

Faculty of Science and Engineering

Department of Spatial Sciences

**Participatory Geographic Information Systems to Anchor the
Creation and Construction of Knowledge to Support Rural
Community Development.**

A case study of Tshane village, Botswana.

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**This thesis is presented for the degree of
Doctor of Philosophy
Of
Curtin University of Technology**

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Declaration

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgement has been made.

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

Signature.....

Date.....

Dedication

I would like to dedicate this work to my wife Matshediso Mulalu, she has always been there for me and my two daughters Game and Bame, who have continued to make me so proud of them. I also remember my late father (Dick Chimpayouma Mulalu) and mother (Kenaope Agnes Mulalu) at this point, they would have been so proud.

Abstract

This research investigated the role of participatory geographic information systems (PGIS) in instituting the culture of using knowledge in order to implement a rural community development strategy that targets improving living standards at the household level. Current development interventions continue to perform poorly because they do not really address people directly, attention has been drawn to the role of knowledge in facilitating the individuals to effect their own development. Geographic information systems (GIS) represent one of the options that the rural community can use to compile and to structure information and to facilitate the construction of knowledge. With regard to what motivates the people to initiate and sustain their own development effort, this research used learning theories to design training material, inform the individual and group learning activities and learning cycles theory to carry out confidence instilling field work research tasks. The overall aim was to work with a rural community to develop a framework that can be used to employ a GIS to a) compile basic data and review current livelihoods, b) determine local needs, c) determine the requirements that will facilitate people to achieve their needs, d) develop a computer assisted information system prototype to hold their knowledge requirements and support their business activities, and e) test the ease with which the local community applied the developed prototype to plan to improve their living standards. Such an approach defined a PGIS framework.

The researcher procured guidance from and secured collaborative leadership with six village development committee (VDC) members, the village councillor and the village chief. The VDC facilitated the ward heads to select trainees from the village community, these together with the VDC became the work force of the research project. Eleven business modelling scenarios and ten business plans were produced. Seven two-man teams used GIS software to digitize village plot parcels from colour aerial photographs and also compiled other basic map data layers. Field mapping was used to check and update the preliminary village plots map, to map the existing electric power and water lines and to update the village roads network. The plot data which included type of fencing, types of buildings, presence of toilet, water or power facilities and number of people were used to determine a sampling frame. The village team carried out sixty one conversational interviews and administered an attitudes scale. An interpretation of the social survey exploratory data analysis results was then used to determine the community needs. A data model for shelter acquisition and goats rearing was developed and an application prototype was developed for it. The prototype was subsequently tested on the host rural community.

The results of the research indicated that as people gain the skills to work with knowledge, they can become active in the tasks that are aimed at improving their living standards. To achieve this, there was need for a supportive stewardship and close tutoring and mentoring from the village leadership and a community livelihood supporting intervention strategy from the community development institutions. A more experiential form of formal education, and a better appreciation of traditional education are required in order to secure dignified and sustainable livelihoods. Such a conceptualization of education is also required for meaningful and beneficial participation to take place. Although the basic infrastructure was low, the indication was that with knowledge and forward planning, a sufficient infrastructure can be developed. However, whether the PGIS initiative could be sustained would depend on

the strength and dedication of the local leadership at the various levels of the community, they would determine whether the PGIS initiative was institutionalized in order to add to the human and social capital of the community.

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LIST OF ABBREVIATIONS

APSRAMB	Animal Production Simulation and Range Assessment Model for Botswana
AUD	Australian Dollar
AVC	Average Vegetation Cover
BFTU	Botswana Federation Trade Union
BIDPA	Botswana Institute of Development Policy Analysis
BLIS	Botswana Land Information System
BWW	Band Wand Weber
CASA	Cyclic Arc of Self-Actualization
CBIS	Computer Based Information System
CBNRM	Community Based Natural Resources Management
CBS	Community Based Strategy
CD	Community Development
CDI	Community Development Institute
CDW	Community Development Worker
CFDA	Communal First Development Area
CPDL	Computer Program Development Logic
CRI	Criterion Referenced Instruction
CYSLAMB	Crop Yield Simulation and Land Assessment Model for Botswana
DFID	Department for International Development
DSM	Department of Surveys and Mapping
DTRP	Department of Town and Regional Planning
DWNP	Department of Wildlife and National Parks
EAST	Enhanced Adaptive Structuration Theory
ESRI	Environmental Systems Research Institute
GDBS	Geographic Data Base System
GIS	Geographic Information System
GoB	Government of Botswana
GSO	Geo-Spatial Ontology
HCHI	Human Computer Human Interaction
HDR	Human Development Report
ICT	Information Communication Technology
IK	Indigenous Knowledge
IRD	Integrated Rural Development
IS	Information System
ISE	Information System for Emancipation
ISKM	Integrated System for Knowledge Management
IT	Information Technology
ITK	Indigenous Technical Knowledge
KCR	Knowledge Content repository
KM	Knowledge Management
LIMID	Livestock Improvement Management Integrated Development
MFDP	Ministry of Finance and Development Planning

MoA	Ministry of Agriculture
NGO	Non Governmental Organization
PCD	Participatory Community Design
PDL	Poverty Datum Line
PDF	Portable Document Format
PGIS	Participatory Geographic Information System
PLA	Participatory Learning and Action
PRA	Participatory Rural Appraisal
RAD	Remote Area Dweller
RCK	Rural Community Knowledge
RNPRD	Revised National Policy for Rural Development
S&CD	Social and Community Development
SDLC	System Development Life Cycle
SF	Spoletto Framework
SLA	Sustainable Livelihood Approaches
SLIMS	State Land Information Management System
SME	Small and Medium Enterprise
SPSS	Statistical Package for the Social Sciences
TA	Tribal Administration
TEK	Traditional Ecological/Environmental Knowledge
TEPB	Tertiary Education Policy for Botswana
TK	Traditional Knowledge
TGLP	Tribal Grazing Land Policy
TLIMS	Tribal Land Information Management System
TPGIS	Tshane Participatory Geographic Information System
UNDP	United Nations Development Programme
UNICEF	United Nations International Cultural and Education Fund
USA	United States of America
USSR	United Soviet Socialist Russia
VDC	Village Development Committee
WDR	World Development Report

CHAPTER 1 INTRODUCTION

Tshane village, which is the study site for this research project, is located in Botswana, which is a Sub-Saharan African country situated in Southern Africa. This country was classified by the World Bank in 2003 as a higher middle income state because of its exceptional diamond-based economy. However, Botswana is still challenged by the poor living standards of its citizens. Tshane village is located in the Kalahari District which has the highest incidence of poverty in the country. There are a number of challenges that Tshane village faces. The village has an inadequate education support infrastructure which results in low student pass rates. The result of this is that the village operates from a low knowledge base. Those who become successful leave the village to take up employment in the towns. The traditional livelihoods are being neglected in preference to welfare programs. The traditional leaders have become civil servants and have largely disengaged from supporting community development initiatives. The community development institutions continue to deliver packaged and standardized development support programs rather than responding to and supporting the village development initiatives.

This research presents a community based and participatory geographic information system (PGIS) supported strategy that is intended to implement the knowledge for human development paradigm. Such a PGIS strategy is made up of the village leaders, a village development committee (VDC) or other village facilitator, community development institutions, the government, the PGIS information technology (IT) artefact itself, the village based PGIS users and the broader village community. The intention is that the PGIS infrastructure should assist to concretize, anchor and support the livelihood activities of the village. This would facilitate the community members to acquire the capability to construct, apply and model knowledge to support economic activities. The underlying proposition is that when the village community members have acquired the knowledge that is leveraged to support their specific livelihood activities, their intrinsic motivations would be activated and they would begin to engage in their own development themselves. This has become necessary because the international development intervention, which

Botswana also emulates, has continued to perform poorly. An unacceptably high proportion of people, especially in the developing countries, such as Botswana, are still dismally poor and live under undignified conditions.

1.1 Background to the Problem

As a typical rural environment, Tshane village is at the periphery of Botswana's core development network. This has contributed to its lag in human development. It is far from the urban centres and the main villages and this makes it even more problematic for it to be provided with the social services. As a consequence, education, health and infrastructural developments are only available at their lowest levels. The diffusions of scientific, technological, economic, social, and political knowledge from the more modern centres have therefore occurred at a very slow pace. This shortage in knowledge has meant that most, if not all of the development interventions that have occurred in the village have not really benefited the people as much as they could have (Government Of Botswana 2002a). In 2006 Botswana was estimated to have 40 percent unemployment and poverty rates (Blaikie 2006). The Kgalagadi district, where Tshane village is located, recorded the highest unemployment and poverty rates.

1.2 Statement of the Problem

There is a general lack of basic knowledge that the households in Tshane village need to have in order to make informed decisions about improving their living standards, based on their own efforts and the support they get from the government and other development institutions. Superimposed on this are three other limitations.

The first limitation relates to lack of knowledge by the community development institutions (Lekoko 2002) of a strategy, that could be used to facilitate the local communities to translate the development policies and programs developed by central government, into productive and sustainable local innovations. The second limitation refers to the misappropriation of the modernity lifestyle by the local community, whereby the wants rather than the needs are given higher priority (Schoenbrun 2006). This results in the household assets being eroded to procure impoverishing liabilities rather than the further accumulation of productive assets. The third limitation relates to the low rating and apparent neglect of local livelihoods

(Weisner 2000), which paradoxically many of the community members still consider to be their main source of livelihood. All these come together and create certain information and knowledge misconceptions, and they also become the hidden beliefs that drive the varied livelihood activities that the community engages in. These in turn manifest in the lack of resources to support dignified lifestyles and even more seriously, the lack of capability by the community members to improve their living standards themselves. What is even more disempowering is the placement by the local community members, of the responsibility to improve their living standards on external agencies rather than on the community itself.

1.3 Significance of the Study

This project argues that all adequately socialized and mature community members, should have problem solving skills in order to be able to contribute to the successful functioning of their community. The world is increasingly becoming urbanized and creates problems that are more complex and progressively more difficult to solve. Therefore, ideally, all human beings should contribute to the pool of solutions that need to be generated in order to address that. One of the challenges that are proving to be difficult to resolve is poverty, yet poverty removes from rather than adds to the pool of knowledge generating capacity. Poverty degrades human dignity, quiets the human intrinsic motivation to achieve human well being and downgrades overall human aspirations. Consequently, poverty deprives society as a whole, of the contribution by a large number of people to the pool of intellect, that it would otherwise have access to if all human beings were enabled to perform at their maximum potential.

The contribution of this research is to add to the efforts that aim at enabling those in poverty to get out of it, so that they can participate in the running and maintenance of their communities to both their own and society's benefit. The ultimate goal of this research is twofold, first it is to institutionalize within a rural community, a strategy that imparts learning and assists in initiating economic activity. A second and complementary goal is to embed within the community, a physical knowledge managing artefact that should be used to initiate and support socio-economic activity.

This research would be considered to be successful if it achieves the following goals:

- a) Facilitates the local leadership structures to re-strengthen and realign their activities more towards supporting the community to improve their living standard,
- b) develops the village community's group decision making and collective action capabilities,
- c) institutionalizes the village community's capability to build knowledge and to create a knowledge managing and leveraging PGIS based IT artefact,
- d) enhances the inclinations of community members to apply obtained capabilities to secure sustainable livelihoods,
- e) assists the community development institutions to review their intervention strategies and to work more to support the community in their self-initiated activities and
- f) enables the village community to carry out its own problem solving activity and to plan for its development needs.

1.4 The Proposition

This research contends that when people acquire knowledge, they are enabled to perform independently and to rely on their own skill and intellect to fend for themselves, and not rely on others for their survival. Therefore, it was expected that as such knowledge was acquired, the ability and independence to secure dignified and sustainable livelihoods would begin to re-emerge. Consequently, as more knowledge was gained the number of people who became successfully self-reliant was expected to increase.

1.5 Motivation and Assumptions

Generally mature individuals are expected to assume responsibility for their own growth and progression in life. Poverty can be viewed as one of the obstacles that people can meet, thus the researcher considered that it was possible to get out of dismal poverty. This tends to make poverty alleviation largely a personal responsibility. National governments and the international community implement mostly broad and supportive interventions, that is why it becomes the responsibility of the individual to take advantage of and use the provided support infrastructure. However, the researcher also notes that in order to act independently, productively and with confidence, the individuals need to realize the importance of knowledge in acquiring the living resources. Consequently, with some background in cartography, remote sensing, geographic information systems and field work experience in producing agricultural extension area maps at the Ministry of Agriculture, it was

possible to visualize a community empowering PGIS intervention. With regard to modelling a solution to poverty alleviation with the support of a PGIS infrastructure, the basic vision was to facilitate the rural community to develop the capability to create, sustain and use a livelihoods supporting PGIS tool. The aim was to assist the community members to obtain a tool that could be used to deliberate practically about their varied problem situations, essentially a livelihoods planning and supporting tool.

In deciding on the PGIS solution, there were a number of basic assumptions that were adopted, they included the following: a) knowledge could be leveraged in order to induce individuals to act independently and to achieve self-actualization and autonomy, b) the community livelihoods could be considered to be one integrated business entity and that therefore, they could be modelled using information systems (IS) development strategies, c) the rural community was composed of the current level of human evolution, it was made up of people who possessed the same type of brain as everyone else, and that therefore, had the capability to understand the IS development concepts, if they were presented in the natural language from which they were developed, d) the rural community members were aware of their poverty situation, and that therefore they were willing to do something about it and e) the threat to the power which was based on differential access to information, which arises when the PGIS artefact opens access to information to the rest of the community, could be offset by replacing the information delivery roles of the community leaders with livelihoods supporting roles. In this way their role will be drawn away from just the communication of new information on policies and development support programs, to supporting implementations.

1.6 The Objectives

The purpose of this research is to contribute to Botswana's continuing effort to develop strategies that could be used to improve the living standards of the citizens of Botswana, particularly those that reside in the rural areas. There is need to institutionalize a strategy that is intended to impart learning and which assists in the initiation and support of economic activities. This research project contends that an adopted procedure should be directed at employing knowledge to empower the individuals to effect their own development by enhancing their livelihood activities.

The overall aim therefore, is to develop a community driven PGIS framework that could be instituted in order to add to the community's human and social capital.

The specific objectives are to:

- a) Explore and identify the components that are essential to build knowledge to support rural community livelihoods.

The questions that are explored as part of this objective are:

- i) What data are required and what skills are needed to gather the data and knowledge? What spatial analysis understanding is required in order to rationalize the data gathering process?

- ii) Who are the expected participants and how are they going to be selected? What are the PGIS user requirements, the community's needs and their expected outputs?

- iii) What spatial data handling and analysis competencies are required?

- iv) How is the community to be involved in the data capture, mapping and the PGIS structuring activities?

- b) Develop a PGIS framework that encapsulates a knowledge repository to support rural community development.

This includes answering the questions such as:

- i) What is the appropriate knowledge repository structure to be used to leverage geographic base data in order to stimulate community development innovations?

- ii) How are the user requirements, the community needs and the knowledge repository to be employed in order to develop a PGIS framework?

- c) Implement and evaluate the PGIS in order to assist a rural community to use it to identify their role in community development.

The questions to ask here are:

- i) What is to be considered in designing an appropriate user interface for a rural community?

- ii) How are the community members going to use the PGIS in order to acquire the knowledge they needed for their livelihood activities?

1.7 The Thesis Scope

This research study assumes a positive view of *participation* and is involved in its application. The basic concept of participation which is used here is that it is about community members becoming involved in village related livelihood improving activities, and that it is about invoking the spirit of community and not about participation in external development projects. The term *community* generally refers to a group of people who share common concerns, values and activities, wherever they may be, and can thus have a number of meanings. This term is used in this study to refer to a group of people at a remote rural village in Botswana and the community development institutions that support their livelihood activities.

The activities involved in this study have largely been outlined in Figure 1.0, they are concerned with developing a PGIS intervention to address rural community development, however the project is not itself a development project. A number of themes are included in the research domain. First, it is the understanding of the formal meaning of geographic space. The second involves the relevance of the constructs of a PGIS intervention to support the livelihood activities of a rural village community. Third, comprehending the value of knowledge and acquiring the capability to recognize valuable knowledge. This is necessary in order to further appropriate it to more personalized use and to support individual or group livelihoods. The fourth relates to adequate understanding and use of the livelihoods support environment, this includes the need to recognize the role of the local leadership both traditional and political, and the need to recognize the role of the community development institutions in supporting livelihoods. The fifth relates to the necessity to explore village groups and to recognize the benefit of group work and group decision making. The researcher considered that without such village groups, the village community could not learn from each other or develop collective problem solving strategies, and the interventions which are initiated would not be sustainable.

1.8 Overview of the Methods

This section provides an overview of the activities which were carried out in order to address the issues raised in the objectives (Figure 1.0). Following the preliminary research conceptualization, the research thesis focus was determined to be the application of participatory geographic information systems in structuring the knowledge building in order to support rural community development. Overall, there were four broad activities: a) developing the methodology, b) developing a generic PGIS framework, c) implementing the generic PGIS framework at the research project site and d) analysing the results and evaluating the PGIS framework.

With regard to developing a methodology, this activity was guided by the requirements of a participatory approach and the need to develop a PGIS infrastructure. The literature review revealed a number of standard activities which were then reformulated to reflect the rural community context. The methods included community mobilization, community training, data analysis and developing a PGIS prototype, community feedback workshops and evaluating the PGIS framework. This was followed by a number of community ‘on the job’ learning activities. These included business process modelling, GIS based mapping, social survey and the administration of an attitude scale. The development of the PGIS infrastructure was carried out in a number of different stages. First, the geographic database and a knowledge content repository were developed, these were then used to produce a PGIS prototype. The prototype was evaluated at the project site and this provided the opportunity to identify the major institutions and to determine the PGIS infrastructure. The community collaboration also included feedback workshops, the production of knowledge objects by a number of community development institutions and the planning of a community knowledge centre as the way forward for the community.

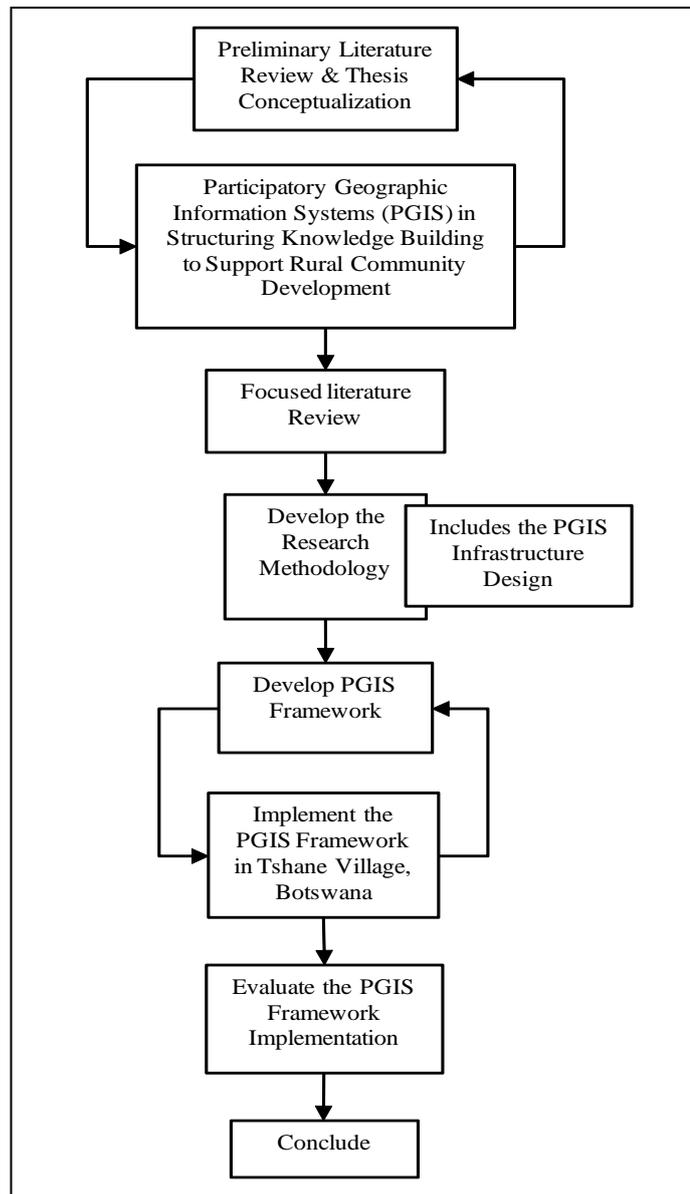


Figure 1.1 Overview of the research methods

The generic PGIS framework was developed within two broad activities. First it was conceptualized and designed from a review of the literature. Second, it was then further consolidated through inputs from the field trips, the data analysis and prototype development and from the prototype testing and evaluation. From the literature review, a number of both standard participatory and PGIS based frameworks which could be used as sources of the PGIS components, were identified. The components which were deemed to be suitable for the rural areas were abstracted and composed into a draft generic PGIS framework. The core of the generic PGIS framework was made up of the convening (community mobilization), the process, the output constructs and the supporting institutional infrastructure. The

field work provided the opportunity to visualize the PGIS framework in operation and to verify and add to the PGIS components. The data analysis and the development of the prototype further specified the processes. These activities offered another opportunity to further consolidate the PGIS framework structure. They clarified and strengthened the need for the facilitation of the application of the PGIS prototype. The feedback, testing and evaluation of the PGIS prototype reconvened the main institutional actors and helped to establish the PGIS infrastructure. This offered the opportunity to observe the operation of an updated version of the PGIS framework and to modify the structure where it was necessary to do so.

The developed PGIS framework was implemented with the active participation of the community for some activities but not for the others. The convening was facilitated mainly by the VDC and tribal leaders. This covered the basic community mobilization processes, the constitution of the local component of the research project management and the selection of the participants and the convening venue. The business process modelling, the gathering of both the geographic and non-geographic data and the administration of questionnaire and attitude scale, were carried out as part of the community training. These activities were therefore carried out largely by the village trainees with support from the VDC and the researcher. The data analysis and the development of the PGIS prototype were carried out by the researcher. The feedback workshops were also carried out as part of the community training and were facilitated by the VDC and the village trainees. The PGIS framework components were not as clearly separable during the implementation as they were in the conceptualization. For example the facilitation operated at all the components and the community members were involved in most PGIS components, either directly or indirectly.

The evaluation of the PGIS framework involved evaluating the following: a) whether the village community could self-organize in order to effect group decision making and to mobilize collective action, b) whether the village community had learnt and acquired the capabilities and skills and c) whether the village community exhibited any inclination to apply the obtained competencies to secure livelihoods. The underlying assumption here was that when there was effective leadership and community facilitation, when the community had skills and when the community members applied their capabilities, then both the PGIS infrastructure and the created

community livelihoods would be sustainable. The researcher noted also that since this study employed a participatory approach, each of the evaluations essentially involved evaluating the level of participation of the village community. Thus the participation was assessed for its impact on the community mobilization, the processes and the outputs. The basic questions which needed to be asked were: a) was the PGIS infrastructure built b) did it anchor the learning successfully and c) did the community members create knowledge which was used to develop livelihoods?

1.9 Thesis Structure

The thesis is divided into seven chapters: 1) introduction, 2) literature review, 3) research design, 4) development of the PGIS framework, 5) methods, 6) results and discussion and 7) conclusions.

Chapter one presents a brief overview of the research subject, purpose and thesis. The background to the problem was then discussed in order to facilitate a better understanding of the problem statement which follows it. This is followed by the significance of the study. The thesis statement is then presented in more explicit terms, this is followed by the motivation and the assumptions. The objectives are then presented and the thesis scope outlines. A brief review of the methods is presented next and indicates how the research issues raised by the objectives are treated. This chapter concludes with an outline of the thesis structure.

Chapter two discusses the literature review. Since this research uses a participatory approach, the chapter begins with an explanation of the concept of participation which is adopted in this research. The issue of knowledge forms a large component of the thesis and is discussed next. The issues covered include the adopted concept of knowledge, the distributed nature of a community knowledge base and Botswana's view on knowledge issues. The attitudes, behaviours and change in community development are then discussed as they relate to the underlying knowledge base which the community operates from. The international development intervention is introduced as the core symptomatic problem. This leads to the concept of knowledge for human development, which is proposed as a possible alternative to the international development intervention. Knowledge use implies knowledge acquisition, so this is discussed next, together with the treatment of the role of the learning theories in knowledge acquisition. Since information technology is at the

core of the PGIS solution, an extensive presentation is presented on the systems concept, GIS and society, the PGIS process itself and the frameworks that have been developed to implement it. The PGIS strategy includes both physical and social science processes, this necessitated a brief explanation of the positivist and interpretive ways of acquiring knowledge.

