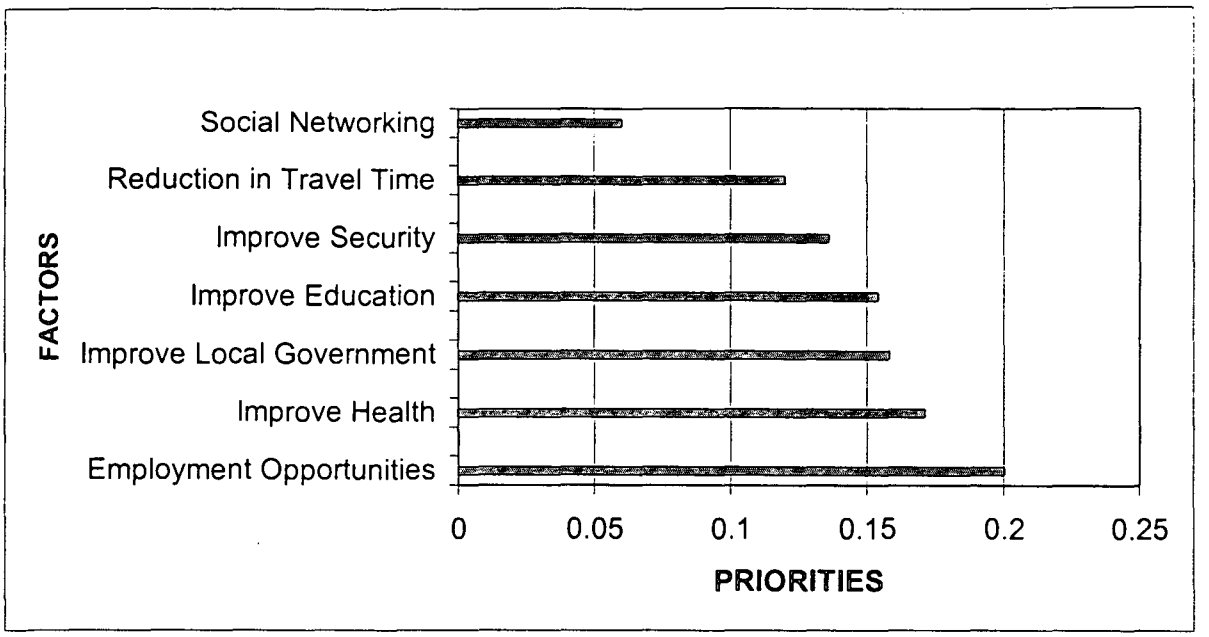


Figure 7.9: Global Priorities for the Main goal: Impact of Rural Telecommunication Infrastructure on Socio-economic Development.

According to the participants, the improvement of rural telecommunications infrastructure will impact mostly on the creation of employment opportunities. This implies that they strongly felt that the provision of good telecommunications infrastructure has the potential of creating jobs. The literature survey also indicated the rural telecommunications can act as a catalyst for economic development including the creation of jobs. Good rural telecommunications infrastructure can also help to improve the situation of saving lives by providing good telecommunications links between the different health sectors and emergency services. It can encourage the use of telemedicine. Similarly it can assist education sector by providing facilities for distance education and internet services. Local government can also benefit from good telecommunication infrastructure. At the moment, they lack the facilities to take advantage of teleconferencing.

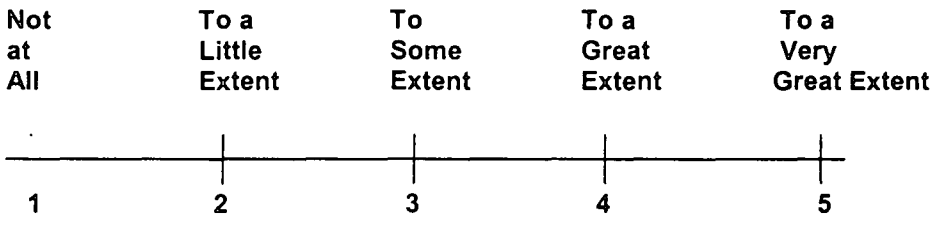
The participants felt that improved education in terms of benefits and ownership will help to solve the security problem. They also indicated that in most cases they would like to meet people face-to-face for social networking, especially those that are living in the same area. Although good telecommunications infrastructure will improve social networking, the main priority is the creation of jobs.

7.4 REFLECTION ON THE APPROACH USED IN THE EVALUATION OF RURAL TELECOMMUNICATION INFRASTRUCTURE

A post session questionnaire was used to gather information on the participants' satisfaction with respect to:

- the approach followed for the evaluation of rural telecommunications infrastructure;
- importance and relevance to the problem under concern; and
- aptness of the techniques used for the evaluation of rural telecommunications infrastructure.

The questionnaire was prepared in line with those used by DeSanctis *et al.* (1990) in Group Decision Support Systems (GDSS). The feedback helped to validate the framework used for the evaluation of rural telecommunications infrastructure. The questionnaire appears in Appendix C1.8 and the participants' responses appear in Appendix C1.9. The responses of the participants were expressed through a 5-point likert scale, the values of which were interpreted as follows:



An analysis of the participants responses are given in Table 7.5 and Table 7.6.

Table 7.5: An Analysis of Participants' Responses to the Post Session Questionnaire.

QUESTIONS	1	2	3	4	5	6	7	8	9	10
Summary data Statistics										
MEAN	3.91	3.73	3.91	3.82	3.18	3.55	3.55	4.00	4.64	4.36
STDEV	1.14	0.90	1.04	0.98	1.25	1.13	0.82	0.89	0.50	0.81
MEDIAN	3.50	3.50	3.50	3.5	3.00	3.00	3.50	3.50	4.50	4.00
MODE	5.00	4.00	4.00	4.00	3.00	3.00	4.00	4.00	5.00	5.00

Table 7.6: Percentage of Occurrence of Each Type of Answer.

PERCENTAGE OF OCCURRENCE OF EACH TYPE OF ANSWER										
Question Intensity	QUESTIONS									
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Not at All	0	0	0	0	9	0	0	0	0	0
To a Little Extent	9	18	18	9	18	18	9	9	0	0
To Some Extent	37	27	0	27	37	37	37	9	0	18
To a Great Extent	9	37	54	37	18	18	45	55	36	27
To a Very Great Extent	45	18	28	27	18	27	9	27	64	55

The results can be summarised as reflecting a very positive attitude as the means of 9 out 10 questions exceeded 3.5 on the 5-point likert scale and in 3 out 10 they exceeded 4. only to one question "*Did you find the techniques used in this framework easy to follow?*" two participants answered "Not at All".

The most frequent answer to the question 1: "*Did you find this workshop **useful**?*" was "To a very great extent". The mean value being 3.91, shows that the workshop was useful to a great extent.

To question 2: "*Do you **now** have a **better appreciation of the link** between rural telecommunications and rural development?*" the responses indicate that there is a better understanding of the link and relationship between telecommunications and rural development, the most frequent answer being "To a great extent".

An analysis of the results for question 3: "*Do you think the **approach used** in the workshop helped you to gain a better understanding of the problems associated with rural development?*" shows that on the average respondents considered that the approach helped them "to a great extent" to understand the problems associated with rural development. Similarly they were positive about question 4 in that they felt that *the time spent on the workshop* was sufficient to understand the basic problems associated with rural development.