Chapter three presents a plan of the research methods, and introduces the study area. The section on the introduction to the study area covers the location of the study site and emphasizes specifically on the consequences of its remoteness. Since human behaviour is underlain by attitudes and beliefs, a summary of these is presented. The community development institutions are then presented as the support infrastructure and the link to central government. The last part of the chapter presents the status of information and communication technology and knowledge management in Botswana.

Chapter four discusses the development of the generic PGIS framework. It outlines how the PGIS framework is composed from a number of PGIS components which were abstracted from the other existing PGIS frameworks. Other PGIS components were abstracted from standard participatory frameworks, especially where such components were not as clearly represented in the PGIS frameworks. The initial component abstractions created a draft generic PGIS framework, further structuring of the PGIS was carried out at the field and at the varied data analysis stages.

Chapter five presents the application of the generic PGIS design at the research project site, this chapter therefore presents the research methods. The methods include: a) a community mobilization component which incorporates agenda setting and project co-management arrangements, b) GIS based mapping, c) the administration of a social survey questionnaire and attitudes scale, d) the geographic database design where the GIS mapping and the social survey data were integrated, e) the creation of a prototype for the shelter and goat rearing components of the community livelihoods, f) the feedback workshops which covered the social data, the testing and evaluation of the PGIS framework and the creation of a number of knowledge structures, g) the creation of a web supported knowledge content repository and h) the results and discussion.

Chapter six presents and discusses the results. When the PGIS strategy was implemented as outlined in the PGIS framework, it unfolded five broad areas of outputs: a) the local leadership, convening and group decision making outputs, b) the facilitation structure, c) the capability building, such as business process modelling, business planning, GIS based mapping, social survey skills, constructing knowledge objects and planning and conducting workshops, d) the physical outputs, such as the business process models and business plans, maps, socio-economic data, the attitudes and knowledge structures e) the social outcomes such as highlighting the role of the local leaders in more actively supporting community livelihood activities, the institution of a knowledge centre, the role of the community development institutions and the role of the community in knowledge building.

Chapter seven discusses the conclusions. Overall, it was concluded that the PGIS strategy does work. Some of the community members who were more directly involved in the project, had started their individual livelihood projects. Other outputs included the institution of a knowledge centre, the mapping of the village wards and the charging of the village ward heads with the responsibility for monitoring the improvement in the living standards of community members in their wards. However, it was noted that progress would be determined by how well the local leaders rose to the challenge of leading for change, the effectiveness of the facilitation, the deployment of the produced expertise, the participation of the broader village community and the development of an appropriate livelihood support environment.

1.10 Limitations of the Study

There were a few limitations that need to be presented, most of which relate to the deployment of the information communication technology (ICT) intervention strategy from a developing country perspective by a candidate from a developing country. This type of research poses challenges where both the required knowledge base and the technological infrastructure are low and where such requisites hardly exist at the research site.

The use of ICT as a research tool from a developing country perspective poses challenges because it requires adequate IT skills which are often not readily available. It involves the consideration of the complete suite of IT skills, such as

systems analysis, database design, application development and the use of the internet. Acquiring such skills within the research process may be part of the learning but tends to detract from focusing on the major task itself. However, much effort was expended in acquiring the basic requisite skills in order to leverage the potential that the PGIS intervention holds in rural community development work, and to present an adequately informative report.

The other limitation relates to the lack of a formal Botswana language based ontology for organizing the treatment of traditional knowledge and its management. Therefore much time was spent on developing the vocabulary that was needed to effect meaningful communication with the local community and in translating the local meanings into the formal IT language.

The last limitation relates to what is generally the limitation with academic research. The way the academic research process is set up is that it ends up with well thought out concepts of solutions but is not involved in the operationalization of the solutions. This often results from the mismatch between the short time bound requirements of the research process and the longer lifetime duration of livelihood activities.

CHAPTER 2 LITERATURE REVIEW

This chapter outlines the basic concepts which were associated with leveraging a PGIS process in order to support the learning, acquisition and application of knowledge and to enhance the livelihood activities of a rural community. A simple description of what the expected overall process should be was used to structure the chapter. In this regard, the application of a PGIS process to rural community development was considered to be a rural community intervention, wherein a village community undertook to carry out four main activities. These activities would facilitate the community members to enhance their livelihood activities and to secure dignified and sustainable livelihoods. These activities are: a) self-organizing in order to prepare the community to implement collective action, b) learning to acquire, build and apply knowledge and thus obtain capabilities and skills, c) recognizing the value of building a knowledge managing facility and d) applying their capabilities and skills in order to secure sustainable livelihoods. This chapter therefore, reviews ideas on how a participation process which is aided by a PGIS intervention can facilitate learning and support community development.

2.1 The Need For and the Potential of a Participatory Process

As a consequence of an initial and disruptive human development strategy, many people have become incapacitated with regard to securing and maintaining dignified living standards. The percentage of people living below the poverty datum line is still unacceptably high for a number of countries. Chen (2007) reports that an average of 41.10 percent of the people in Sub-Saharan Africa still subsists on less than two dollars per day, Botswana is part of this region. Blaikie (2006) notes that over 60.0 percent of the population in Malawi lived below the poverty datum line, literacy was about 50.0 percent, and 30.0 percent of Malawi's households were female headed. Blaikie also estimates about 40.0 percent unemployment in Botswana. Despite Botswana's world famous success economically (Robinson 2009; Beaulier and Subrick 2007; Pillai 2006; Kaunda 2005a; Maipose 2009) poverty is still perceived as one of the greatest challenges facing the country (Government of Botswana 2003b).

The cause of poverty unfolded in three waves of processes, two waves of technology induced social disruptions which occurred in the developed world, and the third wave which was the cold war between the United States of America (USA) and the United Soviet Socialist Russia (USSR). The first wave of activities was the onset of the industrial revolution which created capitalism and introduced poverty (Komlos 1983). The response to address poverty was social engineering (McMichael 2004) which was the intervention to address the urban poverty and human suffering which were created by technology and modernity. This was the first glimpse of a real human development intervention which has since become difficult to discern and pin down.

Secondly, the improvements in technology have tended to cause disproportionate development of economic and political power (Schraeder, Hook, and Taylor 1998; Adams and Brock 1986). These often result with the imposition of disruptive national economic structures onto the weaker nations by the more powerful ones as a requirement for interaction or assistance. An example of such an imposition of power which has had a great impact on human development initiatives was the response of the USA to the global economic disruptions which were caused by the second world war. In order to restore the global economy, the USA introduced the international development project and thus unleashed the full power of non-stakeholder capitalism (Freeman, Martin, and Parmar 2007). Consequently, starting from the 1950s (Ellis and Biggs 2001) the international development project was constituted to leverage the wisdom of the developed world and to deploy the capitalist process to deliver development and to improve the economies of the developing countries. The solution did not take into consideration that the developing country context was culturally and technologically different. Ashok and Beck (2007) note similar concerns with regard to implementing information communication technology projects in the villages of the developing countries. The development policy planning process may not have foreseen the effect of the domination of the incoming culture over the local cultures. As a result, the international development project created more problems than it solved in the developing countries (Black 2007), the greatest being poverty. Thus, world poverty can be traced to the misappropriation of a technological solution and a culture, which caused an ontological mismatch, between an international solution model and the local socio-spatial application domains, to which it was translocated.

Finally, the cold war between the USA and the USSR tainted the international development project further. Official aid was then applied purposefully by the USA and other western countries to cripple national economies (Sillitoe 2000), to achieve economic alliances and to create economic dependencies. On top of this, the international trade agreements have tended to disadvantage the developing countries and to continue to foster economic dependencies. The last straw was that the national governments were no longer fully in control of their national economies (Moyo 2009; Cerny 2009), rather the international global business corporations were (Jenkins 2004). It has now been five decades, poverty is still pervasive and on many occasions the international development intervention has made the situation much worse (Ferraro 2001; Ife 2002; Cleaver 1999; Blaikie 2006).

From the foregoing three cases which unfolded the onset of poverty, it may be necessary to clarify why therefore community development should ultimately rely on knowledge, individual effort and community based collective action. In the first case, where social engineering was instituted to resolve urban poverty, there was an ulterior motive. Poverty threatened the peaceful existence of the more affluent members of the society, and for them to ensure the continuance of their lifestyle, the poverty problem had to be addressed (McMichael 2004; Polanyi 2001). Thus the well off were considering their own interests. In the second case, when the USA introduced the international development project to restore the shattered economy of Western Europe, it was not just carrying out a humanitarian act, it was also implementing a business decision (Hogan 1989). The relatively wealthy USA needed a market and a poor Western Europe could not be such a market. It can be noted that in this case the USA was considering its own benefits. In the case of the cold war, international aid was used to benefit the developed countries more than it was intended to benefit the developing countries (Pender 2005). In addition, the aid has ensured that the developing countries continue to be the market, as was the case during the colonial times. Therefore, there is clearly a need for a more effective human development strategy, one which addresses rural community development directly rather than relying mainly on broad based development policies. A participatory process may be such a strategy.

A participatory process involves collaborating with a rural community in order to develop a community supported rural community development strategy. Currently,

the individuals are expected to use knowledge to effect their own development and improve their living standards (The World Bank 1999; King and McGrath 2004). This approach can be aided by the broader ICT tools (Bracey and Culver 2005) and it offers the opportunity to implement a human development strategy that reaches the poor themselves.

Ife (2002) considers that community development is composed of a superstructure, which entails the establishment or re-establishment of the community institutional infrastructure as well as the reorientation of their intervention strategies, and a substructure which is the actual community work. This research project adopts the latter concept. Thus community development can be considered to be the more logical alternative to the equitable provision of human services and the maintenance of environmental sustainability (McMichael 2004; Arce 2003; Bebbington 2000).

In considering that rural livelihoods are largely place based, the use of a participation process that incorporates the use of the land may enhance the participation of the community. The geographic information system (GIS) which is an information system that is used to collect, store, analyse and visualize place based information, may contribute to enhancing the participation of the community. The GIS instrument is also particularly suited to the village level work because the community then works with familiar places, can easily associate with the pictorial representation of their own rangelands and urban environments and can therefore easily participate. The GIS process should assist the community to gain individual skills, so that they can participate more meaningfully, and work collectively to develop themselves and their villages

2.2 Participation and Collective Action

The concept of participation has been used in a number of contexts. At its simplest level it can be considered to be the involvement by local communities in development initiatives (Tripathi and Bhattarya 2004; Briggs 2005). However, such a concept of participation has been widely criticised in the GIS literature (Elwood 2006; Harris and Harrower 2006; Schuurman 2000). In response to critical GIS, participation has also been used to integrate indigenous and scientific knowledge (Corbett and Keller 2005; Harris and Weiner 2003; Pound et al. 2003). In its broader application domains, participation has been used to assist indigenous communities to

gain access and legitimacy to traditional lands (Chapin, Lamb, and Threlkeld 2005), to contribute to the management of natural resources (Mbile 2003; Blaikie 2006; Kyem 2000; Berkes 2004), to codify and conserve traditional knowledge (Rahman 2000) and to protect the intellectual property rights of indigenous communities (Britz and Lipinski 2001). In all these applications however, participation does not relate directly to improving the living standards of the rural communities (Mansuri and Rao 2004). Although this limits the usefulness of these views of participation with regard to the current research, this does not mean that these concepts are not used totally. In its implementation, participation does involve reference to natural resources management, to codifying and storing local culture specific data and may infer or address intellectual property. However, a better concept of participation is needed.

2.2.1 Participation as Learning

With regard to this research, a more useful view of participation is one which regards participation as a process of leveraging the power of groups to obtain economic, social and political outcomes, which would be difficult to obtain individually (Thorp, Stewart, and Heyer 2005). Such a view of participation recognizes its contribution to addressing poverty. Participation achieves this when it is viewed not only as a poverty alleviation process, but also as a theory of knowledge (Breu 2001). As a theory of knowledge, participation provides a compact concept for organizing the activities that are required to develop a PGIS framework. Participation involves forming groups which work together to address mutual learning (Elkjaer 2003), collective decision making and to obtain stipulated outcomes (Corbett and Keller 2005a). Olsson, Folke, and Berkes (2004) note that local groups have the capability to self-organize, to learn and to actively adapt to changing situations. These capabilities essentially outline the potential PGIS framework processes and allow the local community to represent their local knowledge and perspectives. These could be digitized, visualized and shared (Harris and Weiner 2003).

However, in creating such output, participation may open or increase access to otherwise hidden avenues to goods and services and influence the social and political processes (Elwood 2002). Such accesses may alter the power relations with regard to the dominant groups (Robbins 2003), especially those who obtain their power from

advantageous access to information (Davidson-Hunt and Michael 2007). Although empowerment is the ultimate aim of participation, it may be necessary to manage its influence and to ensure that it does not unnecessarily antagonize the political structure which is needed to support it.

Therefore, there is need to organize the participation adequately for collective decision making. Although there are power differentials within most communities (Chambers 2006b), there is need to neutralize these as much as possible in order to ensure the maximum contribution from the participants. The participation involves assigning roles, engaging in collaborative or adaptive processes, making decisions and creating output. In facilitating this process, there are both manual and computer assisted avenues. Manual facilitation may require: a) meeting preparer, b) minute taker, c) general responsibilities for all participants, d) a group convenor, e) internal liaison person and f) timeline keeper. Computer mediated collaborative work usually involves groupware and may be structured as synchronous or asynchronous (Balram and Dragicevic 2008) and may occur at either the same place or different places. The participation activity itself requires common purpose and collaborative relationships, Schuler, Decker and Pfeffer also outline eight processes, open communication, diverse participation, unrestrained thinking, constructive conflict, democratic structure, multiple sources of knowledge, extended engagement and facilitation (Schusler, Decker, and Pfeffer 2003, p309). However, good preparation alone is not enough, much work is needed to achieve empowering levels of participation.

2.2.2 Levels of Participation

Participation is a complex social interaction where the village community from different rungs of the social class hierarchy, the political machinery, the community development institutions and other community based organizations, bring their varied types of expectations, needs and agendas (McCall 2004a). For Botswana for example, Sammy (2005) identified fifteen issues which underlay the participation. It involves hidden interplays of power not only between the general community and the traditional power holders (Cooke 2002), but also among the community members themselves. Consequently, it has become standard practice to judge the strength of the participation by the amount of perceived power it imparts to the participants and what it achieves (Schlossberg and Shuford 2005; Rifkin 2003) and to represent this

in graphical form. The representation of the level of empowerment is often presented as a ladder of participation (Carver 2001) refer to Figure 2.1.

In mainstream discourse on rural development, participation has been noted to fall short of achieving empowerment (Mansuri and Rao 2004). Figure 2.1 shows that at best, conventional participation is mainly tokenism. The reason for this low performance is that participation is still implemented largely by external experts and is thus guided by non local objectives (Chambers 2006a; Schlossberg and Shuford 2005). However, there are cases where it has been shown to be aligned more with the needs of the community (Castella, Trung, and Boissau 2005; Reddy 2009). It is possible therefore to achieve empowering levels of participation.

Citizen Control	Degrees of Power
Delegated Power	
Partnership	
Placation	Degrees of tokenism
Consultation	
Informing	
Therapy	Non-participation
Manipulation	

Figure 2.1 Ladder **of participation**

Source; Carver, 2001

2.2.3 Enhancing the Level of Participation to the Empowerment Rungs

From the foregoing discussion, a participation strategy that is most likely to empower the local community is one that has been developed in the following way: a) the community is facilitated to design the strategy, b) the design focuses on the community needs, c) the strategy facilitates the acquisition of capabilities and skills to secure the needs, d) identifies the need for the link with the strategic support infrastructure and facilitates access to such support, e) identifies the need for the link with the financial support and facilitates access to such financial services and f)

assists the community to practice what it has learnt by applying the acquired skills to secure sustainable personal or group projects. A major component of this is training, since most of the rural areas usually have low access to services and receive lower qualities of education. However, this should not necessarily be considered to limit the implementation as it is often interpreted. If the type of training is on the job (Kanungo 2004) then it achieves both information and skill transfer. Thus, it enforces knowledge building and construction. Elwood (2002) considers that capacity building achieves the most sustainable form of empowerment, compared to more access to goods and services or increased access to social and political processes. One way of enhancing the level of participation to empowerment levels is to follow a collaborative form of participation.

Collaboration refers to two people or more working together on a project but it also involves knowledge construction (Lipponen 2002). Ashby (2004) presents collaboration as a level of participation that can be considered to be midway up the participation empowerment ladder. Ashby indicates two levels above collaboration as collegial collaboration and farmer experimentation. In the former there is awareness of the researchers' priorities and hypotheses but the farmers may or may not consider them. In the farmer experimentation, there is no involvement of scientists. The lower two levels represent the cases where there is no farmer involvement and where the farmer is consulted respectively. The PGIS process offers the opportunity to learn by doing. This should increase the confidence of local communities to become involved in community development initiatives. The integrated system for knowledge management which is presented in Section 2.7.5, presents a form of collaboration which involves learning based extension approaches that include developing and applying technical information within an environment of shared understanding. Maps and images of the rangelands should help community members who are involved in community development argumentations and deliberations to have their voices heard (Balram and Dragicevic 2008; Rinner and Bird 2009). There is therefore often need to evaluate the level of participation.

Traditionally, evaluation has tended to mean evaluating the impact of development interventions (Davies 2003). However, the evaluation should normally consider why the evaluation is being carried out, what is being evaluated and how (Chess 2000). Chess also refers to three reasons for evaluating, goal achievement referred to as

summative evaluation, evaluation for program improvement as formative evaluation and evaluating for outcomes, which is referred to as impact evaluation. This is similar to Baker (2000) who identifies reasons for evaluating as monitoring, process evaluation, cost benefit evaluation and impact evaluation. The common types of evaluation are either user (Chess 2000) or theory based (Davies 2003; Jones et al. 2008). In the user based evaluation, the participants indicate their degree of satisfaction with the participation process. In theory based evaluation, it is the evidence of the assumptions of the theory that are investigated. The evaluations that focus on the development project are not very useful in evaluating the empowerment that accrues to the local community. Beierle and Konisky (2000) describe an evaluation procedure that uses social goals (valued outcomes) to evaluate participation. Rowe and Frewer (2004) on the other hand, use an adopted definition of project effectiveness to evaluate participation and use empowerment as the measure of participation.

Since the evaluation process evaluates the constructs of participation, it follows that the evaluation constructs in turn outline the participation constructs (Abelson et al. 2003). To support community development, this research project has pursued an evaluation of participation that entails evaluating for empowerment, where the community outcomes serve as the objectively verifiable evaluation constructs. Two types of evaluation processes seem to be applicable. First, Beierle and Konisky's use of social goals to evaluate participation offers a simple quantification process from the application of subjective ratings. The authors use three categories that represent the level of achievement of capabilities. The categories are one, two and three, which represent the unlikelihood of, the likelihood of and the assurance that capabilities have been obtained. Second, the use of the definitions of individual and collective capabilities by Elwood (2002) offers the opportunity to combine the acquisition of individual and collective capabilities and to integrate the two in order to infer empowerment and the sustainability of a participation initiative. The first evaluation method should be used as a formal 'form based' evaluation which is carried out by the community. The second evaluation method assesses the level of participation achieved at each stage of the PGIS process and uses the combination of individual and community empowerment to infer the sustainability of the PGIS process.

Ultimately however, it is the level of learning that should be evaluated for in participation initiatives, because it is through learning that knowledge is acquired.

2.3 How Humans Learn and Solve Problems

2.3.1 How Humans Learn

The human brain creates and stores all personal experiences (Hauser and Spelke 2004), these are supported by search and retrieve processes (Bauml, Zellner, and Vilimek 2005) when problems are solved and decisions made. In creating these experiences, the brain relies mainly on the visions of the environment (Sweller 2003), but it also uses the rest of the other human senses, such as hearing, smell, touch and taste. Therefore, there is a striking similarity in how the brain functions and how GIS operates, both rely on associations of images and information and the recall and deployment of these associations in the execution of tasks. Essentially, this is how humans learn at the individual level. At the group level, the interaction requires that internal models of reality be externalized in order to assist the communicators to assess and judge whether there is a common conceptualization and hence a common understanding (Brewster and O'Hara 2004). This common understanding is a basic requirement for effective communication.

Communication therefore, or articulation, becomes a basic part of learning (Hakanson 2007), thus learning becomes the basic mechanism for creating knowledge. From the preceding parts of this paragraph, it can be deduced that knowledge is the possession of experiences and the internal brain procedures which are associated with these experiences. These are then recalled when they are required and recombined again in order to carry out tasks and solve problems. Again, an instance of striking similarity can be noted between this internal knowledge (tacit knowledge) operation and the computer program, what some have referred to as the ghost inside the machine (Abelson, Sussman, and Sussman 1996), because computer programs do not exist physically until they are invoked. Similarly, knowledge does not exist until it is invoked for application in a given context (McDermott 2000b).

It may be necessary to highlight that all individuals must realize their responsibility in constructing their own version of a transmitted component of knowledge (Liao 2003b), what Oldenkamp (2002) refers to as *knowledge derivate*. This is necessary

because despite the clarification that knowledge cannot be transferred directly, the literature still refers to explicit knowledge, this infers that it is externalized tacit knowledge (Nonaka and Toyama 2005). Nonetheless, it has been noted that knowledge does not exist as a complete product (McDermott 2000a; Oldenkamp 2002). It is always a reconstruction and it is the responsibility of the individual to carry out their own reconstructions in order to secure their own knowledge (Thomas, Kellogg, and Erickson 2001). In group learning therefore, it is important to appeal to the cognitive inputs of the participants. They should be requested to contribute knowledge (Comrie 2009) and not to resort to regurgitating other people's facts. Oldenkamp (2002) notes that in creating knowledge, people perceive, interpret, understand, justify and create their own knowledge (Figure 2.2).

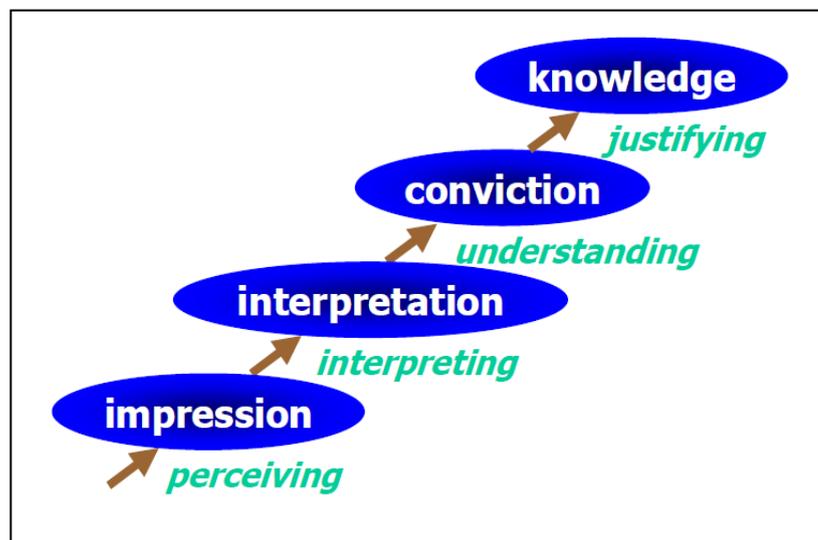


Figure 2.2 How knowledge is created
Source: Oldenkamp 2002, p45

On many occasions, communication and therefore learning occurs at face to face interactions (Baker, Jensen, and Kolb 2005) where the knowledge is shared and thus distributed. Nonetheless, in order to share information, there is need for those who receive the information to be assured that the information which is being communicated is sufficiently reliable (Courtney, Haynes, and Paradise 2005). This condition is necessary to ensure that the information supports sustainable meaning and dependable decision making. Society has therefore created ways of assuring the development of acceptable dispensations of knowledge. For the physical sciences quantitatively intensive positivism is the process used to obtain acceptable levels of

true beliefs (Bharadwaj 2000). For the social sciences interpretive processes produce true beliefs from qualitatively rigorous methods (Butler et al. 2005). The outcomes of both ways of knowing provide the theories that are used to create more acceptable knowledge. In traditional societies, there is no technology to aid the knowledge creation process (Moller et al. 2004) or to store such produced knowledge. In this situation, the storage of such a community based knowledge system, is that it is distributed among the people (Barnhardt and Kawagley 2005). As such, different elements of the knowledge are stored in human memory. This represents the community's knowledge base, but not in technologically intensive form, yet this should not detract from the fact that it is a knowledge system in its own right, and therefore worthy of acknowledgement.