Questions 5, 6, and 7 were related to aspects of the techniques applied in the workshop. Understandably, given the lack of formal training in these techniques, the most common answer to question 5: "*Did you find **the techniques used** in this framework (for example, Stakeholder analysis, CATWOE analysis, etc.) easy to follow?*" was "to some extent". However, the level of user satisfaction in questions 6: "*Do you think the classification of the*

issues and the ***development of the hierarchy*** *made the prioritisation process easier?"* and question 7: *"Do you think the classification of the issues and the* ***development of the hierarchy*** *made the prioritisation process easier?"* increases substantially in the answers of the these questions. Their mean values exceed 4.

In respect to question 8: *"Do you think that the Analytic Hierarchy Process (AHP) is a good technique for prioritisation?" the response* was "To a great extent" (55%). Regarding question 9: *"Did you find* ***working in a group*** *useful?",* 64% expressed an opinion of "To a very great extent". Similarly, regarding question 10: *"Do you think Group Decision-Making is more useful than Individual Decision-Making in problems associated with rural telecommunications and rural development?",* 55% of the respondents answered "To a very great extent".

Summary conclusions of the questionnaire demonstrated satisfaction with the approach and acceptance of the techniques used and also the results.

While Chapter 6 provided a theoretical validation for the framework for the evaluation of rural telecommunications infrastructure, this chapter focused on providing a practical validation for the framework. It is clear from the analysis of the post session questionnaire that the participants were satisfied with the approach and techniques used. The workshop provided an opportunity to clarify the roles of the stakeholders and the issues associated with rural telecommunications and rural development in the area of concern. The workshop was successful. It is the author's view that the framework can be used in other rural areas for the evaluation of rural telecommunications infrastructure. Some of the questions used in SSM and CSH need to be further contextualised and simplified. The process of application of the evaluation framework might need further refinement after several similar evaluations to reflect the need to keep the attention of the participants in the workshops and avoid them being overloaded with new information regarding the evaluation process itself.

Chapter 8

CONCLUSION

8.1 How the Goals of the Research were Addressed?

8.2 Summary of the Practical and Theoretical Contributions of this Research

8.3 Concluding Remarks and Possible Directions for Further Research

There is ample evidence in the literature that indicates that the provision of rural telecommunications infrastructure has many spin offs, for example, improved economic development, better social networking, provision of distance education and internet facilities, the use of telemedicine, etc. (see Chapter 2). What the literature does not emphasise, is that in order to reap the benefits of this infrastructure the rollout must be planned. The latter needs to be based on a holistic evaluation of rural telecommunications infrastructure. The relevant stakeholders, especially those that did not have the power to be heard previously, must be given an opportunity to participate in the evaluation of how the needs of the community in terms of telecommunications provisions are met. At the same time the evaluation process is a learning process about the benefits of telecommunications to the community, business, local government, etc.

The evaluation of rural telecommunications infrastructure is a complex process that involves both technical and socio-economic factors. All evaluation approaches are usually confronted with the challenge of dealing appropriately with complex social systems, where a wide (and often ever changing) variety of actors with different values, interest and motives are interacting. Evaluation findings often reveal a diverse picture of the reality of a programme/project, particularly when viewed through the eyes of various stakeholders. And any attempt at reducing this complex picture in an inappropriate manner will not only harm the credibility of the evaluation, but also bring forth resistance from those which feel not properly represented.

A detailed analysis of the current evaluation practices was carried out. It was found that a single approach was not adequate to take the dynamics of the provision of rural telecommunications infrastructure into account. It was therefore necessary to propose a new framework that was inclusive and transparent, and which empowered the dispossessed. How these were achieved, is discussed in the subsequent sections.

8.1 HOW THE GOALS OF THE RESEARCH WERE ADDRESSED

The main goal of the research was to propose a systemic framework for the evaluation of rural telecommunications infrastructure. To the best knowledge of the author there were no holistic evaluation approaches available to address the complex nature of rural

telecommunications. It was therefore necessary to explore approaches/techniques that were appropriate to deal with the complex and "messy" issues associated with telecommunications. Following Landry and Banville (1992) and Robey (1996), the particular techniques were chosen, combined in a framework and justified on the basis of the triad for the justification of research including the research aim, the theoretical foundation, and research methods (Figure 1.1). The method of research was action research. The process of action research (Figure 1.4) as outlined by Checkland and Holwell (1998) was followed.

The **first subgoal** of the research was to investigate the socio-economic factors that can be used as indicators of socio-economic development associated with telecommunications infrastructure and rural development. Following the discussion in Chapter 2, the introduction of telecommunication services to rural areas can have a major impact on rural development. Socio-economic impact focuses, *inter alia*, on:

- **Economic development:** business vitality in the region, level of employment, housing affordability, future business prospects;
- **Quality of life:** standard of living, contact with relatives, friends and the outside world;
- **Education:** availability of schools, level of education offered, exposure to new technologies; and
- **Health:** availability of affordable primary and secondary health, proximity of health facilities.

In order to evaluate the socio-economic impact of rural telecommunications infrastructure, one needs to identify the socio-economic indicators of rural telecommunications. A differentiation was made between quantitative indicators (for example, the number of rural telephone lines provided) and qualitative indicators (for example, the quality of the services). Quantitative indicators were found to be not necessarily more objective; their numerical value, however, led to more agreement on the interpretation of the results. Qualitative indicators, on the other hand, supplemented the numbers and percentages and, thereby, added a real-life perspective to the evaluation.

This research has shown that a deeper understanding of the issues associated with the evaluation of rural telecommunications and rural development is a precondition for the planning and rollout of rural telecommunications infrastructure. This led the author to investigate approaches for encouraging stakeholder participation and problem structuring. This was the **second subgoal** of the research. After a review of various approaches and techniques, it was found that, *inter alia*, Soft Systems Methodology (SSM) and the Analytic Hierarchy Process (AHP) provided the most attractive options (see Chapters 3 and 5).

This research provided an analysis of the strengths and weaknesses of the various Multiple Criteria Decision Making (MCDM) approaches (Chapter 3). For practical reasons it was concluded that the Analytic Hierarchy Process in its original version (Saaty, 1990a) was a suitable candidate among the MCDA approaches. AHP provides a framework that supports multi-criteria decision-making. The ability to structure a complex problem and then focus attention on individual components amplifies decision-making.

The **third subgoal** was to propose a systemic framework for the evaluation of rural telecommunications infrastructure. The systemic framework for the evaluation of rural telecommunications infrastructure is based on a recent meta-theoretic approach called Multimethodology (Mingers and Gill, 1997). This framework combines several techniques from several paradigms in one intervention. The framework presents a synthesis of multicriteria decision-making, problem structuring techniques and Critical Systems Heuristics within the Multimethodology framework of Mingers (1997a; 1997b), and enhanced by some aspects of the work of Midgley (1997). This allows methods, models and techniques as parts of different methodologies, from different paradigms, to be brought together according to the requirements of a particular intervention.

Following Jackson's call for a coherent pluralism within Critical Systems Practice (Jackson, 1997), this framework aims at the full realisation of the potential of the actors involved in rural telecommunications and rural development to contribute to the evaluation process. It involves stakeholder identification and analysis, issue generation and ranking from three perspectives: technical, cultural and political, which is slightly similar to the idea behind the different types of inquiry in SSM mode two (Checkland and Scholes, 1990). Two more ideas are borrowed from SSM: rich pictures, providing insight into the structure of the problem and the processes associated with it, as well as CATWOE analysis, revealing

different weltanschauungs (world-views). The techniques described so far contributed through their interpretivist nature for the gaining of a deeper insight into the issues associated with the evaluation of rural telecommunications infrastructure.

The emancipatory element of the framework is provided through the answers to a series of boundary judgment questions, following the simplified form of Critical Systems Heuristics (CSH) of Ulrich (1998). The lack of sufficient focus of the systems methods employed in the framework towards certain issues is overcome by the use of a pairwise prioritisation multiple criteria decision approach, the Analytic Hierarchy Process (Saaty, 1990). It has to be noted that AHP (or MCDA in general) is used here as a descriptive and prescriptive decision theory along the definitions of these notions by Keeney (1992). In essence it means that it is seen just as a vehicle for making better-informed decisions by the evaluators and not as a normative technique, imposing a decision on the actors involved.

The **fourth subgoal** was to test the framework. It was decided to test the framework in the Estcourt/Wembezi area (see Chapter 7). The area was chosen because there was a significant rollout of telecommunications infrastructure 1998 and the area has very good potential for economic development.

An analysis of the post session questionnaire indicated that the participants found the framework useful. They gained a better insight into the link between rural telecommunications and rural development. The representatives from the service provider (telecommunication planners) appreciated the insight gained especially for their planning purposes. They experienced very little difficulty in working with CATWOE, boundary questions and pair wise comparisons. It was emphasised by the participants that the multiple perspectives gained shed a different light on the problems associated with the provision of rural telecommunications infrastructure.

8.2 SUMMARY OF THE PRACTICAL AND THEORETICAL CONTRIBUTIONS OF THE THESIS

It can be claimed that for better interventions into complex social problems we need to pursue a systemic approach to evaluation. This should recognise the "interests" of all

stakeholders in the rural telecommunications system and seek to interpret their perspectives, arguments and actions in relation to the institutional and social context.

The theoretical contribution of this research is that a new systemic evaluation framework for rural telecommunications infrastructure was proposed, which to the best knowledge of the author was not published in the literature previously. The framework is based on the theoretical foundations of Critical Systems Thinking following some ideas Jackson (2000), Flood (1995), Mingers (1997) and Midgley (2000), ensuring the guarantee of the interests of the poor and the weak in the development of rural telecommunications. It involves on the practical side a combination of the strengths of some Soft Systems Methodology (SSM) techniques, Critical Systems Heuristics, and the Analytic Hierarchy Process (AHP). Though the techniques included in the framework are not new, their combination and mechanism of integration, the process of the intervention and their justification are original, and constitute the theoretical contribution of this research.

Apart from making a theoretical contribution to the systems field, the combination and mechanism of integration and the process of the intervention is also a contribution to the evaluation field. A pluralistic approach to methodology can be justified from CST, recognising the strengths and weaknesses of various quantitative and qualitative methods in "capturing" or gaining access to the attributes and phenomena of interest at the different levels of social reality. This, according to the author, is the first holistic approach with this particular combination of hard and soft approaches used for the evaluation of rural telecommunications infrastructure which is a third contribution of this research.

On the practical side, this framework empowers those that were previously ignored in decision-making regarding their own community. This framework helps to dismantle the bureaucracy and red tape because there is a better understanding of the issues involved. This became evident from the practical implementation of the framework. The community felt that they were involved in an inclusive and transparent process, and that they were given an opportunity for their voices to be heard. This persuaded them to take ownership of the infrastructure, which might then assist in alleviating the security problems.

The representatives of the service provider realised the importance of involving other stakeholders in the decision-making process. It became clear to them that the top down and

autocratic approach is outdated and is not productive. The dangers of "topdown" evaluation can be particularly acute in this context, neglecting the way in which it engages with, and impacts upon the various interests or "stakes" in a programme thus disempowering those disadvantaged groups whom the programme is intended to help. These considerations will have major implications since a new licence for providing fixed line services will be granted in the short term.

The telecommunications field could also benefit from this research. Decision-making in the main is normally based on quantitative data. These are not sufficient to serve the emancipatory dimensions, which were found through this research to be significant for the improvement of rural telecommunications infrastructure. The proposed framework also considers the soft issues into the process before making decisions. These issues can inform policy formulation, especially in the deployment of rural telecommunications infrastructure.

Monopoly provides one with the opportunity to be autocratic but the entry of new competition changes the scenario. The service provider representatives appreciated their participation in the workshop. They acknowledged the fact that they have a different insight/perspectives of the issues that requires consideration. They admitted that they would take into account the issues raised in their planning of infrastructure rollout. They agreed that the new approach would enable them to make a more accurate assessment of the needs of the community thereby providing a more efficient and cost effective service. It also created awareness among local experts about the potential of such applications in other areas.

8.3 CONCLUDING REMARKS AND FURTHER RESEARCH

The provision of rural telecommunications infrastructure must be planned by systemic process. The mere deployment of rural telecommunications infrastructure does not necessarily imply economic development and social upliftment. The rural communities need to be educated with regards to the use, benefits, and the importance of taking ownership and protecting the rural telecommunications infrastructure. Further research on how to conduct such community education and involvement into the evaluation of issues affecting them is a challenge to Systems Thinking and Operational Research.

The framework has been theoretically and practically validated. It is, however, an evolving one that needs to be further tested and refined and become current practice in the evaluation of existing telecommunications infrastructure for the purposes of improvement of future planned activities in that area. The evaluation of the framework proposed here can be further explored for evaluation of other infrastructure provision activities that can contribute to development.

Governments at all levels are engaged in Integrated Development Programmes (IDP) to alleviate poverty. They are dealing with complex systems, comprising multi-programme initiatives attempting to achieve "joined-up" solutions. These require a "*holistic*" approach to evaluation, which can analyse how policies and programmes interact to produce "synergies" or conflicts. Thus, evaluation must address different levels at which processes operate and effects are produced. The proposed evaluation framework is an attempt to improve current practice for evaluation of rural telecommunications.

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APPENDICES

APPENDIX A: GEOGRAPHICAL AREAS BY TELEPHONE FACILITIES

Geographical areas by Telephone facilities

(Source: Statistics South Africa, 1996)