2.3.2 The Appropriateness of the Village Knowledge System

The special character of knowledge that makes it particularly suited to rural development applications is that it resides inside individuals (Hakanson 2007; Nonaka and Toyama 2003), and that its compilation requires the active input of people as knowledgeable individuals in their own spheres of influence (Chalmers and Fabricius 2007). The knowledge that the individuals hold within the community is referred to variously as traditional ecological knowledge (TEK) (Brodnig and Mayer-Schönberger 2000a; Calamia 1999), indigenous technical knowledge (Aitken and Michel), traditional knowledge (TK), or indigenous knowledge (IK) (Tripathi and Bhattarya 2004). Barnhardt provides a more fitting description when he refers to indigenous knowledge systems (Barnhardt and Kawagley 2005). In a similar manner Brodnig and Mayer-Schönberger (2000b) describe TEK as a knowledge system that functions similarly to a distributed database and considers it to be a scientific system that has its own taxonomy, methodologies and experts.

However, a rural community as an entity that manages knowledge differs from a formal knowledge management system in that it does not have a specific artefact that handles the knowledge management function. (Bellinger 2004b) describes a knowledge managing arrangement as composed of the knowledge leveraging artefact surrounded by community members, external contributors and facilitators. In a similar manner, a traditional system contains a culture and leadership structure that can be considered to be the controlling knowledge leveraging artefact. It has its own

members, external development institutions and organizations and the village wardmen and the elders act as the facilitators. When a village social system is viewed in this manner, it reveals the formal information system's constitutive primitives and should be able to respond to most of the information system development processes. Human beings therefore have powerful brains, they constantly receive huge amounts of information and just as constantly reduce the information to manageable proportions to guide action (Spaulding 2006). People are intelligent beings who contain different beliefs and have differing needs and expectations from life (Allen 2001). These have to be taken into consideration within the participation learning process.

2.3.3 The Role of Human Development Theories in Supporting Knowledge Acquisition

The human development theories support the community development effort by providing an understanding of the way people think, what motivates them and thereby informs the design and implementation of learning programs. Perhaps the single most important human character is the capacity to learn and to create new realities (Hauser and Spelke 2004) rather than just reacting and working with the status quo (Nelson 2002). The effective strategy that can be used to leverage this knowledge creation and management ability can be informed by an understanding of the livelihood activities of the community (Gorelick, Milton, and April 2004). Human development theories can provide part of this understanding.

The human development theories that have been considered to be relevant to this study include: a) Maslow's Hierarchy of Needs theory (Huit 2004b; Maslow 1943) which provides an understanding of what motivates the individuals to achieve, b) the Conflict Resolution Theory (Deutsch 2005) which relates to revealing areas where basic human needs are not being met and which therefore cause the resulting social conflict, c) the social development theory (Jacobs, Macfarlane, and Asokan 1997), as essentially an experiential learning theory whose concepts may be used to inform the structuring of the training and facilitate the learning and d) the self-determination theory (Ryan and Deci 2000a) which outlines the human basic needs for competence, autonomy and relatedness.

Both the preparation of instruction material and the delivery of learning need to be sufficiently informed in order to achieve the expected outcomes. Sweller (2004) notes that the teaching must have a knowledge structure that is consistent with and is appropriate to the knowledge and skills that need to be acquired. This is consistent with how the human brain has evolved in order to match its cognitive structures with the way the information elements are linked in the real world domain (Sweller 2003). In addition, in cognizance of the rational ignorance noted by Krek (2005) and the andragogy requirements (Merriam 2001) of a communal setting, development interventions should consider that community members expect valuable returns from participating and prioritize learning of required expertise. In such cases experiential learning (Kolb 2000) would be the more appropriate learning framework. In addition, Baker, Jensen, and Kolb (2005) note that conversation is part of experiential learning and Nyerges, Jankowski, and Drew (2002) observe that the PGIS facilitates the generation of conversation. Thus the PGIS becomes a particularly useful tool in supporting learning, especially within a rural community setting.

2.3.4 How a PGIS Process can Facilitate Learning

Learning essentially involves two main elements, a remembering element and a task executing element (Leamnsom 2001). Therefore a PGIS as an IT artefact should be able to support learning by storing what needs to be remembered and somehow visually, recreating and re-enacting the task executing experience. Current ICT can do amazing things, but for the purpose of this research there are a number of simpler options. The PGIS maps could be sequenced to tell a story and this could be accompanied by synchronized voice recordings. The voice recording could also be used on its own, whereby the participant creates the visualization. In this case, the human mind creates the recreations and re-enactments of the task execution process. This is possible where the participants already have some experience of the tasks, even when they may not have done them physically themselves. In addition, a video or voice recording of the task execution experience can be produced and linked to the PGIS (Corbett and Keller 2005b). Overall, the experience of planning the GIS project, collecting the data, georeferencing, digitizing, linking in the socio-economic attributes data and visualizing the data, is itself a learning experience.

By using the PGIS approach and working with a rural community, information communication technology (ICT) and community based indigenous knowledge (IK) management strategies can be combined. In this situation, the PGIS as the IT component would facilitate the knowledge compilation, construction and management activity (Reddy 2009) while through articulation, the IK would ensure the capture and incorporation of relevant local data, information and knowledge. Minsky (1967) notes that, through conversation, people externalize their mental models, in order to ensure a common understanding of a given domain. Alavi and Leidner (2001) refer to this mutual understanding as a common and shared knowledge base.

The distributed nature of a village community knowledge base points to the need to use collaborative approaches in order to facilitate the knowledge acquisition, sharing and distribution (Allen, Kilvington, and Horn 2002). Jain (2006) observes that such knowledge management activities require institutional support, the PGIS and the necessary infrastructure it requires should provide the institutional infrastructure. Liao (2003a) outlines some of this institutional support as powerful computers and network technology, although Ngulube (2002) warns against exclusive bias towards high-end technology and the danger of leaving out IK. Ultimately, it can be concluded that, if IK is community based and KM is organization and ICT based, then the combination of IK, ICT and KM concepts should lead to the creation of powerful tools and social processes that can be used to leverage knowledge in order to support community livelihoods. The PGIS, as a place based information system, should be suitable for such rural application and should serve as the more appropriate choice of the ICT component. Many times, human inventions mimic nature, aeroplanes mimic birds, mechanized vehicles us horse power and so on. Computers and information systems mimic the functioning of the human brain in the way they process information and solve problems.

2.3.5 How Humans Solve Problems

Problem solving essentially involves the application of either known or innovated cognitive procedures in order to analyse and diffuse a personally or socially unfavourable situation (Bransford, Brown, and R.R. Cocking 2004). Problem solving therefore occurs at the personal and group levels. Whereas personal problem solving

skills are necessary to achieve expected and respected social, economic and political individual outcomes, it is the application of personal skills to enhance the problem solving capacity of the group that has contributed to the success of human societies (Scardamalia 2002). Collective problem solving has become the mechanism which has been used to manage the complexity of both natural and social systems (Jackson 2003). These views present knowledge as abstract thought and as lived experiences respectively (Gordon 2000) that enable people to contribute thoughts and experience in a collective effort to manage complexity.

Problem solving is essentially learning something new and thus creating new knowledge (Nonaka and Toyama 2005). If problem solving is considered to be learning, Rogoff et al. (2003) note that in socialization processes, learning occurs through keen observation and listening, in which siblings anticipate participating in social activities. Keen observation represents a cognitive analysis of the problem. One way of analysing a problem is to decompose it into constituent sub-problems that correspond to known problem frames (Jackson 1999). This is essentially the positivist deductive approach. In addressing problem solving in information systems, (Fettke and Loos 2003) considers that problem solving involves a reference model because the solution process creates a mental component of the physical problem domain. This process tends to be natural because the problem is perceived externally but modelled cognitively. In this case the basic premise is that to reach a solution, success in task execution must be reached in both the cognitive and the real world domains. Collaboration then is a form of problem solving, especially where people work on the same issue with different specialist input as part of the problem solving strategy.

The PGIS process too represents a collaborative effort where the members of the community, the researcher and the community development institutions come together in order to address the community development problem. Ultimately, the problem solving process includes: a) the purpose of the problem solving activity when a problem has been identified in a given implementation, b) problem definition and representation, c) determination of the cause of the problem, especially a component of the problem that can be solved, d) Strategy construction, e) organization of information and f) the committing of resources to solve the problem and g) monitoring and evaluation.

2.3.6 Problem Solving in Rural Community Development

The community development problem refers to a situation where many community members are not able to provide adequate living resources for themselves and their families and therefore live poor and undignified lives. Pearson (2002) notes that community development must mean indigenous control. In this case, the problem solving involves neighbours working together to solve problems that have been identified by the community itself, and using local resources to achieve self-sufficiency. He notes further that this requires identifying leaders, identifying community rather than individual problems and acquiring the capacity to analyse and solve problems. Stoecker (2001) associates community development with poor communities working with resource providers to develop programs which are focused on helping the poor individuals in the community. (Cavaye 2001) identifies adequate infrastructure, access to services, enhancing business and economic opportunities and establishing a supportive policy setting in order to achieve outcomes.

A number of authors stress the importance of leaders and community power structures in mobilizing community development work. Brennan (2009) links the identification of local power structures with the identification of potential community leaders. Aref, Rezuan and Emby (2009) note that community power is the heart of community capacity building and thus identify the development of capabilities and skills as key to solving the lack of access to a tourism industry. The Carnegie Commission Progress Report recognizes that the well being of communities can be enhanced by strengthening the capacity of individuals to direct change (Spedding 2006). Kuponiyi (2008) also links community power to effective leadership and capacity building. In working with diverse groups of people however, there is need to be aware that each participant holds certain beliefs and that these beliefs underlie the attitudes and behaviours that these individuals portray.

2.3.7 Attitudes, Behaviours and Change in Community Development

Rural community development works with people and the groups they create, it essentially involves change within these individuals, and this change in turn is dependent upon their beliefs and attitudes. The attitudes are created and maintained by the social system in which community members have been brought up (Rizzo,

Corsaro, and Bates 1992). Since a social system is structured to output certain livelihood related outcomes, if these outcomes do not support dignified living standards, then rural community development should entail change. Washington and Hacker (2005) and Bellinger (2004b) relate the change that occurs in the individuals to the change that subsequently occurs in the social system itself. Baskerville (1999) notes that social systems can be studied successfully by introducing changes into their processes and noting how they respond. The PGIS should be an ideal intervention in this case, because it should reveal the various entities, processes and behaviours of the community. Since the system is made up of people, this means identifying the rules that the people work with. This implies that when the rules are changed as determined by the community's needs, the people will operate differently and the system will automatically reflect that because the system creates output that is dictated by the rules that run it. So far, participation, learning and community problem solving have been discussed generally, the next section moves closer to the research project site and discusses these issues with regard to the Botswana situation.

2.4 How Botswana Uses Knowledge and Solves Community Development Problems

2.4.1 How Botswana Uses Knowledge

The Botswana Revised National Policy on Education (Government Of Botswana 1994), The Tertiary Education Policy for Botswana (Government Of Botswana 2005) and the Botswana Federation of Trade Union (BFTU 2007) policy on education refer to a knowledge based economy and the need to develop the appropriate educational and learning processes in order to produce knowledgeable workers. Yet Botswana's latest revised national policy on education dates back to 1994. A Tertiary Education Act was passed in 1999 but has since been superseded by the Tertiary Education Policy for Botswana (TEPB) of 2005. The TEPB places emphasis on growing to cope with globalization, this orientation confers an external outlook in strategy development and biases the intervention to the urban population. Consequently, Botswana, like many other countries, is also still implementing a largely traditional model of education, where the learners are dissociated from the learning environment and confined to the classroom and limited to learning mainly from the teachers. In addition, Botswana's traditional learning is becoming dysfunctional. The older

generation is not maintaining the core values of the local culture and has begun to neglect its traditional livelihood assets (Government of Botswana 2002b). The younger generation has a low respect for the local culture and makes it problematic for those members of the older generation who still value it, to transmit it adequately to them.

2.4.2 How Botswana Solves Community Development Problems

With regard to solving community development problems, Botswana uses three mechanisms, programs that target the individual, group programs and programs that are accessed directly through the civil service. First, the individuals rely mainly on formal education and the procurement of a certificate to solve the unemployment problem. These individuals may take part in the development programs that are offered by government. When the education fails, many fall back to the welfare schemes as sources of employment. Some even consider this to be a source of livelihood. There are also traditional livelihood options, these include subsistence and opportunistic arable farming and livestock rearing. Arable farming is largely rain fed and normally produces low harvests, but sometimes when there is above normal rainfall, those who have the means produce largely to sell, hence opportunistic arable farming. Some people raise large herds of livestock, either cattle or goats or both and live off them. They use the milk from the livestock or sell it. They also slaughter the livestock for home consumption or sell them to procure livelihood resources. However, the traditional livelihoods have come under pressure. A tribal grazing land policy in 1975 fenced off and privatized large portions of communal land. About 23 percent of the country is taken up by national parks, game reserves and forests (Tembo, Manisa, and Maphale 2001). Every part of the country has become a controlled hunting area or a wildlife management area. The opportunity to implement nomadic grazing as a range management technique, has become limited.

As a strategy to implement an equitable disbursement of funds to support community development programs, the Government of Botswana (GoB) has a number of programs which support groups rather than individuals. In such cases, the group is subsidized and the government covers the bulk of the cost of a development project. The group contribution is usually between 10 and 30 percent. The development projects cover arable farming support, livestock rearing, water development and

private businesses. The GoB has also offered grant schemes in the past, such as the financial assistance policy of 1995 and the Arable Rain fed Agricultural Production Programme in 1986.

From the first national development plan in 1966 (Government Of Botswana 1966), the GoB has stressed the need for sound planning. The main focus at the beginning of the independence period was economic planning. This included the effective use of donor funding, the institution of local district councils to contribute to rural development, the development of a national bank to support local business initiatives and the appeal to all citizens to take part in the development of the country.

2.4.3 Trends in Community Development in Botswana

The pattern of development in Botswana does not differ from the general pattern outlined in Section 2.3.1. The difference being that the developed and developing country objects are replaced respectively by urban planners and rural local government structures. A number of rural development policies and strategies have been implemented. In addition, there are more direct anti-poverty safety net programmes, and these include the World War II veteran's fund, old age pension fund, drought relief programs and the destitute and orphans funds (Ministry of Local Government 2002). Unfortunately, most of these programs have short-comings, especially during their implementations. The welfare programs have induced the rural community members to depend on government assistance and a reluctance to engage in serious employment. The basic problem with the development policies and programs is their inadequate alignment with the rural community's needs and poor implementation.

The Rural Development Policy of 1973 (Government of Botswana 1973) was mainly an accelerated physical infrastructure building exercise. The Community Based Strategy (CBS) for Rural Development (Government Of Botswana 1997) had community empowerment principles but has never really been implemented as outlined in the policy. This was mainly because of both a lack of adequate knowledge and a lack of an appropriate and effective implementation strategy. The Community Based Natural Resources Management Strategy (Twyman 2000) was implemented mainly as a wild life based tourism joint venture, where the international tourism companies were the participating partners. The local

communities were not assisted adequately enough to manage the partnership, and most of the benefits accrued to the facilitators rather than to the general community. In a number of cases too, the local community was suddenly landed with large amounts of money which they were not accustomed to handling, this resulted in misuse. The Revised National Policy for Rural Development (Government Of Botswana 2002c) is largely a reiteration of the 1997 Community Based Strategy for rural Development. It is likely to be as poorly implemented as the 1997 CBS because the rural knowledge base and the human and social capital have not really changed. The National Strategy for Poverty Reduction (Government Of Botswana 2003a), is not really a poverty reduction strategy, it is mainly the mechanism for the World Bank to disburse its international loans (Porter and Craig 2004).

Botswana has performed well economically (Robinson 2009), the low success rate in terms of the percentage of people still living in poverty can be viewed as hampered more by the lack of trained, knowledgeable and skilled human development personnel than by the lack of financial resources and/or access to technology (Kaunda 2005). The poverty rate was 47 percent in 1997 (Ministry of Local Government 2002) 30 percent in 2002 (Lange and Wright 2004) and was estimated at 40 percent in 2006 (Blaikie 2006). The problem is compounded further by poverty, low literacy rates, inadequate production resources, institutional and policy conflicts and remoteness of rural areas. The CBS of 1997 and the RNPRD of 2002 which is informed largely by the CBS, relate more to the current research in that they promote the concept of knowledge for human development and a shift away from general rural development to community led human development.

2.5 The Anchoring Role of Information Systems in Community Development

In teaching and learning, an anchor refers to a case study or problem situation that is used to focus the learning on. *Anchored instruction* specifically refers to technology based learning where interactive tools are used to encourage the active construction of knowledge (Shyu 2000; Bransford, Brown, and R.R. Cocking 2004). However, this type of anchored instruction would be difficult to implement within a rural setting where the technology is not adequately available. Nonetheless, the concepts from another form of anchored instruction, namely *criterion referenced instruction* (CRI) are more generally implementable (Popham 1994). The CRI guidelines include

the following: a) that the learning objectives are defined from job performance and reflect the competencies that need to be achieved, b) that the trainees study and practice the skills that they need to master, c) that the trainees are given time to practice and obtain feedback about the quality of their performance, d) that trainees should practice more frequently the skills that are used often or are difficult to learn and e) that the trainees are free to sequence their learning but within the constraints imposed by the pre-requisites of the learning and f) that progress is controlled by the trainees' mastery of the required competencies. The PGIS process contains the basic constructs that are necessary to implement a simple but practicable and effective mode of anchored instruction.

Although an information system essentially defines any communication supporting set up that is intended to provide information, which would include non computer based systems, currently the term information system is commonly understood to refer to computer based information systems (CBIS). Cerruzi (2003), notes that the communicative role of computers now serve to support livelihood activities. This is what is also relevant for this study because the PGIS supports both the creation of and the communication of information. In addition, it should also support the construction of knowledge from existing databases and the elicitation, visualization, storage and management of the more elusive tacit knowledge. The work undertaken by Bharadwaj (2000) and Shelly, Cashman, and Rosenblatt (2006) with regard to creating information systems is also relevant because it involves soliciting assistance from those who are the beneficiaries of the information system construct. Thus the information system construct assumes justifiable legitimacy when it is appropriated to support a rural community to learn the basic skills that can be used to support their livelihood activities. Kanungo refers to information systems for emancipation and notes that rural information systems address "concerns that are qualitatively different" from standard IS concerns "in terms of how they are developed, managed, used and provide value" (Kanungo 2004, p410). These foregoing considerations refer to the design of information systems.

2.5.1 Design Science in Information Systems.

In this framework design suggests mentally conceptualizing a solution and planning for its implementation before the actual physical construction is carried out (Peppers

et al. 2006). The outputs of a design activity are both the process of the design activity itself and the created construct. Information systems (ISs) are designed in a similar manner. In defining what thinking is, Richmond (2005) illuminates the similarity between thinking and designing information systems. He explains thinking as creating mental models, then simulating these so that conclusions can be drawn and decisions made. Ultimately, the PGIS process involves design science in a similar manner to engineering designs, although the design as a process and as a finished product are not as fixed as in the physical designs, such as building a bridge. To date, the lack of a philosophical basis has tended to create technology driven information system development (Sraswat, 1998; Shanks, 1999; Weber, 1999). Vaishnav and Kuechler, (2005) outline five general steps for carrying out information systems research, identification of a problem, suggesting a solution, developing the system, evaluating the system and drawing conclusions from the evaluation. Likewise, Hevner et al. (2004) discuss seven guidelines that can be used to inform research in information system design, these guidelines include: i) design as an artefact, ii) problem relevance, iii) design evaluation, iv) research contributions, v) research rigor, vi) design as a search process and vii) communication of research. Overall, Vijay and Kuechler outline the process of conducting design science research while Hevner et al discuss what needs to be included in the design.

The standard information system design goes through four main phases, the system planning, systems analysis, system design and system implementation (Shelly, Cashman, and Rosenblatt 2006). However, it is desirable that the developed system should be demonstrated to serve the purpose for which it was developed and its performance should be evaluated, thus in addition to the actual process of creating the system itself, there are other considerations. Peffers, Tuunanen, Rothenberger and Chatterjee (2006) discuss six clear and sequenced processes (Figure 2.3). The processes shown in Figure 2.3 can serve very well as a general design science research process model as the authors suggest. Nkwae (2006), in designing a conceptual framework for modelling and analysing peri-urban land problems in Sothorn Africa, followed essentially the same process, refer to Figure 2.4. In fact, the Nkwae conceptual framework language is more natural and therefore provides a better alternative to present a more generic design science research process model. A slight drawback in the Nkwae framework is that it leaves out the communication

component that is noted by (Peppers et al. 2006), assuming perhaps that it should always be part of a research process.

2.5.2 Participatory Information Systems Design

The frameworks in the preceding sections provide general guidelines for developing standard information systems. Such standard information systems designs tend to assume the existence of a formal business entity (Kanungo 2004). Jacobs and Herselman (2006) and Sicat (2005) discuss information systems development methodologies that refer specifically to designing information systems artefacts within rural settings. The former presents developing a business model for a rural telecenter and the latter discusses incorporating fuzzy indigenous knowledge within a GIS in order to support a more locally informed land use plan. These studies are summarized in Figures 2.5 and 2.6. In Figure 2.5, Jacobs and Herselman used interviews, site visits and questionnaires to collect data on the current services of a rural telecenter and to design a related management model for it, they produced a model from which they developed a prototype. In Figure 2.6, Sicat uses fuzzy logic to represent local land use data and to integrate it into a geographic information system.

Although the elicitation of the information system's requirements portrays a form of participation, this is not how the term *participation* is normally applied in development discourse. In the case of Jacobs and Herselman, the telecenter staff is used to provide information which is used to build a model. Although the model is brought back to be evaluated for its appropriateness, the telecenter staff are not really involved in its development. In Sicat's case the community is more involved and is responsible for producing the practical application logic used in land use decisions, but again the formal fuzzy language specification that is required by the program coding process is carried out by the researcher. This apparent expropriation of knowledge and its technical formatting away from the community is a recurring phenomenon in such participation projects. It derives from the community's lack of adequate educational background and knowledge to either participate meaningfully in this process or take it over eventually. The development of information systems in a more participatory context is discussed next.