KWAZULU-NATAL

	Household: Dwelling/Cell Phone	Household: Neighbour nearby	Household: Public Tel Nearby	Household: At Another location nearby	Household: At Another location NOT nearby	Household: No access to a telephone	Unspecified/ Dummy	Total Total
501100 Durban	109567	7063	39967	4630		2217	585	164741
502100 Urban-Inanda	66949	11921	48472	2980		4927	599	138276
502300 NU-Inanda	1046	1742	31196	1335		1978	155	39227
503101 Urban-Pinetown	47387	4878	41592	4035		4766	552	105334
503200 Tribal-Pinetown	4631	511	5451	282		1351	76	12798
503300 NU-Pinetown	97	24	327	55		101	0	605
504101 Urban-Chatsworth	28807	6225	6145	756		1221	145	43722
505101 Urban-Camperdown	4880	1204	13593	480		1590	172	22610
505200 Tribal-Camperdown	169	321	2945	400		2900	72	7007
505300 NU-Camperdown	961	290	2915	1107		1536	37	7001
506101 Urban-Richmond	482	64	240	29		1	0	819
506200 Tribal-Richmond	124	498	913	398		2765	84	5218
506300 NU-Richmond	550	523	1404	1311		1438	55	6706
507101 Urban Pietermaritzburg	42919	4159	32104	4384		5370	437	92258
507200 Tribal-Pietermaritzburg	450	1681	9926	3469		9874	193	29358
507300 NU-Pietermaritzburg	684	641	2239	634		842	42	5339
508101 Urban-Umzinto	6378	564	2884	227		247	39	10485
508200 Tribal-Umzinto	551	4789	10455	1454		8890	254	31013
508300 NU-Umzinto	867	200	996	1291		965	89	4629
509101 Urban-Ixopo	612	705	575	81		223	13	2336
509200 Tribal-Ixopo	70	2416	4868	508		7433	134	17734
509300 NU-Ixopo	484	926	801	1207		719	20	4754
510101 Urban-Alfred	277	76	332	67		82	4	838
510200 Tribal-Alfred	167	3934	3958	590		7012	182	19807
510300 NU-Alfred	180	26	173	145		464	1	999
511101 Urban-Port Shepstone	13076	1144	4363	949		553	153	20340
511200 Tribal-Port Shepstone	483	2474	6870	1644		7252	90	23397
511300 NU-Port Shepstone	922	508	732	1069		575	49	4141
512101 Cedarville	93	70	169	28		7	0	367
512102 Kokstad	1184	465	1723	513		671	10	4959
512103 Matatiele	479	59	399	87		107	11	1142
512300 NU-Mount Currie	527	1066	258	376		2458	14	4730
513101 Urban-Underberg	274	24	175	151		15	3	668
513200 Tribal-Underberg	2	4	15	3		934	0	1056

	Household: Dwelling/Cell Phone	Household: Neighbour nearby	Household: Public Tel Nearby	Household: At Another location nearby	Household: At Another location NOT nearby	Household: No access to a telephone	Unspecified/ Dummy	Total Total
513300 NU-Underberg	301	191	205	683		284	3	2049
516300 NU-Kranskop	134	524	233	197		219	270	1585
517101 Urban-Lions River	3722	521	2623	213		161	56	7366
517300 NU-Lions River	1037	157	371	883		1288	185	4117
518101 Urban-New Hanover	789	76	622	55		202	27	1776
518200 Tribal-New Hanover	38	1161	768	197		4609	65	9720
518300 NU-New Hanover	569	1145	2478	758		1653	73	6944
519101 Mooirivier	560	134	670	115		31	9	1531
519102 Rosetta	53	1	43	7		0	3	107
519300 NU-Mooirivier	513	192	201	1164		192	3	2405
520101 Greytown	1620	154	824	617		323	17	3663
520200 Tribal-Umvoti	66	1643	922	351		5183	107	10714
520300 NU-Umvoti	484	280	768	1647		1423	33	4790
521101 Urban-Bergville	180	147	29	27		51	4	455
521200 Tribal-Bergville	243	2247	6012	326		3233	148	14401
521300 NU-Bergville	314	857	1058	299		547	22	3329
522101 Colenso	284	43	552	22		25	7	935
522102 Driefontein	11	1	3	6		4	0	25
522103 Estcourt	**1925**	**226**	**282**	**130**		**109**	**9**	**2692**
522104 Wembezi	**564**	**497**	**1048**	**268**		**224**	**23**	**2705**
522105 Winterton	**75**	**38**	**75**	**5**		**2**	**7**	**206**
522200 Tribal-Estcourt	**87**	**1247**	**5431**	**750**		**8093**	**121**	**18217**
522300 NU-Estcourt	**364**	**228**	**301**	**341**		**811**	**36**	**2105**
523101 Ladysmith	6410	1020	9122	1136		1214	126	19472
523200 Tribal-Klipriver	24	1317	954	278		7816	37	11385
523300 NU-Klipriver	310	1756	246	369		2099	44	5278
524101 Urban-Weenen	170	129	258	5		104	7	674
524200 Tribal-Weenen	0	344	410	25		773	29	1680
524300 NU-Weenen	64	74	218	14		749	11	1138
525101 Urban-Dannhauser	400	38	394	31		3	0	869
525200 Tribal-Dannhauser	12	177	3200	142		4095	77	9167
525300 NU-Dannhauser	393	33	598	245		9	1	1359
526101 Dundee	2478	359	1725	216		542	18	5382
526200 Tribal-Dundee	39	842	4580	112		1727	66	8266
526300 NU-Dundee	228	240	191	270		519	17	1504
527101 Ekuvukeni	425	407	1056	15		199	41	2143
527102 Glencoe	1002	137	985	127		111	36	2415
527103 Hattingspruit	45	4	0	1		3	0	57
527104 Wasbank	85	8	75	5		1	0	178
527300 NU-Glencoe	84	52	49	103		237	8	887
528101 Charlestown	43	1	275	11		3	0	337
528102 Newcastle	15944	2227	21263	1405		2657	198	45283

	Household: Dwelling/Cell Phone	Household: Neighbour nearby	Household: Public Tel nearby	Household: At Another location nearby	Household: At Another location NOT nearby	Household: No access to a telephone	Unspecified/ Dummy	Total Total
528200 Tribal-Newcastle	28	206	6417	1016		1050	48	10828
528300 NU-Newcastle	353	248	362	278		168	19	1573
529101 Urban-Utrecht	395	36	179	22		33	3	696
529300 NU-Utrecht	287	176	227	236		1488	16	2900
531200 Tribal-Ngotshe	10	265	7	3		581	6	882
531300 NU-Ngotshe	455	485	558	641		1887	41	4697
532101 Paulpietersburg	525	215	417	43		187	8	1400
532200 Tribal-Paulpietersburg	42	413	2262	350		1248	30	6087
532300 NU-Paulpietersburg	203	112	330	808		208	26	1943
533101 Vryheid	3573	217	1798	281		612	53	6662
533200 Tribal-Vryheid	6	78	47	342		234	4	721
533300 NU-Vryheid	597	502	2818	615		2463	104	7540
534101 Urban-Eshowe	1813	366	3431	270		444	64	6397
534200 Tribal-Eshowe	1227	2059	6041	666		16351	241	29888
534300 NU-Eshowe	215	48	109	31		60	4	470
535101 Urban Hlabisa	1033	51	1436	133		407	28	3348
535200 Tribal-Hlabisa	261	1126	6775	345		10505	231	22805
535300 NU-Hlabisa	399	33	421	180		202	9	1557
536101 Empangeni	4183	208	1711	412		178	69	6833
536102 Enseleni	482	80	1104	100		51	12	1830
536103 KwaMbonambi	254	2	186	10		11	7	477
536104 Richards Bay	5494	250	808	524		114	48	7316
536200 Tribal-Lower Umfolozi	428	1374	4739	1300		14116	185	25103
536300 NU-Lower Umfolozi	380	196	157	124		272	99	1240
537101 Melmoth	458	6	212	21		155	19	875
537200 Tribal-Mtonjaneni	45	1139	952	275		4884	134	8963
537300 NU-Mtonjaneni	79	108	215	17		29	1	454
538101 Amatikulu	0	0	0	0		0	0	0
538102 Esikhawini	2775	260	2936	327		272	54	6770
538103 Gingindlovu	110	26	104	6		44	0	291
538104 Mandini	717	13	81	21		13	6	854
538105 Mthunzini	417	14	354	20		8	18	981
538106 Tugela Mouth	38	2	31	10		3	4	88
538107 Vulindlela	178	19	270	21		26	7	521
538200 Tribal-Mtunzini	636	1342	7442	655		7069	205	19882
538300 NU-Mtunzini	549	274	633	231		605	44	2499
539101 Urban-Ubombo	54	8	544	18		21	4	651
539200 Tribal-Ubombo	223	269	5647	256		8781	88	17111
539300 NU-Ubombo	48	59	151	67		410	4	756
540101 Ballito	1213	29	297	27		5	11	1583
540102 Darnall	449	28	101	24		0	0	603
540103 Salt Rock	119	3	10	5		115	3	255
540104 Shaka Rock	143	17	41	5		93	2	301

	Household: Dwelling/Cell Phone	Household: Neighbour nearby	Household: Public Tel nearby	Household: At Another location nearby	Household: At Another location NOT nearby	Household: No access to a telephone	Unspecified/ Dummy	Total Total
540105 Sheffield Beach	220	3	9	0		0	0	232
540106 Stanger	5664	1301	1607	182		476	88	9441
540107 Tinley Beach	46	0	0	0		0	0	46
540108 Tugela	214	75	121	13		3	0	431
540109 Umhlali Beach	203	2	298	1		5	4	513
540110 Zinkwazi	185	1	95	2		3	2	288
541300 NU-Umbumbulu	61	180	460	14		29	12	796
542101 Umlazi	18980	5865	38029	1235		3761	440	68984
543200 Tribal-Ndwedwe	155	795	6168	876		8509	223	19615
544200 Tribal-Mapumulo	154	1185	6209	485		11873	150	23896
545200 Tribal-Nkandla	89	961	4448	497		10474	209	20416
546101 Urban-Nqutu	1266	409	2826	82		401	59	5127
546200 Tribal-Nqutu	181	788	5829	1056		7615	155	23757
547200 Tribal-Msinga	127	2857	8493	1066		12232	193	27848
547300 NU-Msinga	0	0	0	0		0	0	0
548101 Urban-Mahlabathini	1720	126	1781	303		94	34	4091
548200 Tribal-Mahlabathini	158	509	4669	665		7383	174	17658
549200 Tribal-Nongoma	247	516	3925	823		17338	301	26146
550101 Urban-Ingwavuma	30	13	243	12		3	0	304
550200 Tribal-Ingwavuma	127	205	7484	486		13089	137	25962
551101 Urban-Simdlangenstha	316	122	1425	89		372	17	2448
551200 Tribal-Simdlangenstha	65	200	2574	170		5119	26	9635
551300 NU-Simdlangenstha	286	8	394	206		493	33	1499

Figures greater than 0 and less than 5 are randomised to preserve confidentiality

APPENDIX B: THE CLASSICAL AHP PROCEDURE

The pairwise comparisons of n elements are summarised in a matrix A given by:

$$A = \begin{Bmatrix} w_1/w_1 & w_1/w_2 \ldots w_1/w_n \\ w_2/w_1 & w_2/w_2 \ldots w_2/w_n \\ . & . \quad . \\ . & . \quad . \\ w_n/w_1 & w_n/w_2 \ldots w_n/w_n \end{Bmatrix} \qquad \text{(B1)}$$

The information displayed in this matrix is interpreted as follows: every element, a_{ij}, of the matrix A shows the relative contribution to the subject of comparison of the i^{th} activity as compared to the j^{th} activity , i.e.

$$a_{ij}=w_i/w_j \quad 1 \leq i \leq n, \; 1 \leq j \leq n \qquad \text{(B2)}$$

It can be noted that (see Saaty (1990a)):

$$Aw = nw \quad \text{where} \quad w^t = [w_1, w_2, \ldots w_3] \qquad \text{(B3)}$$

The vector of priorities w is obtained from equation 4.3 and is simply given as the normalised eigenvector of the matrix A corresponding to the largest eigenvalue $L_{max}=n$.

When inconsistencies occur, i.e. $a_{ik} \neq a_{ij}.a_{jk}$, this largest eigenvalue is greater than the dimension of the matrix, n. A consistency index is defined by Saaty as $CI = [L_{max}-n]/[n-1]$. Saaty (1990a) further suggests a measure called the consistency ratio. It is a ratio of the consistency index to the average consistency index of a randomly generated reciprocal matrix of the same order. The use of this ratio identifies those comparisons where a revision of judgement is necessary; this is done when the consistency ratio is greater than 0.1. In practice the value of 0.2 is often considered as still acceptable.

When more than one level is involved, hierarchical composition is used to weight the eigenvectors by the weights of the criteria, and the sum is taken over all weighted eigenvector

entries corresponding to those in the lower level and so on, resulting in a global priority vector for the lowest level of the hierarchy (Saaty, 1990a).

The values of the comparisons are recorded in matrices, one for each cluster. These can be processed using an appropriate software package like Expert Choice or HIPRE 3+. The priorities of the factors in a cluster are defined as local priorities. They serve as a basis for the synthesis of the overall or global priorities of the elements in the hierarchy towards the main goal. The availability of user- friendly software for the classical version of AHP allows the decision-maker to concentrate on the nature of the problem and the comparisons between the factors.

In the case of having to deal with more than seven different alternatives at the lowest level of the model, or when these alternatives are diverse, the absolute mode of comparisons in AHP is applicable. In that mode each alternative is assigned a rating according to the predetermined intensities for each factor. It is assumed that one can establish some reference point for comparison of each alternative. It can be noted that the intensities of the factors, as well as the factors or subgoals at the higher levels of the hierarchy, are still compared in a pairwise fashion. Their resulting weights affect the contribution of the ratings assigned at the lowest level of the hierarchy to each alternative. The overall rating of each alternative in case of the absolute judgement approach is the sum of the values of all the individual ratings.

APPENDIX C1.1: PRELIMINARY ANALYSIS OF CRITERIA FOR THE SELECTION OF RURAL AREAS FOR RURAL TELECOMMUNICATIONS INFRASTRUCTURE ROLLOUT

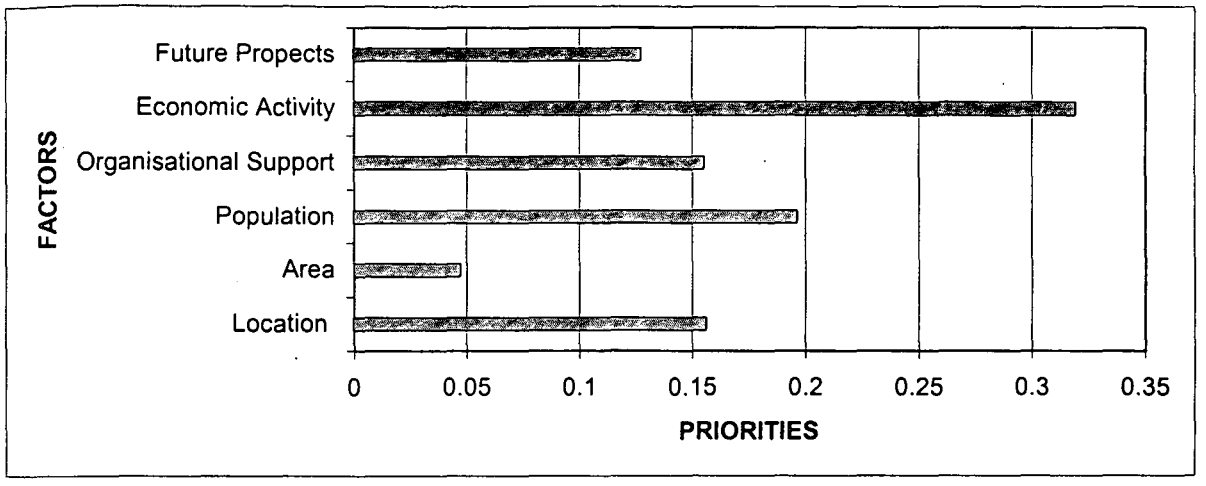
There is a need to consider social, economic, political, and technical issues before deciding on a specific rural area to rollout telecommunications infrastructure. Preliminary interviews with the regional managers of Telkom, currently the only public network operator in South Africa, revealed that there were no predefined sets of criteria for the selection of rural areas for the roll out of infrastructure. The managers indicated that the current assessment and planning was done mainly on the basis of limited statistical data made available from a limited number of local surveys. This, according to the managers, has led to underestimates in some cases, while in other cases to over estimates of the needs for telephones. It was agreed that this was not a satisfactory situation given the limited resources of the country and the telecommunications company.