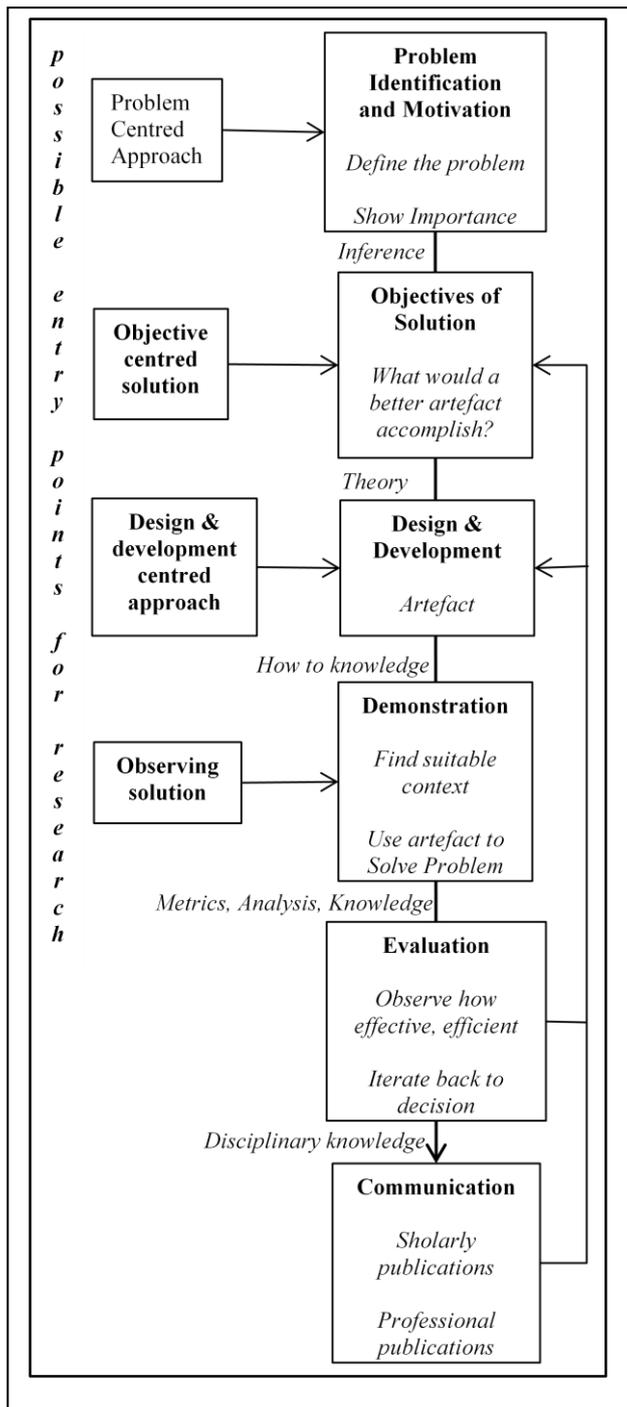


Figure 2.3 Design science research process
 Source: Peffers et al. 2006

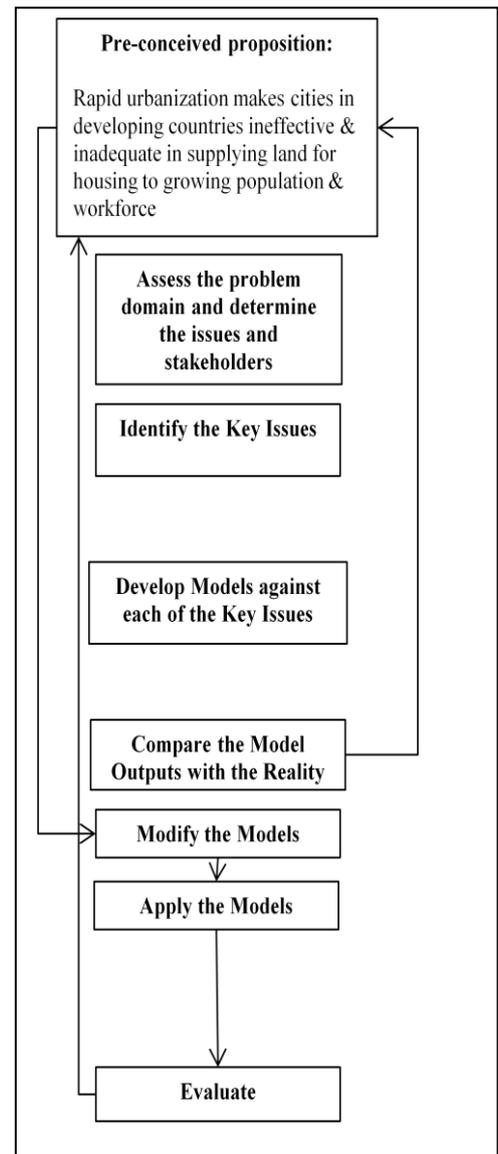


Figure 2.4 Conceptual framework to evaluate peri-urban land tenure and land administration requirements
 Source: Nkwae 2006

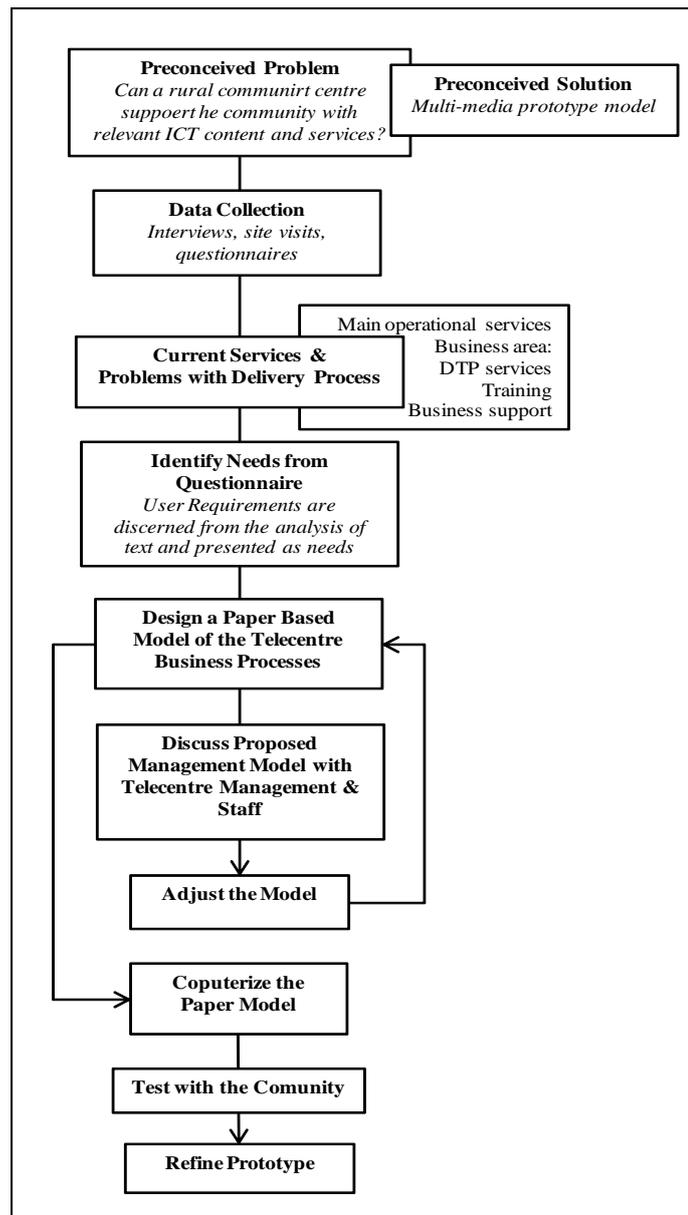


Figure 2.5 Developing a business model for a rural telecenter
Source: Jacobs and Herselman 2006

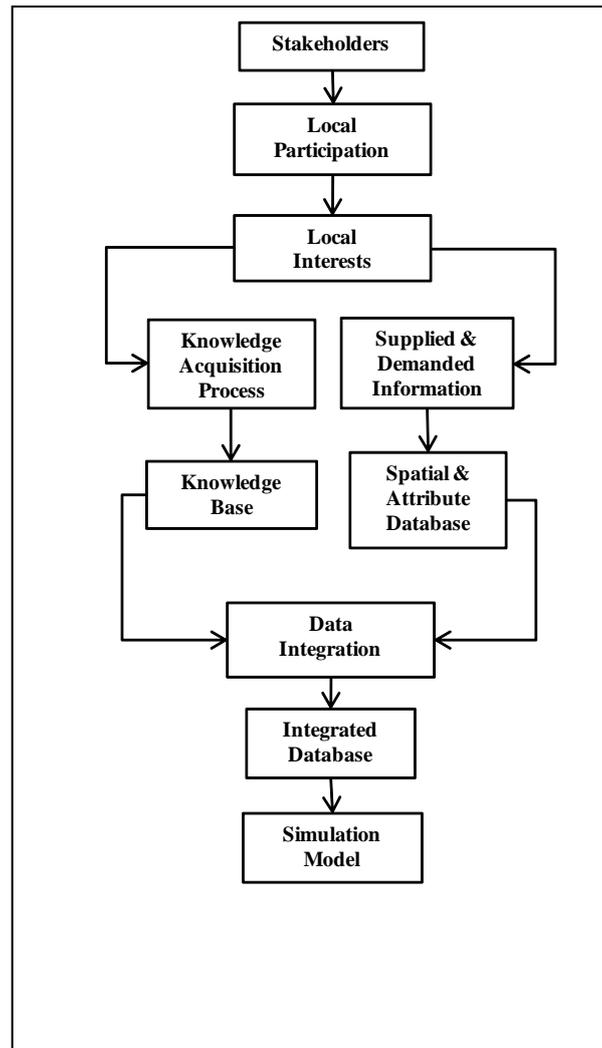


Figure 2.6 Incorporating fuzzy indigenous knowledge within a GIS

Source: Sicat 2005

2.6 The PGIS Intervention Strategy

The PGIS is a special form of information system, which although capable of analysing non geographic data, specializes in analysing geographic information. The information systems research has been noted to be dominated by the positivist approaches (Bharadwaj 2000). This tendency is likely to be a result of the formalization of the deliberative view of human behaviour (Abelson et al. 2003) and a focus on the technological aspects. The thesis suggests that a holistic systems approach provides a better paradigm which can be used to understand a collection of interacting entities as it would be the case in a participation process. These entities would include the information system components and the livelihood activities of a rural community that the PGIS should support. Within a PGIS, the geographic

visualization capabilities of the system can be used to portray the land based activities of the rural community (Corbett and Keller 2005a). In this case, the development of a participatory information system must include not just a wider range of users but must involve these users in the development of the system (Castella, Trung, and Boissau 2005). This necessitates the stressing of the broader social dimensions in which the developed system is subsequently embedded. The following sections introduce the systems concept and its relevance in studying social systems, before discussing the PGIS process, its potential and its limitation.

2.6.1 Geographic Information Systems and Systems Theory

A *system* defines a set of components that work together to produce one or a number of common outputs (Richmond 2005), a GIS is also such a system. However, the inappropriate use of the systems concept has been criticized by a number of authors, for example Bellinger (2004a), warns against a linear input-out model and Jackson (1999) and London (1996) consider the solving of complex problems by dividing them into smaller ones as obscuring the perception of the whole. Nonetheless, systems thinking still forms an organizing principle for a number of processes and is being revisited as the better alternative to reductionism. For example, Senge (2007) discusses the sharing of mental models in learning organizations. It can be observed however, that the breaking of a problem into smaller manageable problems is not necessarily problematic, what causes the problem is the uncoordinated treatment of a common problem solution, whereby the solutions are not brought together in order to constitute the complete solution. System thinking requires the consideration of all actors or objects that are considered part of a problem area. Richmond notes correctly though, that human problems have increasingly required cooperation in their treatment, whereas national and even personal tendencies have fostered independence and isolated action.

The systems theory is a useful tool in problem solving, and GIS, just like other information systems (ISs), represents a system about some other system. It is this character of ISs that make them particularly suited to problem solving because they contain within themselves, the models of the objects, the events and the relationships that exist in the real system (Wand, Storey, and Weber 1999). Thus an understanding of the behaviour of the model system relates to a large extent to an understanding of

the behaviour of the real system. A GIS in particular, has the additional unique property of supporting place based decision making (Longley, Goodchild, and Rhind 2005). This thesis argues that this makes it particularly suited to studying rural livelihoods, which are based on a more direct relationship with the land resources.

2.6.2 Geographic Information Systems and Society

The Geographic Information System (GIS) is one of the instruments that can be used to legitimize the acquisition of knowledge within a rural setting. Since GIS is a computer assisted place based analysis tool, and because most of human activities are geographic (place based) in nature (Burrough, McDonnell, and McDonnell 1998), GIS can play an important role in many community livelihoods related activities. This project aims to extend these concepts in order to devolve the GIS database design concepts into ordinary socio-economic interactions that relate to enhanced community development. This research has incorporated problem structure analysis procedures (Beynon-Davies 2000; Robertson, Sloan, and Bardsley 1990) which can be used by a village development committee (VDC) to clarify its village development role, for example, by specifying village development outputs and suggesting the means to achieve them.

It has been noted that the use of and processes associated with GIS can marginalize local communities and misrepresent their areas ((Nyerges, Jankowski, and Drew 2002; Thompson 2004; Chambers 2006; Georgiadou and Blakemore 2006). Fortunately GIS can also be used to support community empowerment through the development of customized, demand driven user applications, and bringing indigenous knowledge and scientific information together (Crampton 2001; Ghose 2001; Harris and Harrower 2006; McKinnon 2001). Although there are challenges to implementing GIS in the rural areas, there are also opportunities. Many of the concerns raised about GIS (Dyson 2005; Jacobs and Herselman 2006) are associated with the physical technology itself and the paucity of expertise and of the necessary infrastructure in the rural areas, to utilize it effectively. However, when a GIS is implemented and used by a rural community in order to contain both formal and local knowledge and to address the community needs, such as employment and income generation (Thompson 2002), it may increase its relevance, access to the public and introduce cost effectiveness in its application and adoption (Robiglio,

Mala, and Diaw 2003). The GIS can therefore confer benefits to local communities, a point this research is considering. Further, GIS can also be used to support the conservation of and access to information on culture, an issue that has also become another challenge to human development (The World Bank 2007). Thus when the GIS is used within a participatory process, it should address most of the criticisms that are usually labelled against conventional GIS.

2.6.3 Participatory Geographic Information Systems

A participatory geographic information system (PGIS) is concerned with the application of geographic information technology to support participatory problem solving and decision making (Jankowski and Nyerges 2001). Balram and Dragicevic (2006) outline the components of this participatory exercise as experts, the public, networked computers and geographic and non geographic data. Initially, it can be observed that participation in externally initiated development projects referred to participation in actions rather than in decision making. In addition, the success of participation was measured in terms of how it facilitated the successful completion of a project and the achievement of the project objectives (Chess 2000) rather than how it achieved the goals of a participating community (Abelson et al. 2003).

Weiner, Harris, and Craig (2006) outline a wide range of data collection methods that have been used in the participation process, such as digital cartography, sketch mapping, satellite and aerial photograph interpretation, GPS transect walks, mental mapping, spatial multi-media, geovisualization and GIS and virtual GIS. Generally, in such community mapping activities, rural communities have produced both thematic map layers and associated non-spatial data. Robiglio, Mala, and Diaw (2003), discuss a special case where the actual relationships are mapped. These methods offer wide ranging opportunities that can be adapted in order to relate community processes more directly to the actual livelihood activities in order to improve community participation. A recurring observation in the literature on the PGIS strategies is that it is implemented by external agencies (Minang and McCall 2006; Chirowodza et al. 2009). In the Chirowodza study a South African community worked with the University of Kwa-Zulu Natal, Witwatersrand and University of California. In the Minang study a community in Cameroon worked with experts from the Institute of Geo-Information Science and earth Observation in the Netherlands.

What becomes a limitation in such cases is that once the project expires, the association with the community is broken and there are usually no plans for the community's way forward. It is the assumption underpinning this research that the PGIS projects need to be implemented in such a way that their culture adds to the local culture and is appropriated to become part of the community's social and human capital. This can be achieved by linking the PGIS more with the community livelihoods and including a plan for the community's way forward on its own.

2.6.4 The Missing Link in the Standard PGIS Processes

There is often a mismatch between the more specific and immediate community needs and the rather ideological and long term benefits of externally conceived rural development projects (Ferraro 2001). When rural development is defined as improving the community livelihoods at the household level, then a review of reports of past PGIS interventions shows that most activities do not have this objective. The literature on the rural development interventions as carried out by international, national and research initiatives, reveals that most interventions are broadly facilitatory, rather than addressing poverty directly at the household level.

The common objectives in integrating GIS in rural development interventions include the following: a) community mapping (Carton 2005), b) participatory land use planning (Sicat, Carranza, and Nidimolu 2005; McCall 2004b), c) natural resources mapping and management (Martin 1997; McMullan 1989), d) mapping customary land (Weiner and Harris 1999), e) biodiversity conservation (Poole 1995; Natori, Fukui, and Hikasa 2005), community forestry (McCall 2005) and f) integrating traditional ecological knowledge with GIS (Calamia 1999; Robiglio, Mala, and Diaw 2003; Sicat, Carranza, and Nidimolu 2005; McKinnon 2001; Brodnig and Mayer-Schönberger 2000a).

Krek (2005) rightfully refers to rationalized ignorance, a situation whereby the costs incurred in acquiring knowledge outweighs the benefit that derives from acquiring such knowledge. In agreeing with Krek, this thesis argues that the PGIS process should address the needs of the users and that if it does, it can be considered to be a design that is crafted to meet those needs. Once the utility of the PGIS is realized by the community, then it is more likely to be adopted. As an essential component of this thesis much effort has been expended in order to present a more socially

acceptable view of the PGIS process, this what the section on the PGIS frameworks covers.

2.7 The PGIS Frameworks

This research project identifies a PGIS framework as an intervention that has the potential to provide the solution to failing rural community development. The solution is envisaged as filling the knowledge gaps in the capabilities of community members to secure sustainable livelihoods and to identify and use the institutional support infrastructure. The knowledge building should involve input from both local and external experts. Just as important, an essential component of a proposed PGIS framework should be the capability to enable the village community to take advantage of the power of groups and collective action. Finally, the PGIS framework should offer a strategy to manage the village activities. It should provide the safe storage of basic data, requisites and outputs, and facilitate the effective use of the PGIS facility for the benefit of the community. An adequate PGIS framework should therefore be judged according to its potential to meet these requirements.

This section discusses how a PGIS can be planned and implemented in order to maximize the participation and benefit of local communities. Five PGIS frameworks are discussed, the Enhanced Adaptive Structuration Theory (EAST-2), the Spoleto framework (SF), the Geo-Spatial Ontology (GSO), the Participatory Community Design (PCD), and the Integrated Systems for Knowledge Management (ISKM). These frameworks will be judged for their capability to: a) support the acquisition of knowledge, b) identify the support infrastructure, c) organize group work and collective action, d) manage the initiated village activity e) facilitate the community use of the PGIS intervention and f) support integrated knowledge building from the local and external experts.

2.7.1 The Enhanced Adaptive Structuration Theory

The Enhanced Adaptive Structuration Theory (EAST-2) (Jankowski and Nyerges 2001) is a framework that is used to assess the suitability of a data gathering strategy that deploys the GIS tool as a community empowering instrument. The framework is divided into three constructs as shown in Figure 2.6. These cover the convening, process and outcome components. The convening component includes three

subcomponents: a) building the community team and taking into consideration the community system dynamics and its potential biases, b) characterizing the individual or group participants and c) determining what the role of the GIS should be and how its output will support the processes. The process component considers decision making to be a social interaction activity, this should support group activities and collective action. The process component also has three sub-components, how the intervention instrument is appropriated by the community system, how the appropriation is done by the participants and how the GIS influences the appropriation. The last component has two sub-components which relate to the task and social outcomes respectively.

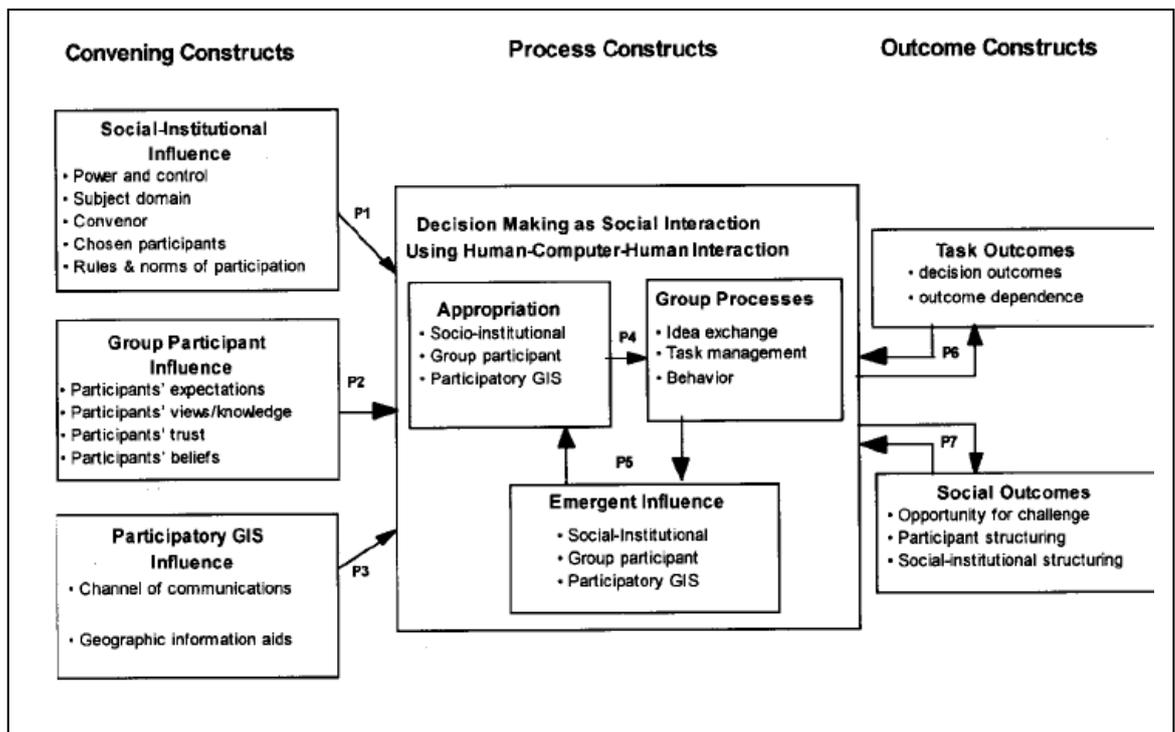


Figure 2.7 The enhanced adaptive Structuration theory
Source: Nyerges, Jankowski and Drew 2002, p8

Overall, the EAST-2 identifies most of the expected components, however it is not explicit about the institutional support structure. It refers to power and control under the social institutional influence component of the convening structure. This focuses on the power relations but is not explicit about the role of the institutions in supporting the community development effort. What this research considers to be a

limitation about the EAST-2 though, is that it does not show the link between the outcomes and the convening constructs, this implies a weak monitoring and evaluation role. The EAST-2 is also silent about the mode of knowledge acquisition although it identifies “idea exchange” at the process construct.

2.7.2 The Spoleto Framework

The Spoleto framework (SF) (Rugg 2001) is used to rationalize the thinking about community planning where geographic information is used. This planning role can be appropriated to plan the support and implementation of community livelihoods. The SF (Figure 2.8) shows that the GIS is positioned between the policy makers and the community, it shows that the GIS facilitates the policy makers in their processes to address the problems that are faced by the individuals in the communities. In this way, the GIS is used to identify and provide information on the problems and their solutions. The GIS may use models to make predictions and it may also provide options that are used to illustrate various scenarios. However, because the GIS often uses a language that is poorly understood by both the policy makers and the community, a geographic information mediator is often required, this identifies the facilitation role which is required to link the technology and the community.

The SF appears to be oversimplified since the communities and the policy makers’ components are usually more complex than they appear on Figure 2.8. Rugg (2001) notes that this simple structure poses problems with the SF. The community development institutions tend to be both the producers and users of the GIS information while the GIS output is used more by the planners than the other stakeholders. Nonetheless, the SF can be noted to emphasize the often recurring concerns about the communities and the policy makers. With regard to the communities, the common concern is that the communities often do not participate fully enough in the GIS operations, whereas it is critical that they do. With regard to the policy makers, the SF places emphasis on the need to recognize the importance of considering the role of policy in evaluating the use of geographic information. This is an important link because where the community members have used policy programs and have developed mapped output such as goat kraals and poultry houses, such map objects can be visualized and thus portray some of the implementations of the policy. However, overall, the SF contains the core components that are required to

rationalize and structure a PGIS framework that is suitable for application in rural communities.