A workshop was therefore held with the managers to develop a set of criteria for the selection of a rural area for the rollout of telecommunications infrastructure. The first step involved the generation of ideas by the managers during a brainstorming session. After analysing and classifying the data, the following criteria were identified:

- **Location** of the district (with respect to the major centres for economic activity in the province)
- Area **in square kilometres**
- Population **of the proposed region**
- **Economic activity** in the region
- **Organisational support** in terms of political stability and government structures
- **Future prospects** for the region

The next step was to prioritise the criteria that were identified. This process involved comparing the criteria in terms of its *intensity* of importance in the selection of a rural area. The Multiple-Criteria Decision-Making (MCDM) model called the Analytic Hierarchy Process (AHP), which was developed by Thomas Saaty in the late 1970s, was used for the prioritisation process (see Appendix B). The 1-9 point scale of the original AHP was used in measuring the judgements of the managers through pairwise comparisons about the ratios of

the weights of the criteria (Saaty, 1990). The participants were asked to make comparisons using questionnaire forms. The author using a software package, Expert Choice, version 9, captured the judgements from each form. The aggregated group judgements are obtained as the geometric mean of the individual comparisons following Aczel and Saaty (1983). The results of the prioritisation process appear in the figure below.



The Priorities of the Criteria as processed by Expert Choice, Version 9.

Economic activity (EC.ACTIV) with a priority rating of 0.319 was perceived to be most important. This means that the potential for economic development of a rural area was the most important criteria for the rollout of infrastructure. Population (POPULATI) with a priority of 0.196 was the second criteria that should be considered next in order of priority. The infrastructure should serve a reasonable size population. It does not make economic sense to spend large sums of money on infrastructure to serve a very small population. This does not imply that areas with small population should be ignored. Alternate means of providing service to these areas need to be investigated. It must be noted that this research focuses on fixed line telecommunication services.

Location and Organisational support (ORG SUPP) have almost equal importance with a priority rating of 0.156 and 0.155. The latter may also be an indication that there is a strong correlation between the level of organisational support and the location of a particular district with respect to the main centres of the provincial economy (Durban, Pinetown and Pietermaritzburg). Future prospects ranked fifth, with an importance rating of 0.127, and the last criterion, Area, plays a relatively small role in the selection process according to the

judgements of the managers. This exercise also indicates that population density is far more important than the size of a rural area for the selection process.

APPENDIX C1.2: LIST OF WORKSHOP PARTICIPANTS

Surnam	Initia	Affiliation	Position	Phone No.
Shelembe	M L	Umthsezi Council	Mayor	0825592315
Ndlovu	S I T	Umthsezi Council	Deputy Mayor	0825592311
Nunes	C I S	Umthsezi Council	Speaker of Council	0828503048
Vermaak	J G	Umthsezi Council	Town Secretary	
Magubane	V H	Umthsezi Council	Municipal Manager	
Chetty	K K	Umthsezi Council	Ward Councillor	0828503026
Dlamini	B A	Umthsezi Council	Ward Councillor	0827769962
Mtiya	N V	Umthsezi Council	Ward Councillor	0721700797
Masoka	M	Umthsezi Council	Ward Councillor	0827769967
Nyoka	P P	Umthsezi Council	Ward Councillor	0828503057
Njoko	S	Umthsezi Council	Ward Councillor	0827769958
Mbatha	S	Umthsezi Council	Ward Councillor	0828503052
Mkhize	T V	Umthsezi Council	Ward Councillor	0828503070
Nyathi	N F	SAPA Estcourt	Constable	036-3533852
Shabalala	M S	SAPS Estcourt	Inspector	036-3523180
Magubane	B T	SAPS Estcourt	Constable	036-3523180
Mkhize	K E	SAPS Estcourt	Constable	036-3522280
Lane	S A	Estcourt Hospital	Admin Officer	036-3522100
Maseko	M A	Estcourt Hospital	Admin Clerk	036-3522100
McKelvey	M J	Telkom Estcourt	Manager	0827821583
Perrin	R G	Telkom Estcourt	J Manager	0823725263
Maharaj	N	Telkom PM'Burg	J Manager	033-3950400
Rajah	R	Telkom PM'Burg	J Manager	033-3959422
Mabaso	A	SANCO	Member	0833488899
Motsoeneng	D	SANCO	Chairperson	0829706864
Mbanjwa	T B	SANCO	Organiser	036-3531280
Moor	J	Estcourt Farmers' Ass	Vice Chair	036-3525674

APPENDIX C1.3: LIST OF STAKEHOLDER GROUPS

Group 1: Local Business (Big and Small) and Farmers Associations

Group 2: Local Council, Provincial, and National Government – sometimes referred to as government agencies.

Group 3: Telkom and Eskom

Group 4: Health and Police Services

Group 5: Local Community, NGOs, and Tribal Authority

APPENDIX C1.4: WORKSHOP AGENDA AND OUTLINE OF THE PRESENTATION

Workshop 1: Held on 10 October 2001, from 11h00 – 13h00 at Estcourt Local Government Offices.

Objective of the Workshop: To use the SSM approach to create a better understanding and develop multiple perspectives of the problems associated with rural telecommunications and rural development.

The Workshop: The following agenda was used to provide focus and guide the workshop.

Agenda

1. Identify the relevant stakeholders that have a role in the evaluation process and their assumptions.

2. Explore the technical, cultural, and political issues affecting the evaluation.

3. Perform a multiple perspective analysis of the evaluation through the CATWOE technique. Explain CATWOE first and then proceed with the analysis.

The goals of the workshop were explained and a brief background on rural telecommunications and development were given. This was presented in the form of the following overhead slide:

GOALS OF THE WORKSHOP ON THE EVALUATION OF RURAL TELECOMMUNICATIONS INFRASTRUCTURE

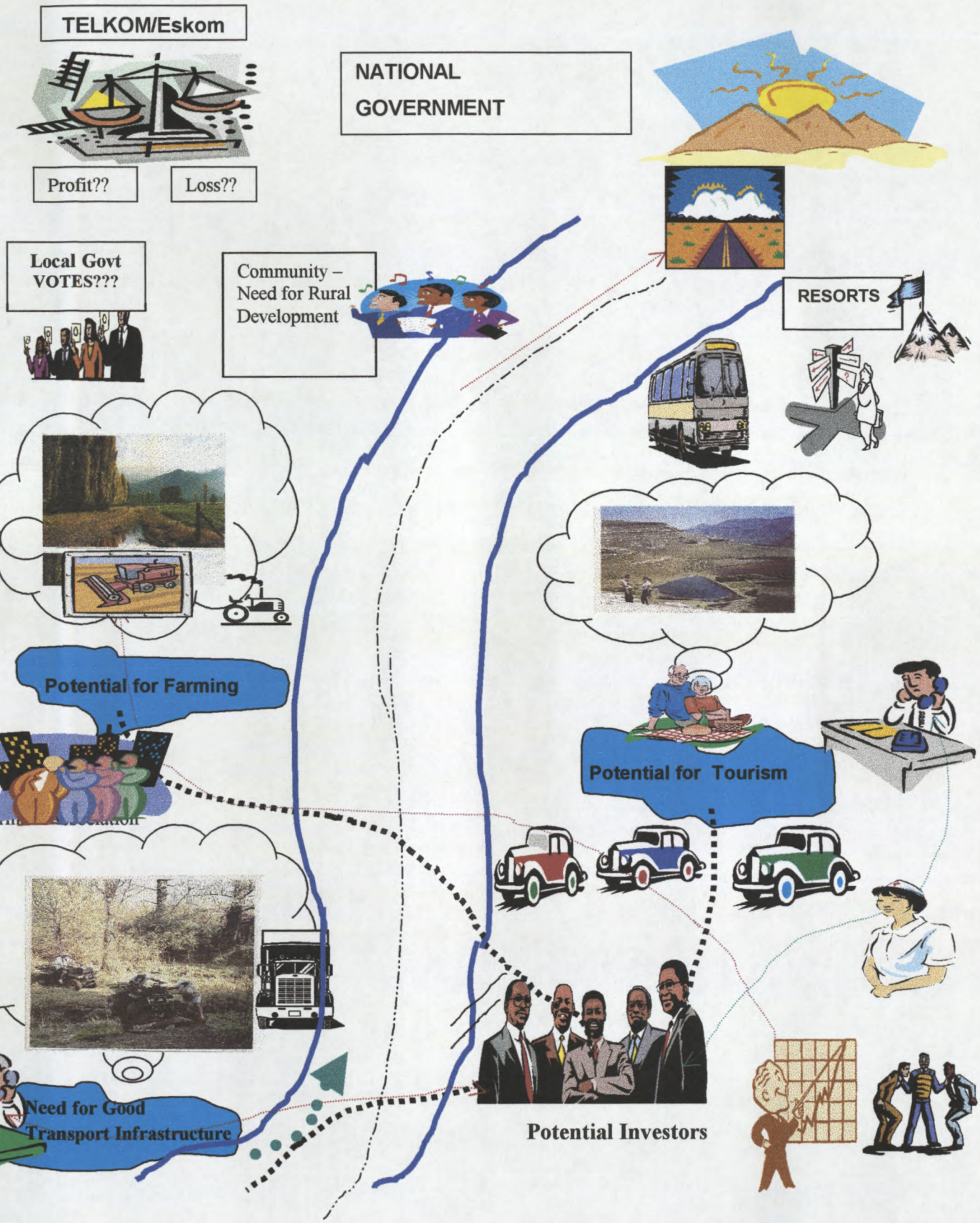
The purpose of this workshop is to test a SYSTEMIC FRAMEWORK for the Evaluation of Rural Telecommunications Infrastruture.

BACKGROUND

- 50 - 55% of the South African Population live in Rural Areas
- There is a lack of appropriate/proper infrastructure for Rural Telecommunications and Integrated Rural Development
- Marked Imbalance in infrastructure provision in Historically Black Townships and Rural Areas
- Socio-Economic Issues and the E-Commerce
- Although Telecommunications is an Important ingredient of Development, provision of Telecommunications in Rural Areas does not necessarily guarantee development
- Planned provision of infrastructure is necessary (Need to involve Stakeholders)
- Need for Evaluation and feedback – Necessary for an Integrated Approach to Rural Development
- Evaluation can provide useful input to Telecom Planners and after rollout – Evaluation can provide useful feedback to the respective agencies

The points listed above were elaborated on in order to place the problems associated with rural telecommunications and development in its proper context.

APPENDIX C1.5: REVISED RICH PICTURE DEPICTING DEVELOPMENT POTENTIAL OF THE WEMBEZI AREA



APPENDIX C1.6: CATWOE ANALYSIS QUESTIONNAIRE

CATWOE ANALYSIS

Customers: The customers, beneficiaries or victims of the provision of the lack of rural telecommunications infrastructure.

.....
.....

Actors: The people that are involved in the activities in the system – those that make the rural telecommunications system work.

.....
.....

Transformation process: The process that transforms input into an output. The aspect of the problem that you want to transform and improve with respect to rural telecommunications infrastructure.

.....
.....

World-view: Your perspective of the problem – what assumptions are made, and what do you regard as desirable for a rural telecommunications system? What is your perspective of the problems associated with rural telecommunications infrastructure.

.....
.....

Owners: Those in the system that have decision-making authority – those who can stop the deployment of rural telecommunications infrastructure and the community from achieving its desired aims.

.....

.....

Environmental constraints. The socio-economic and political environment in which the rural telecommunication system operates. The environment includes those factors that will impinge on the situation, and over which the actors and owners have no control.

.....
.....

APPENDIX C1.7: BOUNDARY QUESTIONS AND RESPONSES TO THE SOURCES OF MOTIVATION FOR THE EVALUATION AND IMPROVEMENT OF RURAL TELECOMMUNICATIONS INFRASTRUCTURE

1. Who ought to be the actual clients i.e., whose interests should be served? This refers to those that are interested in the customer satisfaction, network reliability, speed and responsiveness, etc.	
Business	Consumers and the Service Providers
Govt. Agencies	Customers and Service Providers
Community Reps	Community; Schools; Clinics; Police; Business
Health and Police	Consumers
Telkom	Community; Traditional Council; Schools; Business; Clinics; Police

2. What ought to be the possible positive spin offs of the evaluation of rural telecommunications infrastructure?	
Business	Identify needs; Establish obstacles – where and who is responsible for them; Lobby for resources
Govt. Agencies	Improved services; Better payment culture
Community Reps	Provide report back to government
Health and Police	Establish the needs for the community; Enable finances to be provided.
Telkom	National connectivity for all users; Benefit all users

3. How does one determine whether the provision of improved services constitutes an improvement in the area? Has life in Wembezi changed since 1998? How?	
Business	Consumer feedback; Reduced crime; Economic and social improvement; Better education and a more informed community
Govt. Agencies	Increase in the number of customers because of improved services
Community Reps	Improvement in security, education, and social life
Health and Police	Compare the before and after state
Telkom	Sustain a good working infrastructure; Provide feedback from all sectors; Increased demand for services

APPENDIX C1.7: BOUNDARY QUESTIONS AND RESPONSES TO THE BASIS OF POWER FOR THE EVALUATION AND IMPROVEMENT OF RURAL TELECOMMUNICATIONS INFRASTRUCTURE

4. Who ought to be the decision-maker/s, i.e., who has the power to change circumstances with regards to the deployment of rural telecommunications infrastructure?	
Business	Govt. Service Providers; Local and Tribal Authorities
Govt. Agencies	National and Provincial Govt.; Community Leaders; Service Providers
Community Reps	Traditional Leaders; Govt. Local Council
Health and Police	Tribal Authorities and other Community Leaders
Telkom	Telkom; Community; Local Govt.