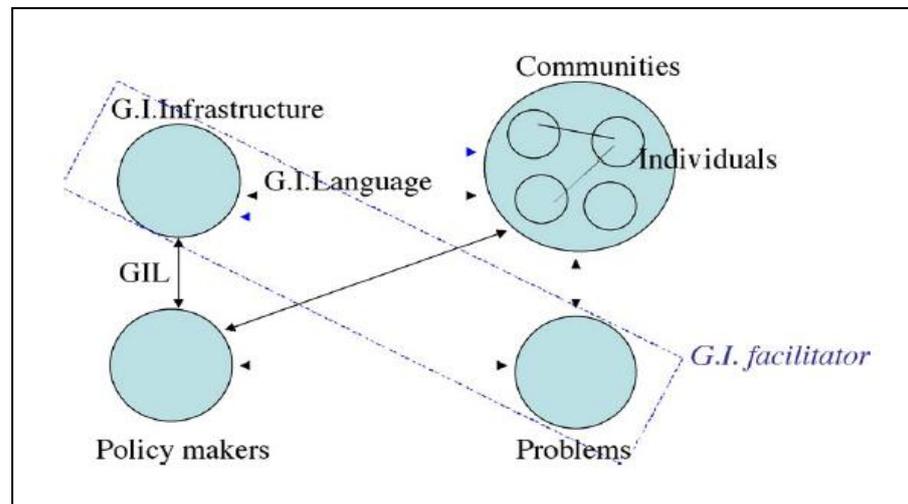


Figure 2.8 The Spoletto framework
Source: Rugg 2001, p76

2.7.3 The Geo-Spatial Ontology

Sieber and Wellen (2007) use the concept of ontology to link a real community activity system and its representation. Ontologies essentially refer to specifications of conceptualizations and present formal descriptions of what exist in real life (Smith 2003; Recker and Indulska 2007). In this way, Sieber and Wellen work towards facilitating the creation of a community supporting framework which is crafted to contain and generate community relevant knowledge (Figure 2.9). This can be interpreted as identifying the community activities component and the IT component that should manage the activities. Within the GIS, ontologies are used to expose the geographic objects and processes embodied within the GIS database. By exposing the objects of a conceptual model, these model objects can be related to the community objects and their attendant attributes, this can be used to verify the legitimacy of the PGIS framework. Such strategies have been developed to assess how truthfully an information system model captures the reality it represents (Recker et al. 2005; Fettke and Loos 2003; Wand, Storey, and Weber 1999). The GSO framework would then dictate that the objects that are included in the information system's logical ontology are derived from the local community's world view as

much as possible. In order for this to happen, a true participatory approach needs to be implemented. Sieber and Wellen note that in the GSO, participation is implemented by obtaining knowledge from the local experts. However, the weakness of this activity may derive from its implication of a unidirectional knowledge extraction from the locals into the IT artefact. Although the GSO outlines a limited number of the required PGIS components, it emphasizes and highlights the need for the input of knowledge from the local experts, which considers the core aspect of a participation process.

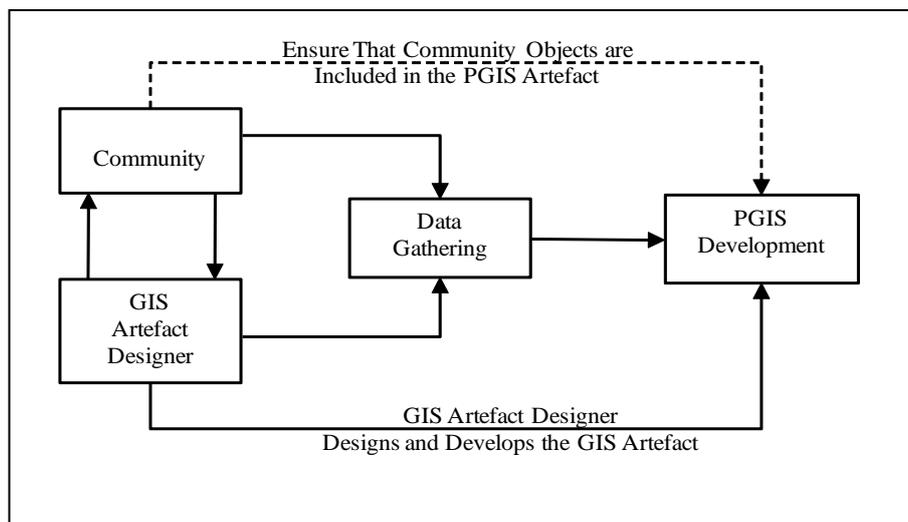


Figure 2.9 The Geo-spatial ontology framework
Source: Sieber and Wellen 2007

2.7.4 The Participatory Community Design Framework

The participatory community design (PCD) framework (Figure 2.10) is intended to facilitate discussions and group decision making and to enable participation in design activities of geographic communities (Pipek et al. 2000b). Figure 2.10 shows a proposed solution model as well as the planning process model. These representations are then placed on the discussion board by the planners so that the different world views and proposed solutions that are presented by the participating community are debated publicly.

The PCD framework is a technologically intensive public participation model and requires computer based models of the design construct as well as the planning process model. It assumes that the public has the capability to not only interface with

these but also to provide their input as well. Such an approach would tend to have limited application within a rural setting where the information communication technology infrastructure and computer literacy are low or absent. However, the availing of a platform that facilitates the free access to participation in community activities should be recognized as a community empowering intervention. The PCD is similar to the argumentation mapping process (Rinner 2006), where map based tools are used to support the input of community contributions to the presented deliberations.

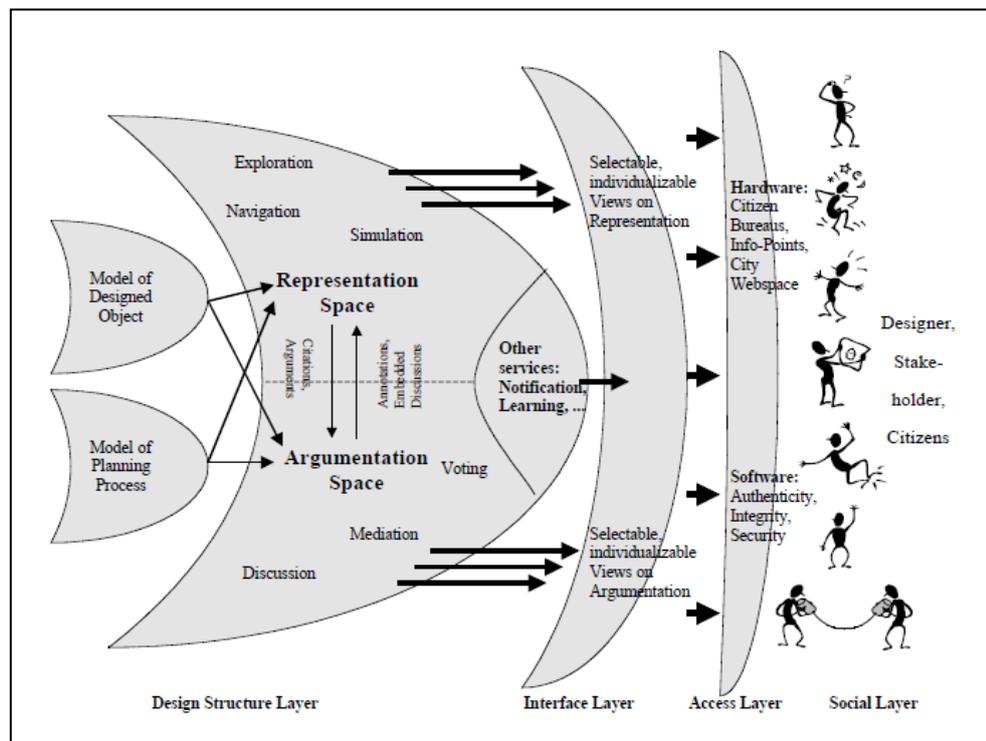


Figure 2.10 The participatory community design framework
Source: Pipek et al. 2000, p364

Within the PCD, planning is defined in order to relate directly to participation and in such a way that it ensures effective participation. In this case planning is considered to be cooperative action among varied stakeholders. Planning is also intended to offer the varied stakeholders the opportunity to present and argue in support of their view points. Lastly, planning is considered to be communicative action wherein the individuals externalize their cognitive models of reality and thus facilitate the inspection of varied view points. Thus, the PCD is very explicit about the knowledge building processes.

Perhaps what is not clear from Figure 2.10 is that the process is not as unidirectional as indicated but rather iterative. Nonetheless this approach ensures that the logical ontology (Sieber and Wellen 2007) which in Figure 2.10 is referred to as the interface layer is derived directly from the community input. This arrangement would support the derivation of a community customized user interface (access layer in the PCD diagram).

2.7.5 The Integrated Systems for Knowledge Management Framework

The integrated systems for knowledge management (ISKM) framework is similar to the EAST-2 framework discussed in Section 2.7.1 although it differs from the EAST-2 framework in that it does not include the output component, it therefore focuses more on the learning. Figure 2.11 shows that it is made up of the two main components. The first component relates to studying the problem and the containing environment and the second component deals with the data gathering and information dissemination. The framework is much more explicit about the need for contracting and collaborative planning before the actual data gathering takes place. The ISKM particularly notes the need for the extension workers to change from the traditional mode of packaging and delivering solutions to recognizing the operations of the social systems, wherein the members of the community are guided by their own rather resilient beliefs and world views.

The ISKM should therefore be useful in supporting the community mobilization, the agenda setting and the participation activities. In this respect, the ISKM places emphasis on the monitoring and evaluation of these activities and points to the need for ongoing evaluation and adjustment of procedures. However, such activities would need to be limited within the relatively time bound confines of a research undertaking. Nonetheless such activities are necessary to increase the probability of achieving the outputs that the community expects.

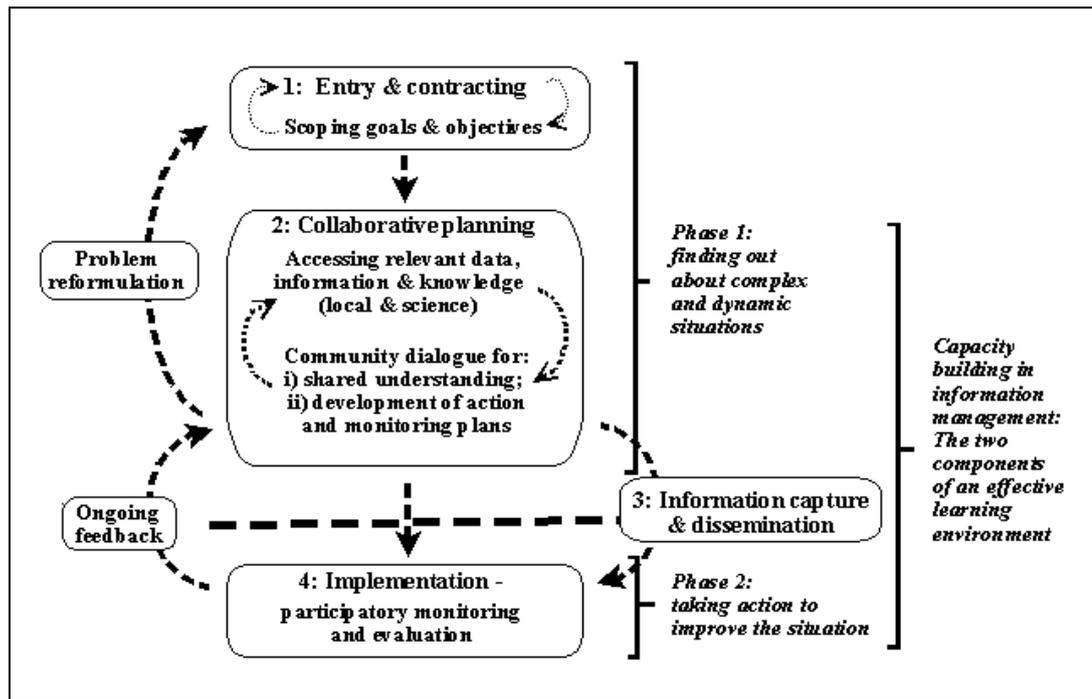


Figure 2.11 The integrated systems for knowledge management
Source: Allen et al. 2001, p5

2.7.6 The Sustainable Livelihoods Framework

In contributing to the theories about the role of information communication technology to development, Duncombe (2006) uses the sustainable livelihoods approach (Brocklesby and Fisher 2003; Carney 1999) which he transforms into information system format in order to study the information needs and uses of rural micro enterprises in Botswana. According to Duncombe's rendition, the sustainable livelihoods approach (SLA) broadly translates into five components: a) the rural community context of vulnerability, which essentially describes the poverty situation and the threats to livelihoods, b) the community member assets which are used as bases to launch development strategies (Mathie and Cunningham 2003), c) the community development institutions which the community members use to implement their development strategies, d) the community members strategies which are eventually adopted to effect livelihoods and e) the outcomes of the deployment of the community livelihood strategies. These concepts are illustrated in Figure 2.12.

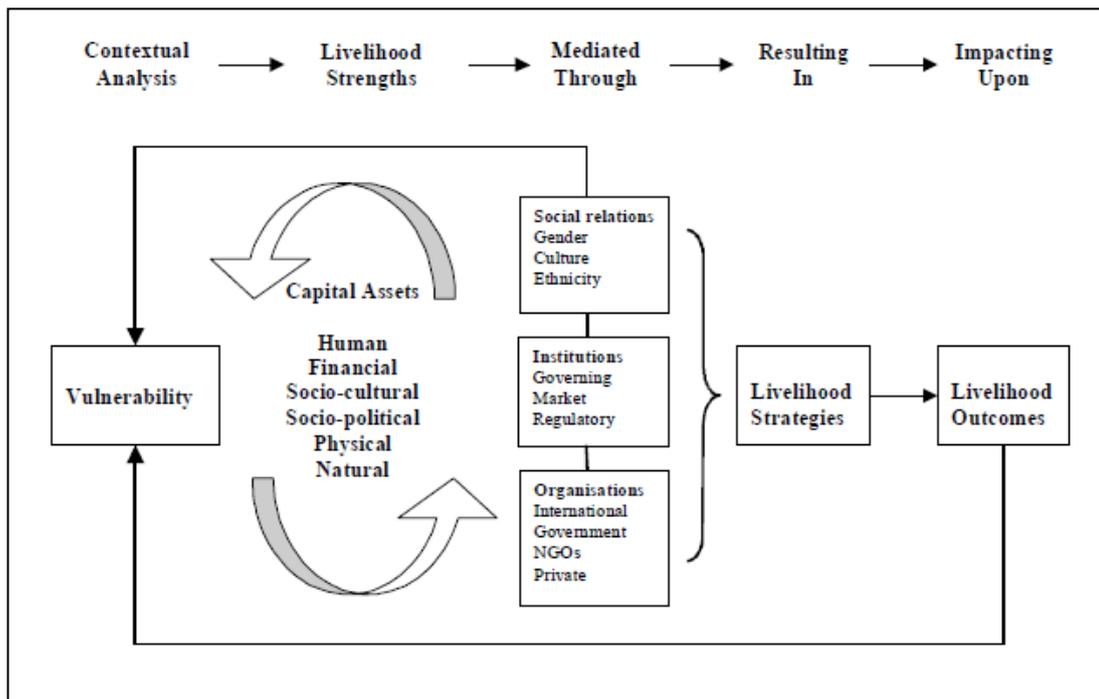


Figure 2.12 Adaptation of the sustainable livelihoods framework (Carney 1999)
 Source: Duncombe 2006, p87)

Duncombe transformed the presentation in Figure 2.12 into an information system format which is shown in Figure 2.13. Although Figure 2.13 appears less clearly structured compared to Figure 2.12, it has become more explicit about the participation, the need to apply the obtained knowledge and to use the community development institutions to attempt to change the vulnerability situation, and to refer back to the vulnerability situation. The referring back to the vulnerability situation identifies the evaluation component of Figure 2.13. More importantly, the cycle refers back to the data elements too, signifying that this component changes and the need for the information base to be kept up to date. Finally, Figure 2.13 identifies the importance of the resources that are needed to implement the livelihood solution plans. Figure 2.13 outlines clearly the essentially PGIS components, these are the threatened community livelihoods which represent the problem situation, the data requirements, the community participation, the produced information and its application and the role of the development institutions.

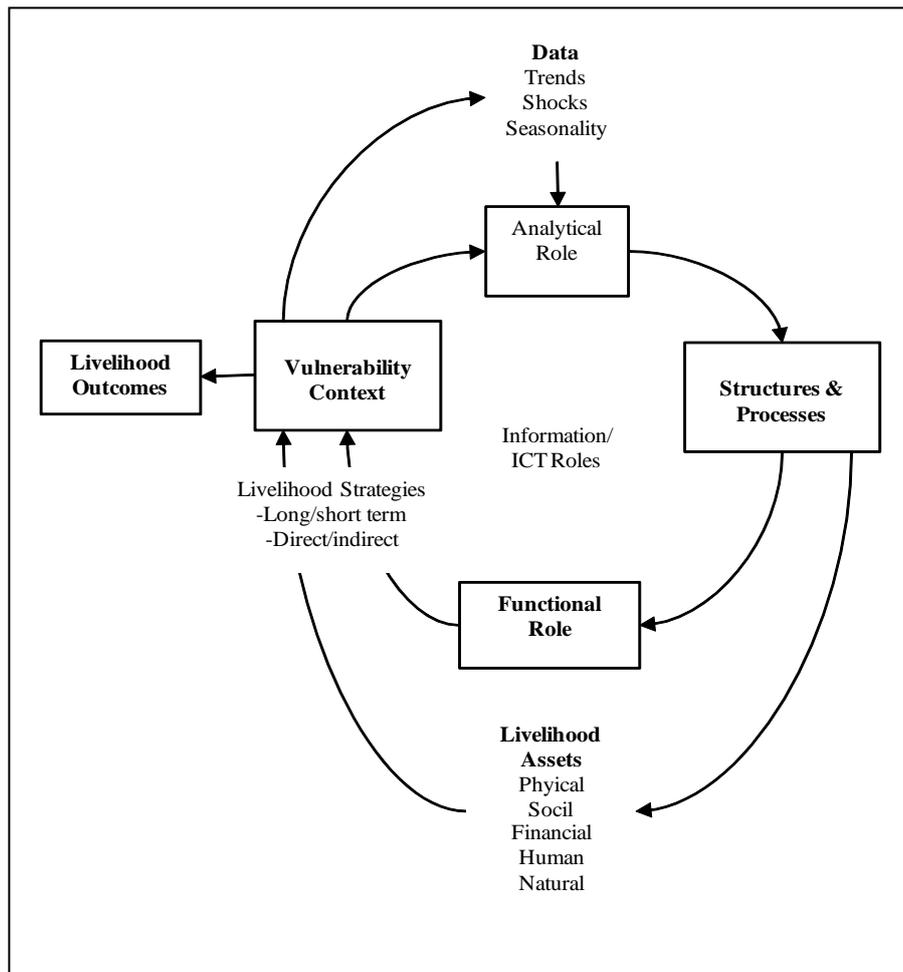


Figure 2.13 The sustainable livelihoods framework in information systems format
Source: Duncombe 2006, p89

2.7.7 The Information Systems for Emancipation Framework

Kanungo (2004) presents a rural information system whose objective is the emancipation of a rural community in India. This concept is similar to the concept which is used in this research, which is to create and construct knowledge in order to support rural community development. The basic difference is that the approach builds and places an information system construct within a community, whereas this research emphasises building the information system construct with the community. The concept of using information for emancipation purposes is similar to the concept of using knowledge to escape from dependence on relying on other people to achieve livelihood objectives. Kanungo had not provided an illustration, the author created an illustration based on the clear implementation steps which were provided, the illustration is shown as Figure 2.14.

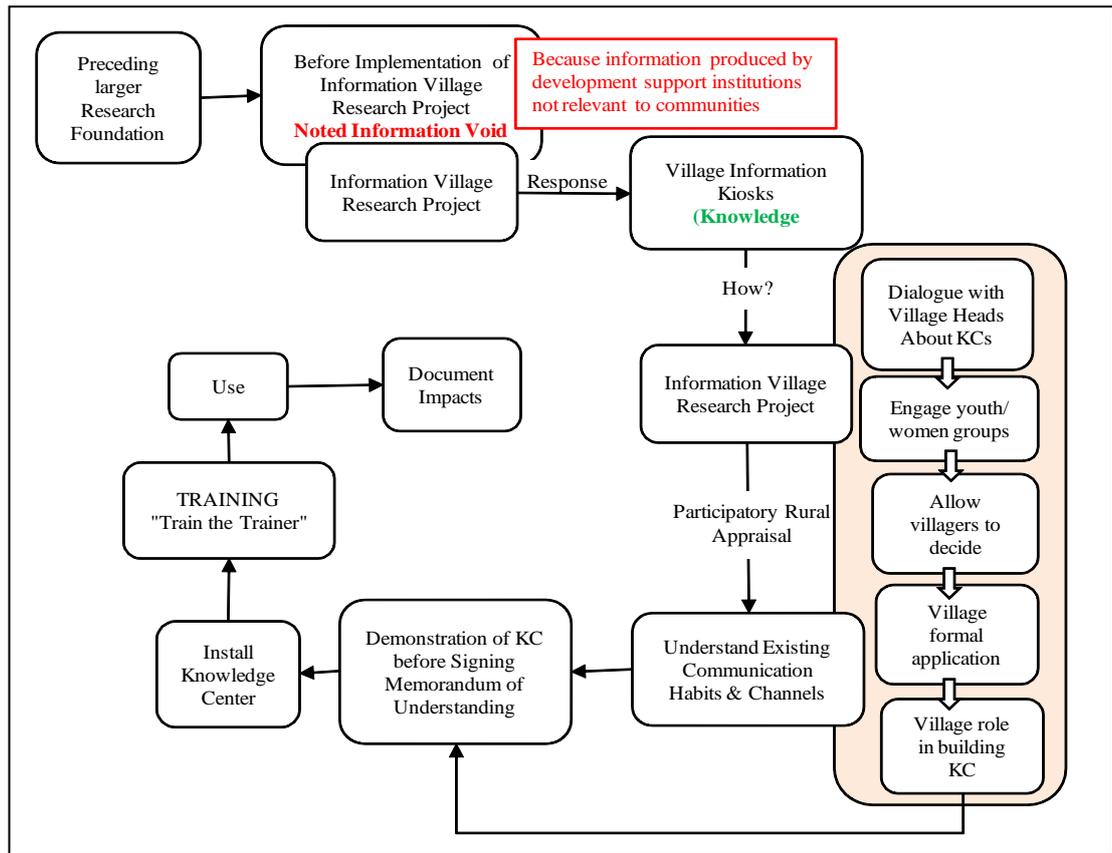


Figure 2.14 Information systems for emancipation
Source: Kanungo 2004

The information system for emancipation (ISE) is made up of seven main constructs, the research project stuff, the village leaders, the community, a knowledge centre (KC), a component of the community that becomes the knowledge centre users, a training element, the use of the KC by the community and the documentation of the impacts. The KC is essentially a personal computer based information outlet that is linked to an internet and radio served central hub. The village requests are processed by the KC, sent to the central hub which provides information which is then relayed back to the community.

With regard to its impact, the ISE induced the execution of projects by the village community. In one project some villagers took up life insurance policies. In another project knowledge on grain prices empowered a villager to bargain for appropriate prices for her harvest. In the third project the villagers were able to use the internet to find an entomologist and a veterinarian to provide technical solutions to serious local problems. The KC was also used to identify a government training program and

credit scheme so that a villager could start a livelihood project, and there were more projects. The ISE becomes effective in achieving its objectives because it seeks to identify the community information needs first, and based on the community livelihoods and the needs, adds value to the information by identifying solutions that use the community information. Also judging from the community projects that resulted from interacting with the KC, it becomes clear that the information is also used backwards to create innovations by introducing new community projects, such as the internet based second hand clothing market which was started by the community.

The discussion of the PGIS frameworks presented so far show that there is a role for a PIS process in rural community development. The various implementations of the frameworks have also indicated a number of shortcomings that result from not focusing on the improvement in the well being of community members. Consequently these strategies are not explicit about strategies that focus on using the PGIS to support community livelihoods. This is the shortcoming that this research project seeks to address. It aims at deploying the PGIS strategy to identify the community livelihoods, their information and knowledge needs and to determine the processes and the resources that are required to develop the livelihoods. Nonetheless, the PGIS strategies offer a menu of components, strategies and processes that can be repackaged in order to create a PGIS framework that addresses rural community development. In this context, the PGIS would be used to improve community livelihoods rather than the physical infrastructure or other broad and long term development goals that do not address the immediate basic needs of the community.

2.8 Managing the Community Knowledge

The participation and learning activity should generate much data, information and knowledge. Therefore there is a need to plan how all this will be captured and archived in way that will facilitate easy retrieval and use by the community members. In considering that rural villages tend to have limited ICT infrastructure and that the computers are often new to such areas, there is need to set up a simple knowledge managing facility. In addition, for the remote rural areas one of the pressing needs is simply access to documents. The documents should include: a) development policies and funding programs, b) technical documents such as manuals

for the various types of community projects (poultry, small stock such as goats or sheep, piggery, tannery and so on), c) “how to” technical charts such as crops or animal management calendars, application procedures etc, d) various types of application forms for land and for government or private funded loans and e) information about sources of information.