5. What resources and other conditions of success ought to be controlled by the decision maker/s when planning the deployment of rural telecommunications infrastructure?	
Business	Positioning of infrastructure; Who should be involved in the process; Financing
Govt. Agencies	Provision of infrastructure i.e., roads, electricity, and security; financing; Assets
Community Reps	Financing; Rules and Regulations
Health and Police	Roads; Power; Water; Financing
Telkom	Access roads to build infrastructure; Eskom – requirement to build good infrastructure; Budget

6. What should the decision-makers/s *not* have control over during the evaluation of rural telecommunications infrastructure?	
Business	Who should get the tenders
Govt. Agencies	Deciding for the community – what is good
Community Reps	Where to roll-out infrastructure
Health and Police	Tenders
Telkom	Deciding for the community – needs

APPENDIX C1.7: BOUNDARY QUESTIONS AND RESPONSES TO THE SOURCES OF KNOWLEDGE FOR THE EVALUATION AND IMPROVEMENT OF RURAL TELECOMMUNICATIONS INFRASTRUCTURE

7. Who ought to be the planners? Who are competent to participate in the planning process of telecommunications in rural areas?	
Business	Govt.; Service providers
Govt. Agencies	National and Local Govt.; Service Providers; Community Leaders
Community Reps	Traditional Leaders; NGO's; Local Councillors; Beneficiaries and customers
Health and Police	Local Govt.; Indunas and Chiefs; Business
Telkom	Telkom; Eskom; Local Govt.

8. Who should be brought in as experts to aid the process of evaluation of rural telecommunications on behalf of the community?	
Business	-
Govt. Agencies	Consultants
Community Reps	Expert from within the community
Health and Police	Telkom; Consultants; Experts from within the community
Telkom	Experts from business, farming, and local govt.

9. Who should be assumed to provide some guarantee of the proposed improvement of rural telecommunications infrastructure?	
Business	Planners; Service Provider; System Installers
Govt. Agencies	Agreement between all the role players involved in the planning process
Community Reps	Service Provider; Traditional Leaders; Local Councillors
Health and Police	Govt.; Telkom
Telkom	Telkom

APPENDIX C1.7: BOUNDARY QUESTIONS AND RESPONSES TO THE SOURCES OF LEGITIMISATION FOR THE EVALUATION AND IMPROVEMENT OF RURAL TELECOMMUNICATIONS INFRASTRUCTURE

10. Who should represent those who cannot speak for themselves, e.g., the disabled, the illiterate, future generations, etc?	
Business	Tribal Structures; Local Authorities
Govt. Agencies	Community Leaders; Educators
Community Reps	Civic Associations; NGO's
Health and Police	Local Councillors; NGO's
Telkom	Local Councillors; NGO's

11. How should those who have been disadvantaged be given the chance to improve themselves? What process or mechanism should be in place so that representations can be made to the relevant authority with respect to rural telecommunications.	
Business	Communicate problems to Local Authority
Govt. Agencies	-
Community Reps	-
Health and Police	Providing a better communication network
Telkom	Communicate problems through their representatives

12. What is your 'vision' of the improvement of the telecommunication infrastructure in the Wembezi rural area?	
Business	Better communication; Better social status
Govt. Agencies	Proper planning before infrastructure rollout
Community Reps	-
Health and Police	Communication for all at affordable rates
Telkom	Provide universal access to telecommunication services

APPENDIX C1.8: POST IMPLEMENTATION QUESTIONNAIRE FOR THE EVALUATION OF RURAL TELECOMMUNICATIONS INFRASTRUCTURE

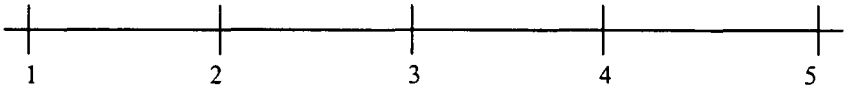
This questionnaire gathers information on the participants' observation of the approach, relevance, importance and aptness of the techniques used in the workshop. The feedback helps to validate the framework used for the evaluation of rural telecommunications infrastructure. The participants were required to read each question and circle the number that best expresses your answer. A guide to the rating is given below:

1	2	3	4	5
Not at All	To a Little Extent	To Some Extent	To a Great Extent	To a Very Great Extent

1. Did you find this workshop **useful**?

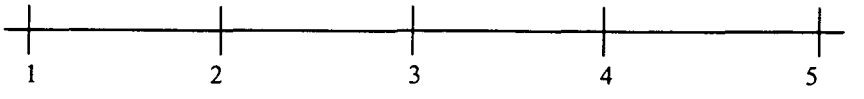
2. Do you **now** have a **better appreciation of the link** between rural telecommunications and rural development?

3. Do you think the **approach used** in the workshop helped you to gain a better understanding of the problems associated with rural development?



4. Do you think that **the time spent** on the workshop was sufficient to get a better understanding of the problems associated with rural telecommunications and rural development?

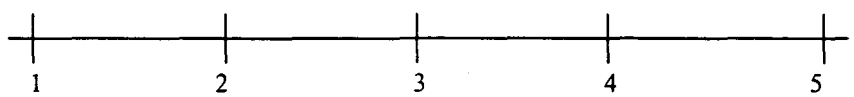
5. Did you find **the techniques used** in this framework (e.g., Stakeholder analysis, CATWOE analysis, etc.) easy to follow?



6. Do you think the classification of the issues and the **development of the hierarchy** made the prioritisation process easier?

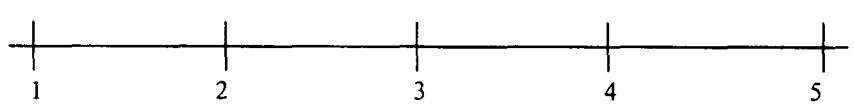
7. Did you find the **pairwise comparison** easy to follow?

8. Do you think that the Analytic Hierarchy Process (AHP) is a good technique for prioritisation?



9. Did you find **working in a group** useful?

10. Do you think Group Decision-Making is more useful than Individual Decision-Making in problems associated with rural telecommunications and rural development?



APPENDIX C1.9: RESPONSES OF THE PARTICIPANTS TO THE POST SESSION QUESTIONNAIRE ON THE FRAMEWORK FOR THE EVALUATION OF RURAL TELECOMMUNICATIONS INFRASTRUCTURE

	1	2	3	4	5	6	7	8	9	10
Participant 01	5	5	5	5	5	5	5	5	5	5
Participant 02	5	5	5	4	5	4	4	5	5	5
Participant 03	4	4	4	4	3	3	4	4	5	4
Participant 04	3	4	4	4	3	2	3	4	5	5
Participant 05	3	4	4	3	2	3	3	3	4	3
Participant 06	3	3	2	4	2	3	3	4	4	4
Participant 07	3	3	4	3	4	5	4	4	4	3
Participant 08	5	4	4	5	3	4	3	4	5	5
Participant 09	2	2	2	2	1	2	2	2	4	4
Participant 10	5	3	4	3	3	3	4	4	5	5
Participant 11	5	4	5	5	4	5	4	5	5	5

APPENDIX C1.10: LOCATION OF ESTCOURT IN RELATION TO DURBAN