There are generally two broad streams of thought with regard to knowledge management, the cognitive and community perspectives (Swan 2001b; Sørensen and Lundh-Snis 2001). In the cognitive perspective knowledge is considered to be something that exists within someone, which means it can be extracted through its externalization, coded, stored and distributed and thus generally made available to other members of an organization or a community. The community perspective posits that knowledge does not exist in ready-made and packaged form, that it is created at social interactions and within specific contexts (Nonaka and Toyama 2003). The latter concept of knowledge is much more natural and is therefore relevant to this research. Some have even considered that knowledge is embodied in people and that knowledge management is equivalent to human resources management (Kang, Morris, and Snell 2007; McDermott 2000a) However, there is still need to capture something in order to have knowledge content to use and share. The closest thing to knowledge is information or even data, so the cognitive or technological perspective of knowledge is still relevant, as long as it is understood that it is only a facilitatory arrangement for the creation of knowledge by people.

Therefore in this research knowledge management is considered to be managing the creation of knowledge in a similar manner to the inquiring systems concept (Courtney, Haynes, and Paradice 2005). In this case people learn from others through participation (Elkjaer 2003) and learn by performing certain tasks (Gorelick, Milton, and April 2004). What will be captured will be the outlines of the knowledge creating objects and concepts. To support this type of knowledge management activity, basic application software that facilitate communication, note making or editing, search and sketching and illustrating will be used. These include Microsoft Office’s Outlook, Excel and Word, knowledge structuring software such as the free CmapTools, and free conceptual modelling software such as Dia. The generalist metaphor (Nanard and Nanard 1993) will be used to effect a mode of interacting with

the KCR that assumes that a user has enough general knowledge and vocabulary to enable effective search for required content in the KCR.

2.9 Integrating Positivist and Interpretive Methods

From the 1980s up to the early 2000s, Kaplan and Duchon (1988) note that most of the IS research used a positivist framework.. In 1991, Orlikowski and Baroudi reviewed 155 articles from five journals and reported 89.7 percent dominance of positivist based papers Orlikowski and Baroudi (1991). Mingers (2001) noted that between 1983 and 1988, 97.0 percent of the IS papers were positivist. Chen and Hirschheim (2004) reviewed 1893 papers between 1991 and 2001, they reported 81.0 percent positivist papers and only 19.0 percent interpretive. Whereas Mingers advises that the research that is tested from different paradigms is more reliable, Smith (2006) notes that the mixing of methods introduces inconsistencies between the researcher’s ontological assumptions and the results obtained. Nonetheless, the method that seemed to be more appropriate is the one based on the triangulation techniques implemented by Mingers (2001) and Lee (1991), these approaches are illustrated below in Figures 2.16 and 2.15 respectively.

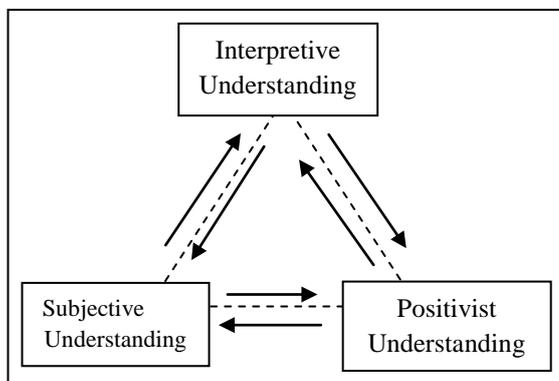


Figure 2.15 The relation between subjective interpretive and positivist world views

Source: Lee 2001

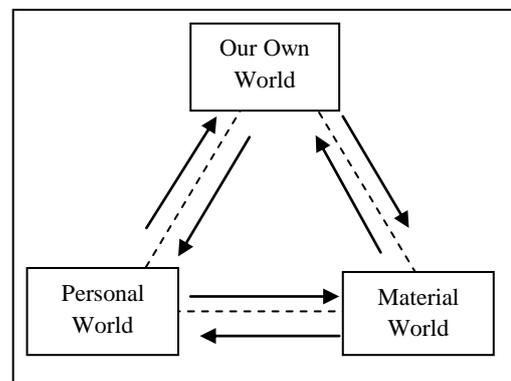


Figure 2.16 The relationship between the personal, social and material world

Source: Mingers 2001

Both of these approaches refer to personal subjective meaning, social meaning and abstracted meaning in different ways. Lee (1991) refers to individually owned subjective understanding, the social meaning as interpretive understanding and the abstracted understanding as positivist understanding. Mingers (2001) refers to the

subjective personal world, the multilayered world composed of multiple meanings from interacting individuals and the objective material world which is independent of human beings, essentially the abstracted positivist world. Both authors note that because of the links between these views of the world, which span both positivist and interpretive worlds, it is possible to work with both interpretive and positivist world views.

2.10 Chapter Summary

This chapter reviewed the concepts that were useful in developing an effective PGIS framework. Starting from the requirement to understand the need for and potential of a participatory process, the chapter presented participation as learning and linked the levels of participation to community empowerment. The concept of learning also dictated the need to understand how humans learnt and in noting the social nature of learning, recognized the appropriateness of adopting a participatory approach. This required the active participation of the community as the holders of knowledge. The use of development theories was deployed in order to understand the thinking behaviour of humans and to use them to understand human motivation, conflict resolution, social learning and self determination.

Having determined the prerequisites for effective participation, the PGIS was checked for its relevance in supporting such participation work. The discussion then moved to how humans solved problems especially the problems relating to the community development. The beliefs, attitudes and behaviours of the participants were then noted to be worthy of consideration as they enabled the understanding of the participants. Since Botswana was the community development problem site, a review of how the country worked with knowledge and specifically how it handled the community development issue was presented. Also, since the main intervention tool was information system a more detailed discussion of information systems development, especially GIS and PGIS were presented, particularly as they related to their application in rural areas. A number of tried PGIS strategies were presented in order to source input to developing a generic PGIS framework which could be used in the rural areas of developing countries.

Seven PGIS frameworks were then presented. Overall, these frameworks covered the following activities, i) convening, ii) process, iii) outcomes, iv) the GIS link between

the policy makers and the community, v) insight into the actual processes of negotiated decision making and vi) the role of community development institutions. The specific character of the IS construct was presented which led to the discussion of the IS conceptual framework. This was followed by a brief discussion on integrating positivist and interpretive approaches. Lastly a tentative discussion on the perceived mode of analyses was presented. The conclusion that was drawn was that despite some limitations of the PGIS intervention, it has the potential to effect a successful community based development strategy. The project site was also noted to contain most of the required PGIS supporting infrastructure.

CHAPTER 3 RESEARCH METHODOLOGY

This chapter presents a proposed plan of activities which were deemed necessary to complete the research successfully. These activities are the conceptualization of the participatory geographic information system (PGIS) intervention strategy, meeting the community and integrating the project, conducting the training, data analysis and developing the knowledge content repository, community feedback workshops and evaluating the PGIS framework. This discussion will be guided by the overview of the research methodology depicted in Figure 3.1. This chapter also introduces the research study site.

3.1 Conceptualization of a PGIS Intervention Strategy

The review of the literature provided insights on the need to develop a participatory and empowering community development strategy. This showed the necessity to acquire more in depth knowledge on the participatory approaches, specifically those which use geographic information systems to support community development activities. A closer inspection of the PGIS frameworks revealed three main intervention constructs, the convening, the processes and the outputs. Based on these main PGIS constructs three field trips were planned, these would cover eight activities. The first field trip would cover the first two activities, which would be the community mobilization and the training. The third activity would be the data processing, analysis and development of the PGIS prototype. The second field trip would cover the fourth, fifth and sixth activities. These would be feedback, the evaluation of the PGIS prototype and the development of the knowledge structures by the community development institutions. The seventh activity would be the final data analysis and review of the PGIS prototype. The third and last field trip would cover the closure of the formal component of the research study, assist with safe data keeping and participating in planning the community's way forward with the PGIS initiative.

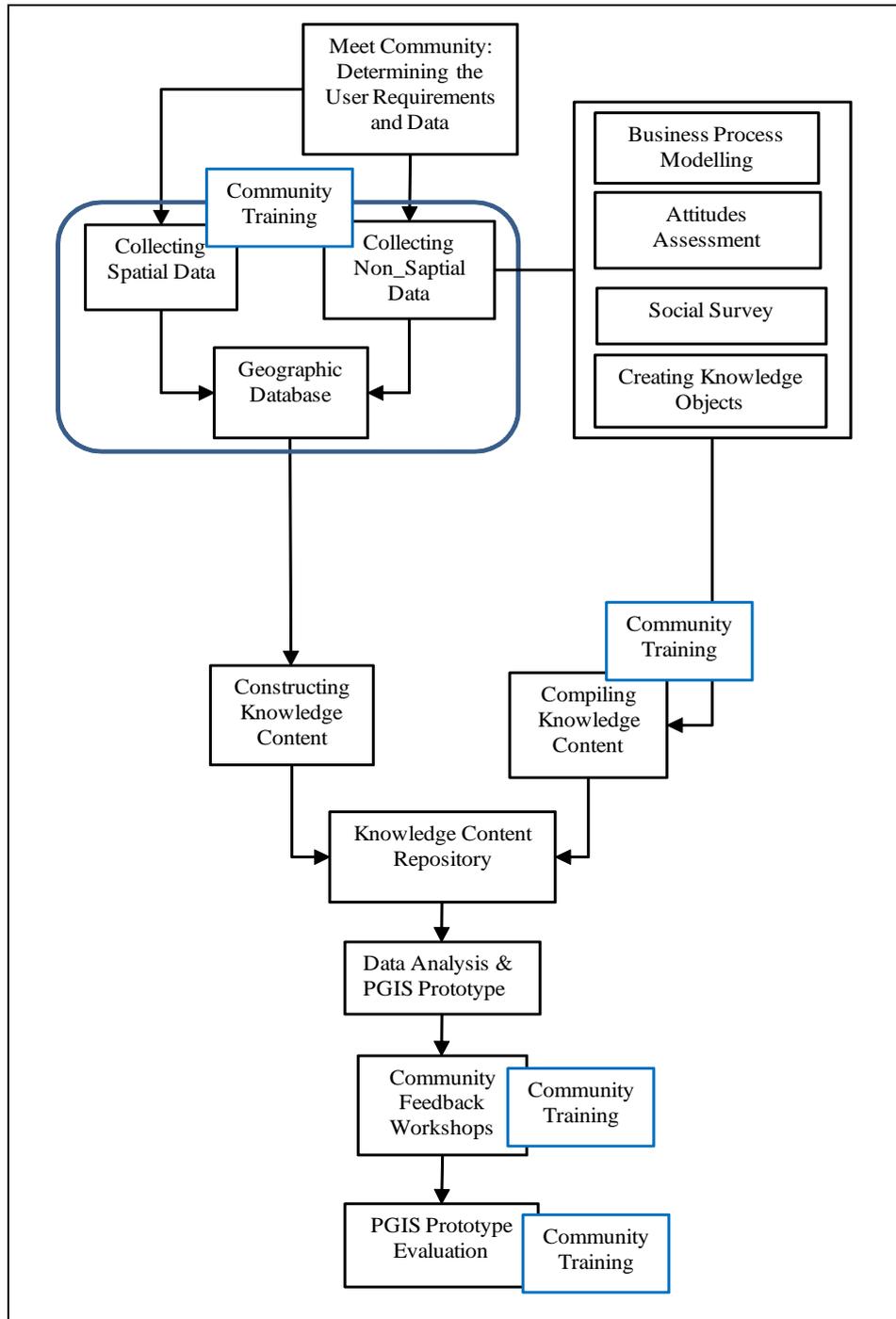


Figure 3.1 The research methodology

3.2 Meet The Community and Integrate the Project

This activity was aimed at ensuring the active participation of the community. It included the recognition of and the preferred involvement of the village leadership. This would involve the village chief and his ward heads, the village development committee (VDC) and the village councillor. The perceived initial tasks included

mutual learning in order to agree on a common view of the community development problem and to develop a common vision of change, securing a convening location, conducting the initial training for the VDC and selecting the village trainees.

A preliminary perception of the problem which had been identified by the researcher as a lack of adequate knowledge about how modern livelihoods are secured, and also the lack of knowledge about and the use of the livelihoods supporting institutional infrastructure, would be discussed and agreed upon. This lack of knowledge is linked with improving the living standards of the community members at the household level. Since the acquisition and use of knowledge was considered to be the basic empowerment component, the intervention strategy should put in place, a tool that the community members could use to acquire knowledge as either individuals or groups. The basic aim would be to build the personal capacity to value knowledge, understand how knowledge is built and for the individuals to become tuned to their constant knowledge constructing consciousness.

The concept of community development as improving the living standards at the household level was to be used to determine the community needs. Considering the rural setting and its poverty situation, Maslow's theory of the hierarchy of needs (Huitt 2004a) would be used to select what would be the most basic needs (Figure 3.2). The envisaged community needs at the household level were perceived to be shelter, clothing, food and health. A theory of human motivation was useful to employ when the poor communities were considered because there was need to understand the apparent acquiescence of the poor, even while they lived under undignified conditions. A theory of motivation attempted to explain how an individual obtains the energy, the drive and the persistence to secure a dignified livelihood. Figure 3.2 outlines the factors which are likely to affect personal achievement and growth within a given social community, and how the need for recognition and respect should form part of the personal drive to self-actualization. Following on the definition of knowledge as applied know how, the basic approach would be to involve the community members in carrying out real tasks so that they could produce the research project outputs and in the process acquire the necessary capabilities. On completion of this involvement, the community members would have learnt how to: a) identify the required knowledge, b) obtain the skills required to gather the data, c) understand the spatial data handling and analysis and d)

organize themselves into the required groups in order to carry out the tasks effectively and efficiently.

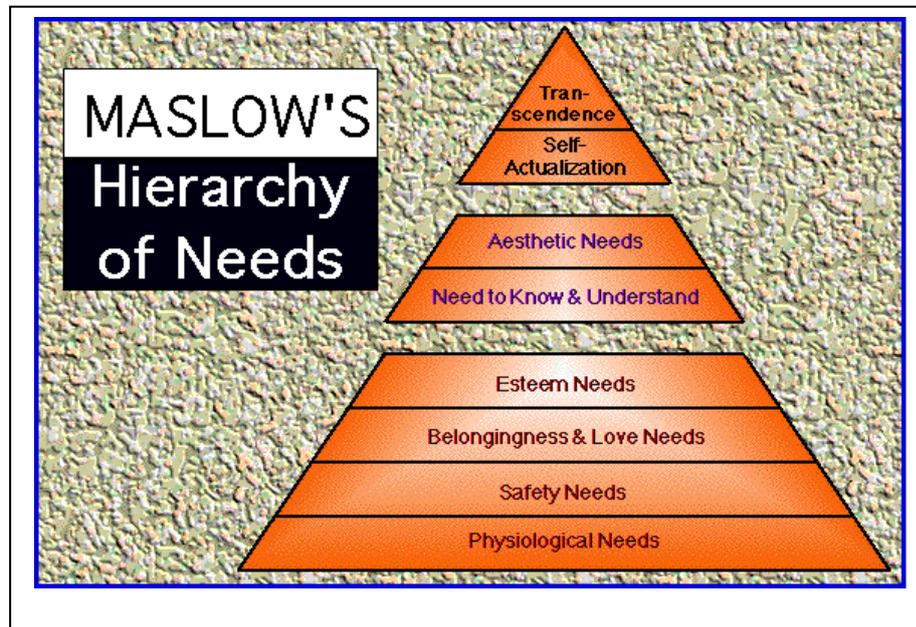


Figure 3.2 Maslow's hierarchy of needs
Source: Huitt 2004, p1

3.3 Community Training

The village training was used to generate the required data and carry out other group decision making processes which were required for the research project. Five main areas of training were aimed at: basic business process modelling and business planning, the compilation of the village map layers, conducting the social survey and administering an attitude scale, the conduct of the feedback workshops and creating the knowledge structures for the varied livelihood activities as envisaged by the village community and the community development institutions.

3.3.1 Business Process Modelling and Business Planning

Section 3.7.8 will show that the businesses created by many Batswana are neither successful nor sustainable. The reasons presented for such failures are lack of business and financial management skills, misappropriation of funds, low presence at the business facility, lack of capability to make business plans and lack of capability to succeed in securing venture capital. Based on these, the plan was to work with a number of village trainees and to simulate the process of planning to start a business.

This was referred to as the business process modelling. This activity would involve the common and basic business planning considerations, such as identifying the project mission, vision, objectives, inputs, processes and outputs. The concept of a computer program development logic would be used to guide this task. This is essentially the basic process model which depicts problem solving as information processing composed of data, process and output. The link to the computer program was intended to rationalize the appropriateness of the computer tool and present it as a problem solving instrument. This would be one way of presenting the computer as a tool in assisting people in their varied tasks. By including the preparation of business plan, this process would also introduce the spatial aspects of a business. These would include the presence of competitors, the customer catchment, the identification of and location of community development support and financial institutions. Thus, this process should also rationalize the need to use a GIS.

3.3.2 The Training on the Mapping of the Village Base Map Data

When community development is defined as improving the living standards at the household level, such a definition clearly identifies the village plot as the logical unit to base the data collection effort. In addition, the business process modelling also identifies the need to recognize the importance of the geographic space in organizing the livelihood activities. Therefore, the training on the GIS based mapping would follow the business process modelling. The GIS based mapping was planned to come before the social survey because it was going to be used to determine the sampling frame.

The village base map data would include the village thematic map layers which were deemed to be the necessary base for supporting a land based knowledge acquisition process. In addition to the village residential plots, the thematic map layers should include the water pipe lines, the electric power lines, the public water points (locally referred to as *public stand pipes*), the village institutions, the livestock watering points and the businesses. The training would involve in-house mapping of the thematic map layers using on screen digitizing of colour aerial photographs. The in-house mapping would be followed by field mapping to plot the thematic layer objects which could not be depicted by the in-house mapping. The field mapping would also be used to check and correct the in-house mapping. An important aspect of the field

mapping would be to add the related basic residential plot data, such as the presence of water or electric power connections, the presence and type of fencing, presence and type of toilet facilities, types of buildings in the plot and the number of people in the household. The field mapping of the residential plots which could not be picked by the in-house mapping would involve improvisation on scaled field sketching. More details on the households data would be provided by the social survey and the attitudes scale.

3.3.3 Training on the Application of GIS to Determine the Sampling Frame.

The power of the GIS as an efficient integrator of data from different sources lies in its capability to link data to spatial objects. This should be possible to demonstrate at the field using the mapped village residential plots and their related basic data. The sampling frame would be based on the type of house that was used as the main house, and the number of people who lived in the household. These two characteristics taken together should indicate the house quality and the room occupancy ratio. Based on previous experience from the project site, it was possible to suggest basic criteria to use in order to select the target households. In this regard, the quality of the houses in a given plot and the number of people in the household should provide sufficient indication of a non-desirable household situation. Botswana's National Policy on Housing (Government of Botswana 2000) was used to provide the guide that a healthy room occupancy ratio was one room to two people and that more than two people per room was an unhealthy situation. Apart from the room occupancy, the type and condition of the house would also be used as an indicator of poor living conditions. Therefore, it should be possible to link the field collected residential plots data to the village plots layer, and to carry out a simple query to identify certain main house types and where the room occupancy ratio was less than 0.5.

3.3.4 The Training on the Social Survey and Attitude Scale

The social survey should be preceded by training on the design and testing of a questionnaire. The mode of administering the questionnaire had to be personal interviews in order to provide the training on conducting such interviews. A draft questionnaire would be used as a base for a participatory design of a final questionnaire. The testing of the questionnaire should provide the initial practice for

the trainees but the main aim of testing the questionnaire would be to assess its completeness, its tone and its effectiveness with regard to eliciting data on the basic needs and other related information. The questionnaire design should present another opportunity to assess the level of understanding of the research project objectives and the whole concept of knowledge for human development. The attitude scale would also be completed from a participatory discussion of a draft, this process would be similar to the development of the questionnaire.

3.3.5 Training on Creating Knowledge Structures

In participatory initiatives there is need to ensure that both local and scientific knowledge are given equal priority ratings. Although the local experts would most likely not need training in expressing their knowledge verbally, there should be need to facilitate the creation of an environment where the participants should become involved in the visualization of the knowledge, so that it could be captured and stored for future use. The training on creating knowledge structures should provide the opportunity to consider the knowledge held by individuals in a more comprehensive manner, and should create the realization that the local community had expertise which the external experts did not have. This activity needs to be part of the process for creating the knowledge content. A knowledge structuring software tool would be used to capture the drafts that will be created at the community workshops which would be convened for this purpose. Part of the training will therefore be on imparting the skills to some of the trainees to use the software.

3.4 Data Analysis and Developing the Knowledge Content Repository

This activity should include three main tasks, developing the geographic database, compiling the knowledge content and designing the user interface and prototype. Field work data would be used to determine the community livelihood needs and the PGIS artefact user needs. Based on these a conceptual data model would be produced, this would be followed by the production of a logical data model. The logical data model would then be implemented to produce the physical geographic database (Peffer et al. 2006; Fidel and Pejtersen 2004b; Fidel and Pejtersen 2004a). The geographic data would also be formatted using specific spatial processes such as feature data set creation, building topology and selecting an appropriate spatial reference. A knowledge repository should be developed to provide an avenue to

source new knowledge, re-construct existing knowledge for specific uses and to simulate the procurement of effective and sustainable livelihoods. Based on the identified community livelihood processes and other expressed specific needs, a GIS interface would be customized to produce a rural community oriented user interface.

3.4.1 Developing the Geographic Database

The geographic database (GDBS) should be constructed to support some of the activities of the community livelihoods, it should be made up of selected thematic map layers and related attribute data. It is anticipated that the village plots should play a central role since it is from these places that the community members plan their activities. Most of the other places, such as the arable lands, the work places, the livestock watering points and the firewood collection points should be linked to the village plots. The attribute data which provides the intelligence to the thematic map layers should be derived from the basic map feature attributes, the social survey, the attitudes and the other data which will be collected from the field. Based on the livelihoods activities which need to be supported, data flow diagramming will be used to determine the processes which should be supported. From the process descriptions, it should be possible to identify the attributes which are required to support the selected processes, and to produce the required tables. The tables would then be related as required to each other and to the thematic map layers they apply to, this should represent the GDBS.

3.4.2 Developing the Knowledge Repository

With regard to developing the knowledge base, this research proposed a simple knowledge repository. This should be a search and retrieve option which would be based on web page hypertext links and simple search options which are available in most standard applications (Windows Explorer, Microsoft Excel, Adobe Acrobat Reader and Microsoft Word). The collaborative work on the tasks should be supported by Microsoft Outlook and the adding of comments to documents which form ongoing discussions. Such an option should be more easily implementable, especially considering a remote and isolated rural community setting. The knowledge acquisition and construction activities would be based mainly on the use of the knowledge repository. This type of knowledge management practice uses the

generalist metaphor (Swan 2001a), which assumes that although the generalists have shallow knowledge on most domains, they nonetheless have a wider view of many domains. This should link well with a traditional setting where people know a little about everything (Hawthorne 2002). In this situation then, an individual should have a vocabulary that is wide enough to support successful searches of knowledge content. It would then be up to the individual to further construct the knowledge and apply it to personal pursuits. However, such activities should be documented and be part of the knowledge use and building process.

3.4.3 Developing a Customized User Interface

This activity relates to setting up a computer interface that the rural community could use to access the information and knowledge. The facility should also be used to assist the community members to simulate livelihood processes and to support the construction of knowledge for specific livelihood projects. The user interface should use data from both the geographic database and the knowledge repository but should mostly work with data, information and knowledge which are linked to map features. The aim here would be to customize a GIS interface, rather than develop a new interface from the start. The basic operations which should be anticipated include adding basic content to the GDBS and the KCR, searching and retrieving content and creating simulations. To support content input and retrieval, the data should be organized into thematic folders such as the research literature, knowledge objects, government development policies and other policies, project support programs from both government and other sources and expert profiles and so on.

3.5 The Community Feedback Workshops

A second field work would be conducted to provide feedback to the community. The feedback should be conducted through village workshops in order to continue the participatory process. This should be an opportunity for some of the village community members to interface directly with the project rather than just as the providers of data in the questionnaires or the attitude scale. This should also be the opportunity to capture the voices of the community and for this reason, the workshops should be held at the *kgotla* (*public meeting place*). The intimidatory nature that the *kgotla* holds for some of the community members should be planned for, so that all community members are facilitated to provide feedback on the

information they would have provided. The feedback should be planned around the PGIS framework components and should include the leadership and convening constructs, the facilitation, the processes, the development of a knowledge management facility, the role of government and the outputs.

3.6 Evaluating the PGIS Framework

The evaluation should assess the involvement of the community at all components of the PGIS framework. Specifically, the evaluation should involve the assessment of each component with regard to the level of collective participation, the level of individual capabilities attained and therefore the level of individual empowerment. Finally, the evaluation should assess the implication of the levels of participation and empowerment on the sustainability of the PGIS framework components. Therefore, the presentation of the results and their analysis should pay particular attention to the implications of the levels of participation and empowerment of each PGIS framework component, so that ultimately the overall sustainability of the PGIS process should be derived from a synthesis of the participation and empowerment levels of the PGIS framework components.

A subjective and interpretive system would be used to produce numerical ranks of the implications of the levels of participation. These numeric ranking would be used to assess the level of collective participation which would have been attained using the ladder of empowerment. Based on the output expected for each component, it should be possible to indicate which level of participation had been obtained. The level of participation would be derived from the participation ladder and would be assessed as non participation, tokenism or empowerment. The assessment of the level of capability attained at the individual level would be judged by assessing the likelihood of that skill to support action, such a capability likelihood options list should not contain many options in order to provide more realistic estimates, only three options should be suggested, these are: a) skill acquired will not be sufficient to support action, b) skill acquired may support action and c) the skill acquired should support action.

3.7 Introduction to the Study Area

Chapter two discussed the various knowledge requisites, concepts and strategies that the village community members need to acquire in order to develop individual livelihood securing capabilities and skills. It also discussed the community's need to develop the capability to work collectively in order to achieve community development. This section investigates whether Tshane village has the infrastructural foundation that is needed to support the successful implementation of a PGIS process. After introducing the study area more detail is presented on a number of issues. First to be discussed are local leadership and community mobilization structures, the organizational structures to support learning and the village facilitation services. This is followed by a discussion of the community attitudes as they relate to the base used by the community for knowledge construction. The community development support process is then presented which includes an overview of the rural development institutions and the policy development process. The fourth issue covers the ICT and knowledge management support in Tshane and the last issue discusses the Botswana business environment.

3.7.1 Location of the Study Area

Tshane village is located in the Kgalagadi (Kalahari) district which is in the western and desert part of Botswana. It is 500 km from Gaborone, the capital city of Botswana and over 200 km from the nearest urban centre. It is flanked by a number of ranches on its northern, north eastern, eastern and south eastern sides (Figure 3.3). The ranches originate from rural development initiatives. These ranches include: a) the private tribal grazing land policy (TGLP) ranches which were introduced as a range management strategy in 1975, b) the remote area dwellers (RAD) ranches which were introduced to serve and support mainly the Basarwa tribe, c) the artificial insemination ranches which were introduced to support the livestock sector and to assist Botswana to improve their breeding stock, d) communal first development area (CFDA) ranches, these were used as part of one of the government's trial rural development strategies where the goal was to concentrate the development activity in one area, so that it could serve as a growth centre which would then serve the surrounding areas.

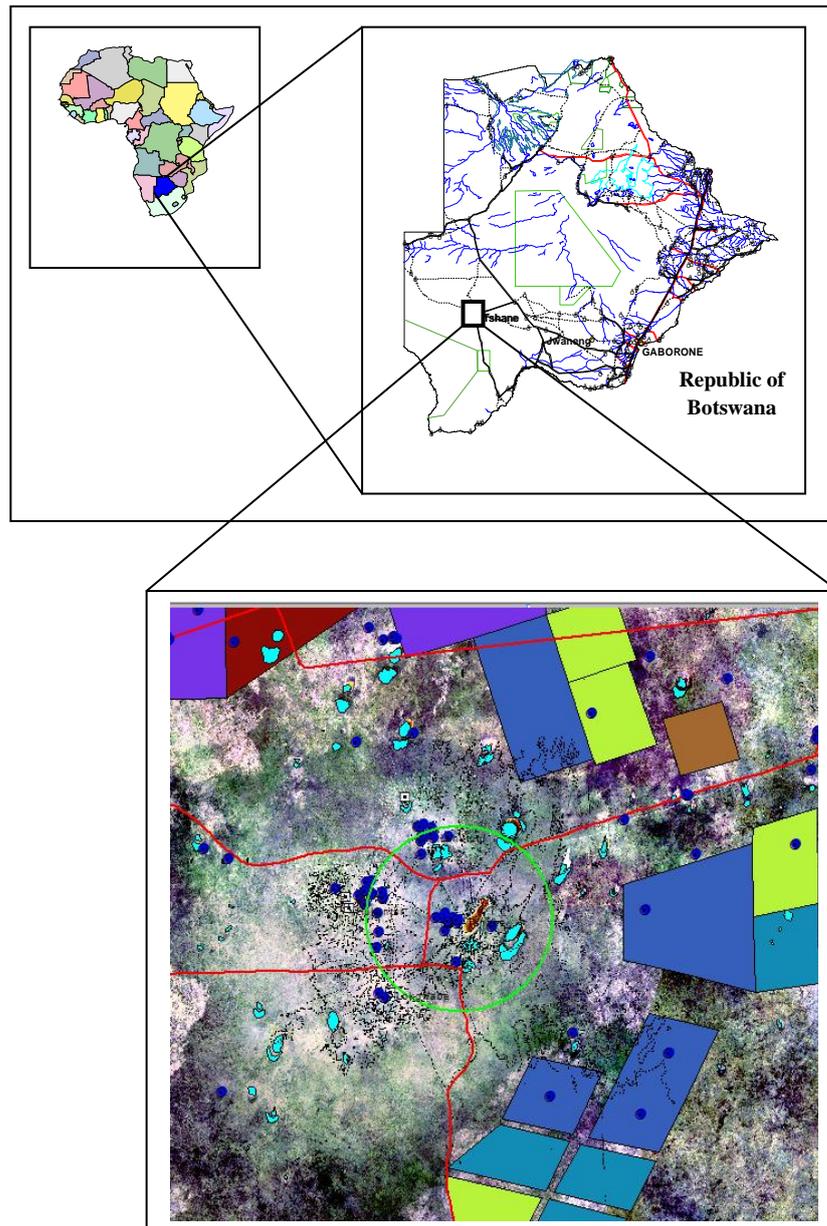


Figure 3.3 Location of study area

3.7.2 The Local Leadership and Community Mobilization Structures

Section 2.3.6 discussed the importance of the community leaders and power structures in mobilizing the community development work. In Tshane village as in most of the official villages, the leadership structure is composed of the village chief, who is head of the tribal administration (TA), the ward heads, the village development committee (VDC) and the village councillor. The village meets at a public meeting place called the “*kgotla*” for its community related activities. The traditional structure of the *kgotla* is a semi-circular open courtyard constructed of

wooden blocks (Figure 3.4). The current kgotla design is a hall-like structure, and what used to be the traditional kgotla structure has been extended into an enclosure and now serves as the kgotla fence, this is also shown in Figure 3.4. However, the village meeting place at the village ward level still retains the traditional kgotla structure. The VDC is supervised by a village based social and community development (S&CD) office which is part of the District Council (DC). There is also a village extension team (VET) which is made up of all the village development institutions. The VET coordinates the village development activities. There are other village institutions which can be used to assist in mobilizing the community, these include, the farmers committee, the parents teacher association, the village health committee, the youth group and various church committees.



Figure 3.4 The Traditional kgotla (left) and the current kgotla structure (right)
Source: Botswana National Atlas 2000 & Field work 2007

Before the 1972/73 financial year when Botswana attained diamonds-based economic independence, the kgotla was used to facilitate and coordinate the village development activities (Taylor 2002). In pursuit of rural development the government has now effectively extended its influence into the rural areas. Currently the Tribal Administration is employed by government through the District Council and now the kgotla serves as one of the four main media through which the government communicates with the local community. The other three avenues that the government uses to maintain the link with the rural community are the District Council (DC) which is responsible for the main rural development task, the District Administration, which is the main government administration institution at the local level and the Land Board (LB), which is responsible for the allocation and administration of the tribal land.

3.7.3 Organizational Structures to Support Learning.

Tshane village as a rural environ still follows a traditional lifestyle because most of the livelihoods are based on the land resource. Correspondingly, most of the learning occurs within the everyday social relations of the village rather than within any elaborate set of formal institutions. However, with regard to such formal education structures, Tshane village has one primary school. The nearest junior secondary school is 13 km away in Hukuntsi village, and the nearest senior secondary school is 106 km away in Kang village. In addition, some of the community development institutions do provide formal short courses, especially for those members of the community who intend to start or have been supported to undertake particular livelihood projects such as poultry or goat rearing among others. With regard to supporting a computer facilitated community development intervention, there are four possible venues which have access to electricity, the police service facility, the prison services facility, the tribal administration offices and one of the class rooms at Tshane Primary School (TPS).

Tshane village is one of four villages that are within a 13 km distance from one another (Figure 3.5). They are sometimes referred to collectively as the *Matsheng Villages*, which means *the pan villages* because each is located near a pan. The numerous little areas which are shown in Figure 3.5 are the arable lands and the dashed lines are the roads and tracks. Although Tshane village is the oldest of the four villages, it is currently the least developed. When Hukuntsi became the political sub-district headquarters, most of the development infrastructure was established there. The DC, the DA, the LB and most of the government extension institutions are located in Hukuntsi. Consequently, any livelihood based community development intervention, such as the PGIS process has to consider Tshane village's disadvantageous position with regard to the availability of the business support infrastructure and the customer base. Tshane links with the DC through the TA and the S&CD officer. It links with the DA through village based government institutions such as the agricultural demonstrator and the livestock advisory centre and finally it links with the LB through the ward based land overseers. Thus, apart from the village based facilities, Tshane village also has access to assistance at the Hukuntsi offices.

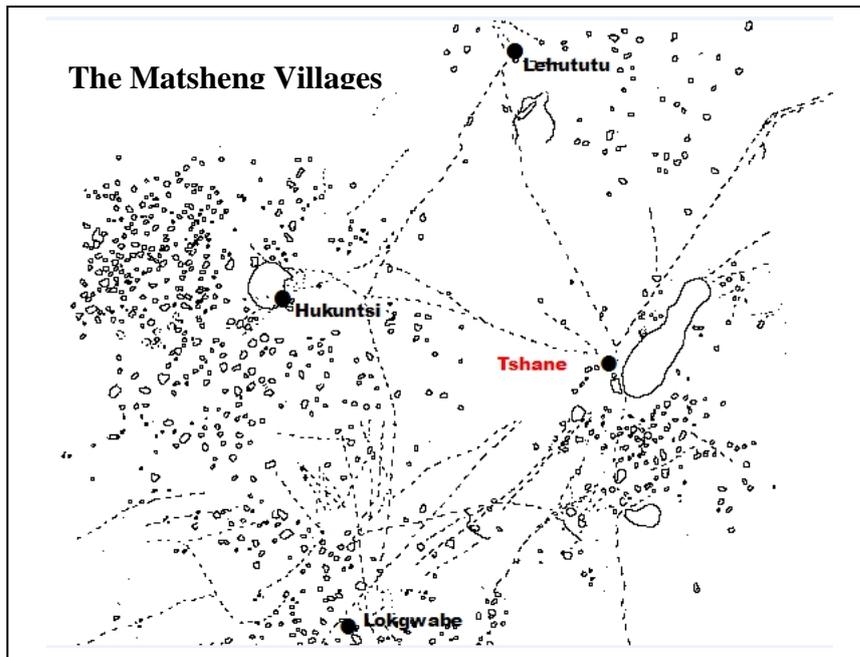


Figure 3.5 The Matsheng villages

3.7.4 The Facilitation Services

There are four main local government institutions which provide the facilitation services at various levels. These are the District Council (DC), the District Administration (DA), the Land Board (LB) and the village based Tribal Administration. In addition two other village based institutions should be able to provide the facilitation services. These are Social and Community Development office and the Village Extension Team (VET). Tshane village has access to facilitation services from all these bodies. For example, the procedure for introducing the research projects to the village is carried out through the DA office. The DC facilitates access to social welfare services through a village based social and community development officer. The LB works through village based land overseers. At the village level, the VDC and the village community are facilitated in their various activities by the VET and the development institutions in the village. Through the village based development institutions, the village has access to other external development institutions.

3.7.5 The Institutions and Attitudes as the Bases for Knowledge Construction.

Human knowledge is derived from the social system, and the meanings and values therefore derive from a given community's culture. The culture in turn is based on the institutional structures that the community creates, these structures are also used

as an interaction medium (Nyerges, Jankowski, and Drew 2002). The institutions are therefore important in understanding the community's knowledge base, its attitudes and hence its behaviours. The development of the prevailing attitudes and the related institutions is discussed within three periods: a) before and during the colonial period (pre 1885-1966), b) the early independence period (1966-1970) and c) the post-diamonds period (1972/73-present).

3.7.5 (a) Pre-1885 - 1966

Before and during the colonial period, each district in Botswana was administered independently by a district chief. Each village was headed by a village chief who was assisted by the ward heads (Bar-On and Prinsen 1999). Human development was organized around and implemented by the chief (Hope and Edge 1996). The livelihoods which were based on rain fed arable farming, livestock rearing and hunting and gathering were facilitated but were largely individual or household responsibilities (Mogalakwe 2006). Formal education was not a priority (Maipose 2008), was carried out largely by the missionaries and was focused mainly on primary education. It can be concluded from this that the concept of formal education was not really understood essentially because it bore no relevance to the traditional lifestyles. In Botswana international development had not been experienced at this time and the government had no resources with which to undertake rural development as it is undertaken in its current form. The spirit of self-reliance was strong simply because there was no other option, it was a way of life.

3.7.5 (b) Early Period of Independence

The main pre-occupation in Botswana immediately after the gaining independence in 1966 was the drive to create a nation state (Government Of Botswana 1966). This process began the intrusion into and control of local communities by the central government (Tordoff 1988). Four local government structures were created, the District Administration (DA), the District Councils (DC), the Land Boards (LB) and the Tribal Administration (TA) (Monagen 2006). In addition, the village development committees (VDCs) were established at the village level, the district development committees (DDCs) were established at the DA level and a number of community development institutions (CDIs) were introduced into the rural areas to provide development oriented extension services. Consequently, the DAs, the DCs,

the LBs, the DDCs and the VDCs all took different responsibilities which were initially performed by the chief, thus diminishing his power greatly and diverting allegiance from him to these other local government institutions (Bar-On and Prinsen 1999). However, the village chief remains a much more real village institution, and as the convener of the *kgotla* which the central government uses to communicate with the villagers, may or may not contribute positively to rural development initiatives.

Overall, during this period, although the rural communities' allegiances were altered, the means of livelihood remained unchanged. The improvements in living standards still relied on individual effort. The country still did not have enough funds to run the economy. However, the attitudes to traditional livelihoods must have begun to change during this period, because the hard and tedious traditional livelihoods which were based on livestock rearing and arable farming became supplemented by comparatively easier lives which were based on salaried employment. The attitude to education also changed as formal education came to be linked to livelihoods. Education then assumed meaning, its symbol, the paper certificate ensured an individual a job in the civil service, more so since at the beginning of a newly established government, there were many job vacancies.

3.7.5 (c) 3 The Post-Diamonds Period (1972/73)

Although the diamonds were discovered at the end of 1969, it was not until the 1972/73 financial year, that the generated revenue exceeded the expenditure. This period represents one in which the government had enough resources to finance many more local initiatives (Danevad 1993). During this period not only did the value of education become much more clearer, other interventions were introduced. First, the international development intervention could be implemented. Secondly, the welfare system was also introduced, initially as a drought relief scheme but now it has become a permanent labour intensive scheme, which is used as a source of employment for the rural population. Botswana's main rural development strategy still translates into the building of the physical infrastructure (Mogalakwe 2006). Ultimately, the enhanced presence of the central government in the rural areas generated within the local people certain understandings with regard to the meaning of development, the role of government and the role of the village community. To

the community, development meant the building of the physical infrastructure and the government's role was to provide employment or welfare. The role of the community was to expect these from government and do relatively little in return. These understandings need to be considered when human development interventions are being implemented.

3.7.5 (d) The Attitudes Generated by the Institutional Structures

Seven main attitudes have been deduced from the preceding sections. First, when the allegiance of the community was drawn away from the chief, and he was no longer the locus of activities in the village, his loss of power induced an attitude of less respect from the community. The consequence to the community has been that there was no longer the guidance and the sense of community that existed when the chief was the locus of the community's identity. In addition, the introduction of the traditional leaders allowance has turned chiefs into government officials on a salary. This has drawn their attention away from the concern with the welfare of the community under their care.

Second, education became perceived as the entity that provided a certificate that was used to obtain a job, this attitude still persists today. The content of the education itself is not viewed critically. The focus is on passing the examination, and not on the acquisition of practical skills. Consequently, when the students do not pass the examination, life seems to offer no other livelihood options. Third, rural development has come to mean the development of the physical infrastructure rather than human development. The result of this is that this form of rural development does not provide an adequate livelihood supporting infrastructure. In addition, the lack of enhanced economic activities does not provide enough proof of the inadequacy of the rural development system to support the initiation of productive local economic activities.

The fourth attitude relates to the effect of formal employment on local livelihoods. Essentially, the availability of formal employment has meant that traditional livelihoods are no longer viewed as important. The consequence of this is that such traditional livelihoods which could provide a better opportunity to improve the living standards, are being ignored because they are given a lower rating and priority, compared to formal employment. Such a reaction develops from giving money a

higher rating than the physical assets which are already owned by the community. A fifth point to note is that formal employment, where one becomes an employee detracts from the realization that the economic assets are used to produce money, since a salary is viewed to be the entity that produced the money. The result is that the money has become important in its own right, a tendency which is now reflected in the national pre-occupation with money. The people now fail to realize that livelihoods that are based on a salary and money are really poverty in disguise as when these are taken away, people fell directly into poverty.

The sixth attitude relates to the influence of the welfare system, because the welfare is sourced from taxing the working members of the population. Since many people in the rural areas are not employed, a misconception has developed, whereby the welfare some people received was perceived to come from the government. The government was then misconstrued as the entity with unlimited supplies that should be given to the people for free. As a result the government was expected to freely provide not only welfare but education, employment, housing and a host of other requisites that the people should be providing for themselves.

The seventh attitude can be seen as a disruptive effect of influences of technology and modernity. In brief wants have become more important than needs. This is contrary to the rules of accumulation whereby satisfaction of the immediate wants is consciously postponed as a basic strategy to accumulate wealth. The consequence of this was that the resources that many rural individuals procure, were not used to their benefit. In summary recognition of these attitudes is essential to a successful community development program.

3.7.6 The Community Development Support Process

This section covers an overview of the rural development institutions, and the policy development process. Its basic aim is to indicate the lack of engagement by the local community in the activities of the community development institutions and in the policy formulation process.

3.7.6 (a) Overview of the Rural Development Institutions

An overview of the main rural development institutions is presented in Figure 3.6. The main message which is being communicated is that the rules which operate in

this social system create output that does not support rural community development adequately. This situation exists because the local community lacks basic knowledge (Hope and Edge 1996) and uses general knowledge (Bransford, Brown, and R.R. Cocking 2004) to make livelihood decisions. The bulk of the decision making is made by the central government. Generally, the citizens are expected to participate in the economic activities of the central government. The logic of this is that the involvement in the national economic system in turn facilitates the government to support the livelihood activities of the community (Makgala 2004).

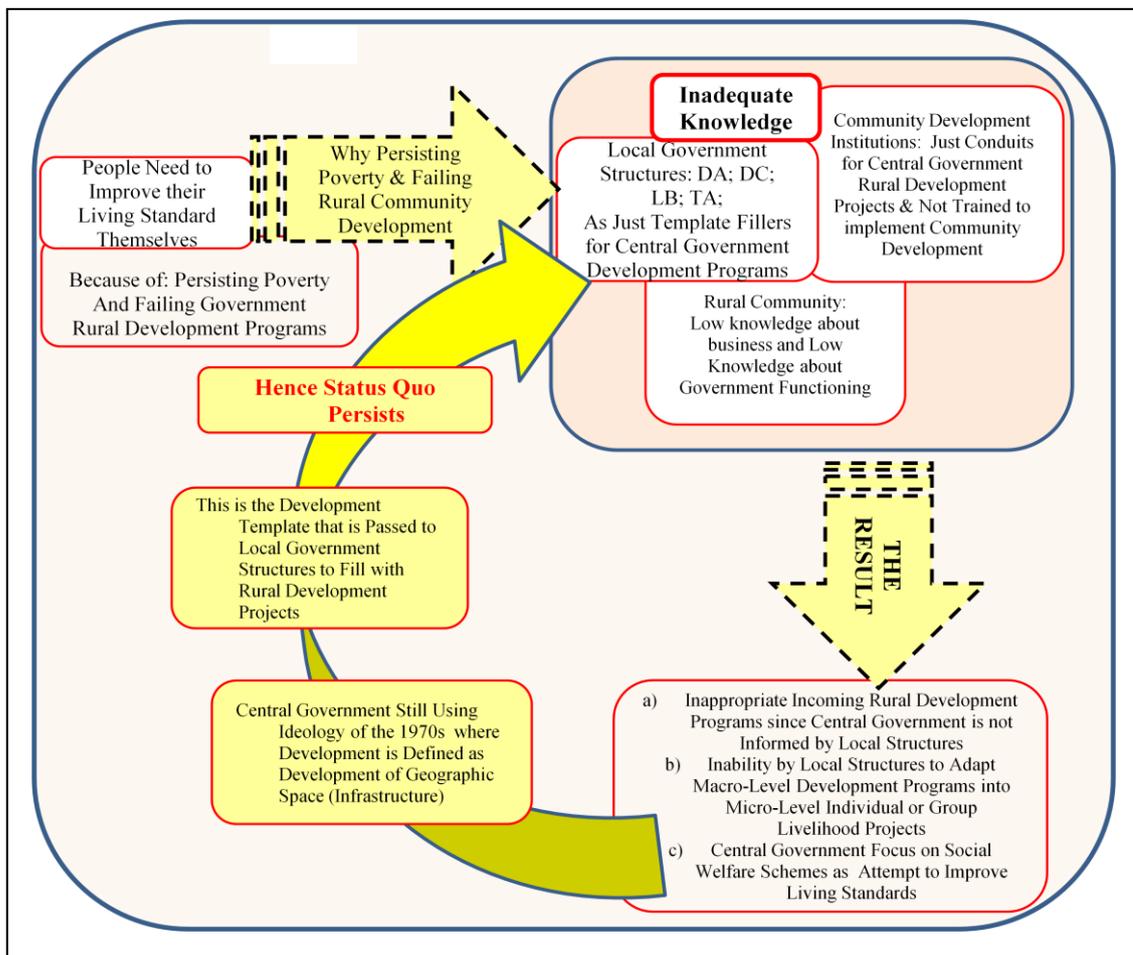


Figure 3.6 Rural development process and institutions in Botswana

It becomes important therefore, that the community participation is effective enough to impart empowering knowledge. This should enable the community to articulate its needs and thus enhance the probability of influencing the development policies to meet those needs. At the village level, this participation in the policy formulation

process is assumed to occur through the traditional public meeting forum (Leith 2006; Monagen 2006). However, this assumption needs to be revised.

A number of authors have pointed out that not all the community members are free to speak at the village *kgotla* meeting (Martin 2008; Lewis 2006; Mompati and Prinsen 2000). In addition, many people do not even attend the *kgotla* meeting anymore. Thus on many occasions, the *kgotla* meeting serve largely as quick legitimacy visits. In most cases, the major decisions are made before the *kgotla* meeting and after, refer to Figure 3.7 which shows two views of this process by Lewis (2006) and Hope and Somolekae (1996). In both the Lewis and Hope and Somolekae illustrations there are higher level consultations before and after the *kgotla* meetings. The flows of activities are towards and away from the *kgotla* system, there are no feedback mechanisms. After the *kgotla* meetings the policies are formulated and the community does not get the chance to review the final decisions before they are implemented into policies.

Consequently, the villagers are informed about issues rather than being consulted to debate about and contribute to the issues. Often, a new issue is presented for the first time at the *kgotla*, and after a lengthy presentation of what was likely to be a very complex topic to the local community, the community members were expected to respond there and then and to contribute to propositions for solutions. Considering the very low education levels in the rural areas and their remoteness from the major centres of activity and therefore their limited access to information and knowledge, it cannot be reasonably expected that the local community could contribute much to the policy formulation process. Nonetheless, usually after such *kgotla* meetings, it is recorded that the public has been consulted.

Fortunately, in Botswana, it can be noted that the central government does make the effort to accord the local government structures and communities the liberty to inform the policy formulation process. The main drawback lies with the local environment itself, it simply does not have adequate capacity to do this (Government Of Botswana 2002c). The decentralization efforts which were tried had limited success. Consequently, most of the development planning including rural development planning was withdrawn back to central government. As the following discussion will demonstrate the development planning is directed by the central

government and it is carried out at the local government level mainly by central government field institutions.

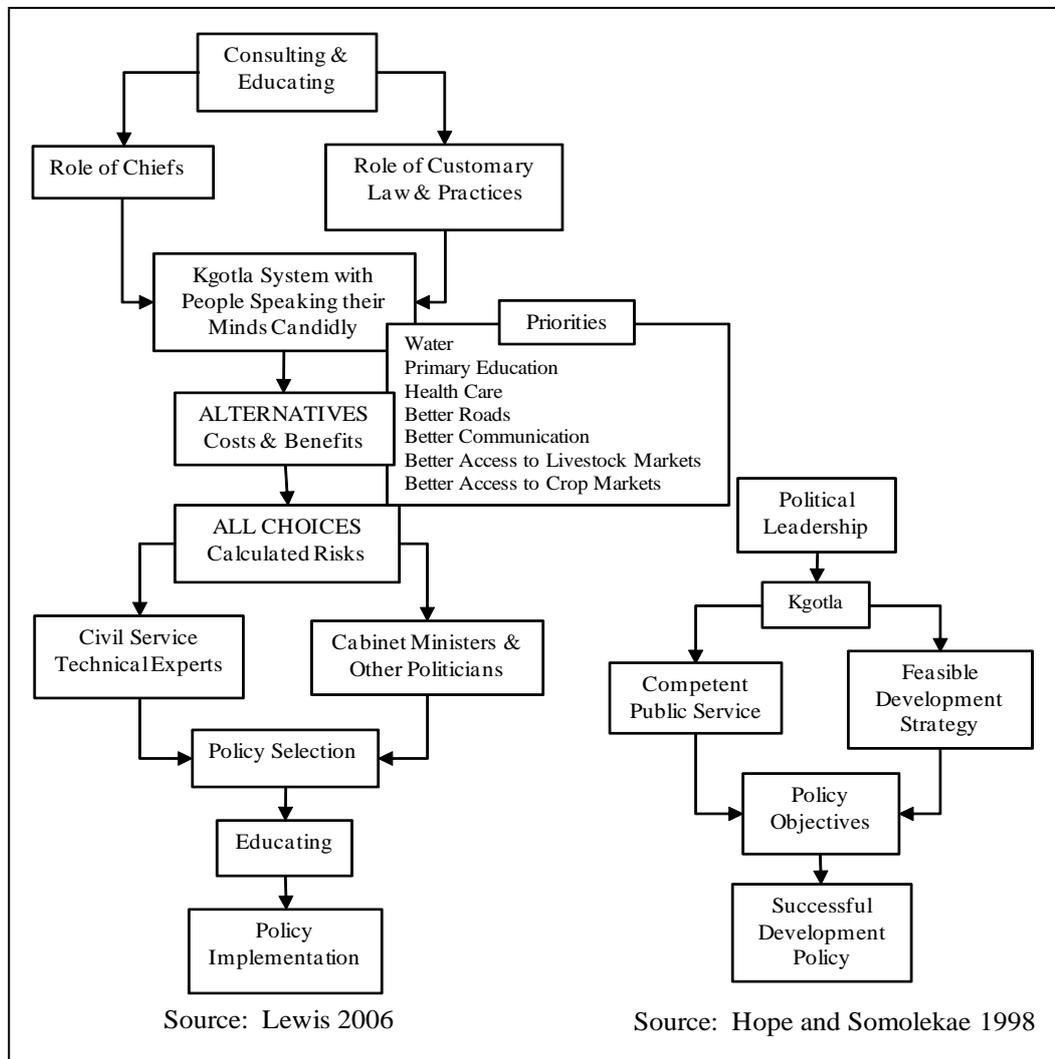


Figure 3.7 The Policy Formulation Consultation Process in Botswana
Source: Lewis 2006; Hope and Somolekae 1998

3.7.6 (b) The Policy Development Process

The Government of Botswana (GoB) has based its policy formulation priorities and process on rural development since independence in 1966 (Government Of Botswana 1966). Although a number of policy documents such as the Community Based Strategy for Rural Development of 1997 (CBS) (Government Of Botswana 1997), the Revised National Policy on Rural Development of 2002 (Government Of Botswana 2002c) and the National Policy on Culture of 2001 (Government of

Botswana 2002b) explicitly refer to developing the capacities of local communities in order for them to become innovative and to improve their living standards, the GoB still implements largely rural development programs, rather than community development programs (Table 3.1).

Table 3.1 Botswana national development spending 1976-2000

Source: Lange, 2004, p499

Items	Spending (%)					
	1976-1980	1980-1985	1986-1990	1991-1995	1996-2000	All Years
Defence	9	7	15	8	11	11
Education & Health	19	16	19	18	24	19
Economic Services, of which:	55	55	46	41	41	47
Agriculture	8	9	11	4	5	7
Mining	7	5	4	7	3	5
Water & Electricity	8	11	9	9	15	11
Roads	22	14	7	10	11	12
Other Transportation & Communication	6	12	11	7	4	8
Other Economic Services	4	4	5	3	4	4
Other Development Spending of which:	17	23	19	26	28	23
General Administration, Housing, Urban Regional Development	15	16	15	20	22	18
Food, Social Welfare & Other Community Services	2	6	4	6	6	5
Total	100	100	100	100	100	100
Government Development Budget as Share of:						
Total Government Budget	41	38	44	35	33	38
GDP	12	13	13	13	12	13

Botswana's policy formulation process is considered to be informed by the local structures, mainly the village public meeting (*kgotla*). However, a closer inspection of the development plan production process at the district level reveals that it was actually the central government institutions that produce the development plans (GoB, 2002), refer to Figure 3.8. This research argues that if the development plans are truly developed at the village level and passed up the government hierarchy, then the national development plan would reflect the needs of rural communities. Likewise, the development policies would be appropriately informed and the programs and projects will be more consumable by the local communities and the uptake of the development projects by local communities would increase.

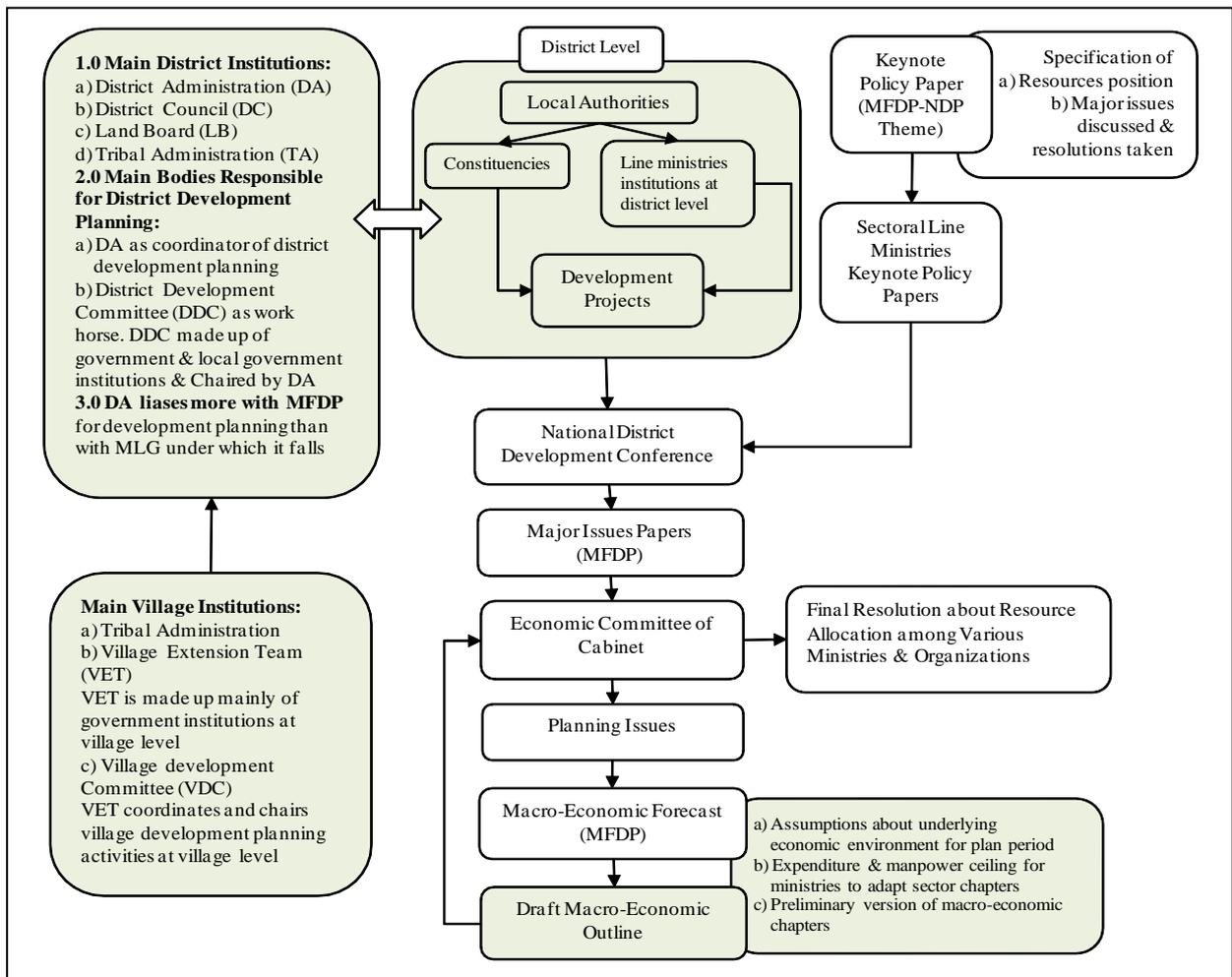


Figure 3.8 Botswana's National Development Plan Production Process
(Source: Government of Botswana, 2002; Graphic by Author)

3.7.7 The ICT and Knowledge Management Support in Tshane

Computer based knowledge management requires networked computers, access to the internet and groupware (Liao 2003b). In Tshane village only two government departments use computers, there is no networking and no access to the internet. The nearest access to internet services is 13 km away, at the District Council offices in Hukuntsi village. At Hukuntsi, there is also access to the internet through wireless technology. However, one cellular phone company is currently seeking to improve its service reception strength in Tshane village, and hopefully in the near future there will be access to wireless internet in Tshane village.

In terms of the availability of land information management facilities which are similar to a PGIS infrastructure, two attempts have been made to produce land information systems which would be used to manage the tribal land. The first was the

land information system (LYNSIS) which the Land Boards (LBs) were tasked to produce in 1996 (Figure 3.9).

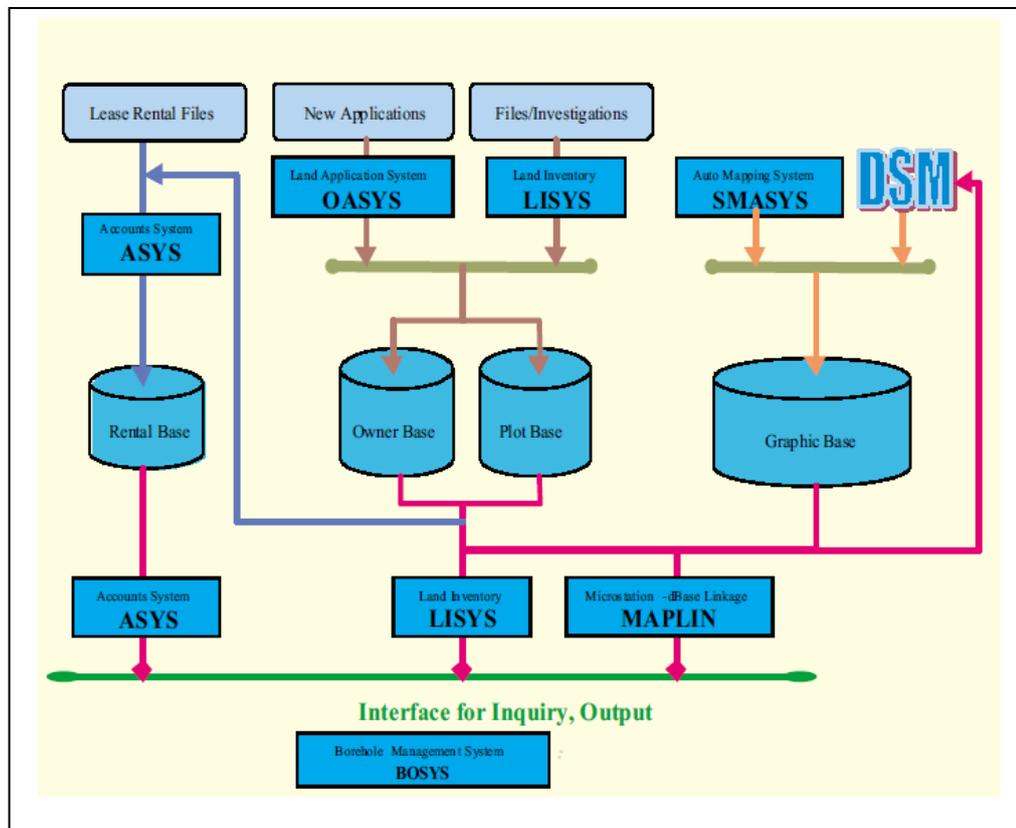


Figure 3.9 Land Information System for the Land Boards of Botswana
Source: Botswana National Atlas 2000, p180

The development of the LYNSIS was attempted by a few of the ten LBs, but there was poor coordination and a computer aided design (CAD) software (Microstation) was used as the geographic data management system. The use of the CAD software rather than a GIS software necessitated writing programs in order to link CAD map files with the related attribute data, none of the LBs could do this and few of the Chinese technical teams who were brought into Botswana could do it either. This project failed and was abandoned. Nonetheless, LYNSIS was designed mainly to manage tribal land and to provide administrative and accounting support to the LB office. Therefore LYNSIS did not have any community development functionality. The second and current attempt is the Tribal Land Information Management System (TLIMS), Figure 3.10. This time the project is coordinated at the national level. The Land Board in Hukunsi village is one of the stakeholders, therefore the PGIS initiative which is going to be started in Tshane village should get some support from

there. TLIMS, like LYNSIS is mainly a land management system and does not have functionality that is directly aimed at supporting community development.

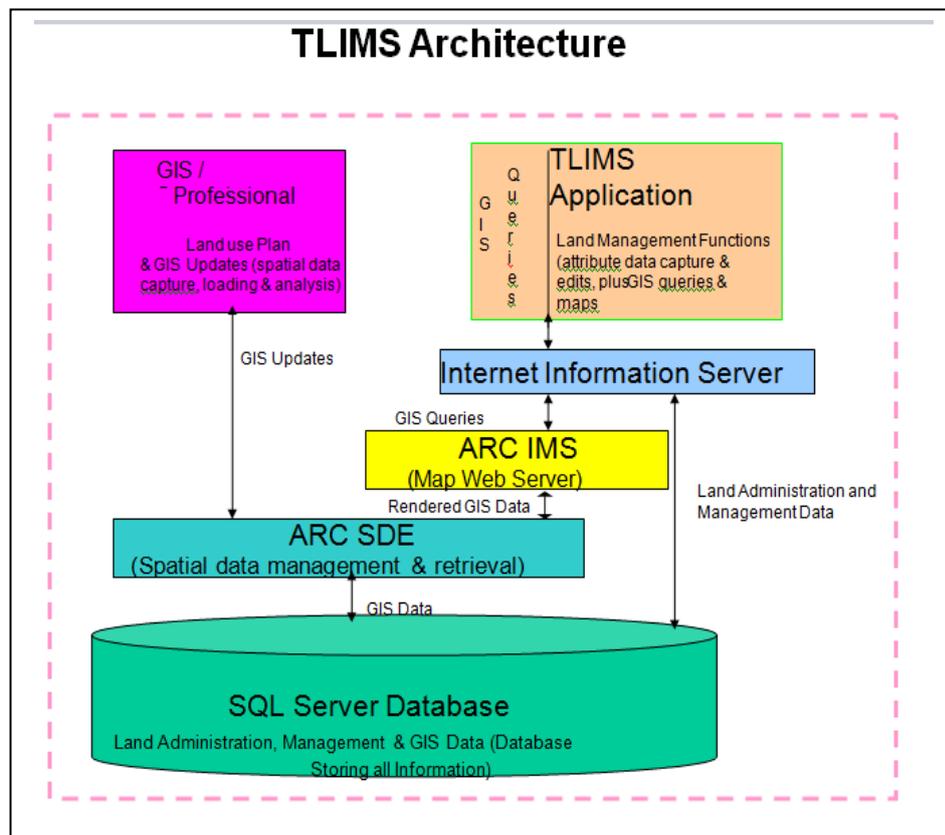


Figure 3.10 The Tribal Land Information Management System
Source: Botswana National Atlas 2000

3.7.8 The Botswana Business Environment

In Botswana, many people view businesses as employment opportunities rather than as options for differing types of self-driven livelihoods. It is difficult to understand why Botswana can be so passionate about livestock and amass large heads of cattle, goats and sheep, yet fail to recognize that the same logic that is applied in accumulating such livelihood assets is the one that is used in formal business ventures. The business logic is to invest, re-invest and grow. This section reviews past and current business activities in Botswana.

Historical trends reveal that general trading in Sub Saharan Africa was carried out by outsiders Best (1970). Best notes 85 percent Lebanese business presence in Liberia between 1964 and 1965, 80 percent European business presence in Sierra Leone in

1960 and 70 percent Indian business presence in Uganda in 1965. In Botswana, the foreigners were openly opposed to Batswana starting businesses, and in 1949 80 percent of the businesses were foreign owned and in some areas of the country the foreigners had exclusive business rights. Best (1970) linked the successes of the foreign business community with the leading edge that the business owners had. These included advances in industry, adoption of commercial agriculture, the use of entrepreneurial skills and established business contacts. Nonetheless, Best notes that it is possible to move from being consumers, shop assistants and sales persons to owning shops, but points out that there are problems of insufficient capital, business inexperience, lack of own transport and insecure business contacts. These issues relate to venture capital, business management, transport and information access.

With regard to venture capital, Temtime, Chinyoka, and Shunda (2004), provide a comprehensive account of Botswana's initiative to provide financial support to businesses. These initiatives started with the development of the Botswana Development Corporation (BDC) in 1970 which was intended to support large business start ups. Other initiatives include: a) the establishment of the Botswana Enterprise Development Unit in 1974 to support start up operations of small businesses, b) the Local Procurement Program of 1978 which reserved 30 percent of annual investments for small businesses, c) the Financial Assistance Policy (FAP) of 1982 which was a grant scheme covering the start up of both small and large enterprises, d) the Tswelelo (PTY) Limited which provided the BDC type funding but for small and medium enterprises and e) Citizen Entrepreneurial Development Agency of 2001 which replaced the FAP. This indicates that the source of venture capital is not a problem, access mechanism and requirements and just lack of information about such programs are the real barriers to the use of such assistance. An operational PGIS process should support the information access part of this venture access problem.

With regard to the business inexperience, Farstad (2002) presents an extensive coverage of the procurement of entrepreneurial training from the secondary schools and vocational training centres in Botswana. However, the author notes problems with the classroom type of learning. This is noted to limit the exposure to real world experiences and creates an incomplete and de-contextualised aspect of the classroom setting. The application of information communications technology (ICT) should

also support business initiatives by providing access to information and customers in a non obtrusive unbounded way (Jha and Strous 2007; Dyson et al. 2006) where the necessary infrastructure is in place. Duncombe (2006) used the sustainable livelihoods approach in an innovative way in order to assess the information use of small and medium enterprises in Botswana. The results showed that these businesses did not use information mainly because they did not have access to it. Thus a major contribution of any information management initiative that is undertaken should be to enhance basic access to information.

3.8 Chapter Summary

Chapter three covered the original conceptualization of the research project, the initial planning of the data gathering and introduced the study area. The activities were planned around the implementation of a conceptualized PGIS framework. The main processes of the PGIS framework as discerned from the literature review included the convening, the participation processes and the outputs. Based on these activities, three field trips were planned. The first field trip would cover the facilitated community mobilization and the training which was required to enable active participation. This would be followed by the data processing, analysis and the development of a PGIS prototype. The second field trip would cover the feedback of the results, the evaluation of the PGIS framework and the creation of knowledge structures by the village community and the community development institutions. The second field work would be followed by the final data analysis and the review of the PGIS prototype. The last field trip would cover the delivery of the final PGIS framework, official closure of the research project and participation in the community's planning for the way forward.

Chapter three also introduced the study site and highlighted the remoteness of the site and the gradual decline of access to communal land. The research site was specifically queried with regard to the adequacy of its facilities to support the implementation of a PGIS framework. Thus the issues which were discussed related to the status of the village leadership structures to mobilize the community and the presence of village structures to support learning. The other site attributes which were discussed related to the availability of the facilitation services and the role of the support institutions. Other attributes which related to the contribution of the

community development were the review of the community development support and policy development processes. The PGIS framework was about instituting a PGIS infrastructure and supporting the development of community livelihoods. In this regard, the status of the information communication technology, knowledge management structures and the business situation were also discussed. The attributes of the site indicated that it would support the implementation of the PGIS framework as it was conceptualized. The next chapter builds on the conceptualized PGIS framework processes and develops a generic model of the PGIS framework which was subsequently implemented at the project site.

CHAPTER 4 PARTICIPATORY GEOGRAPHIC INFORMATION SYSTEMS FRAMEWORK

This chapter presents how the PGIS frameworks discussed in Sections 2.7.1 to 2.7.7 in Chapter 2 were used to develop a generic PGIS framework. The chapter is divided into two main sections. The first section assesses the core objects in each frame, with the aim of selecting the ones which would be suitable to include in a PGIS framework. The second section presents an assembly of the selected PGIS framework objects and how they have been recombined to create a generic PGIS framework which would be applicable in most rural settings, especially of developing countries.

4.1 Selecting the Core Objects from the PGIS Frameworks

The graphic summaries of five of the PGIS conceptual frameworks discussed in Section 2.7 are shown in Figure 4.1. This includes the EAST-2 framework, the Spoleto framework, the geo-spatial ontology theory, the integrated systems knowledge management and the participatory community design framework. The other two frameworks are presented in Figure 4.2. Overall, the seven conceptual PGIS frameworks taken together indicate nine main PGIS components: a) the convening construct, b) the convenor, c) the process construct/participation, d) the outcomes construct, e) the geographic information infrastructure, f) the policy makers, g) the planners, h) the application of acquired knowledge and expertise and i) the storage of knowledge. However, for the purpose of this research project, it would not be necessary to separate the planners and the policy makers.

Section 3.1 which covered the conceptualization of the PGIS framework, outlined the activities which were anticipated to be carried out in three field trips. The activities of these field trips when viewed in detail outline nine main activities: a) community facilitation and mobilization, b) community training, c) data processing, analysis and production of a PGIS prototype, d) community feedback workshops, e) testing and evaluation of the PGIS prototype, and development of knowledge structures, f) final data analysis, g) review of the evaluated PGIS prototype, h) research project closure and safe data keeping and i) way forward for the village community. These activities will be used as guides to querying the PGIS frameworks and to search for the relevant components which could be abstracted into a generic PGIS framework.

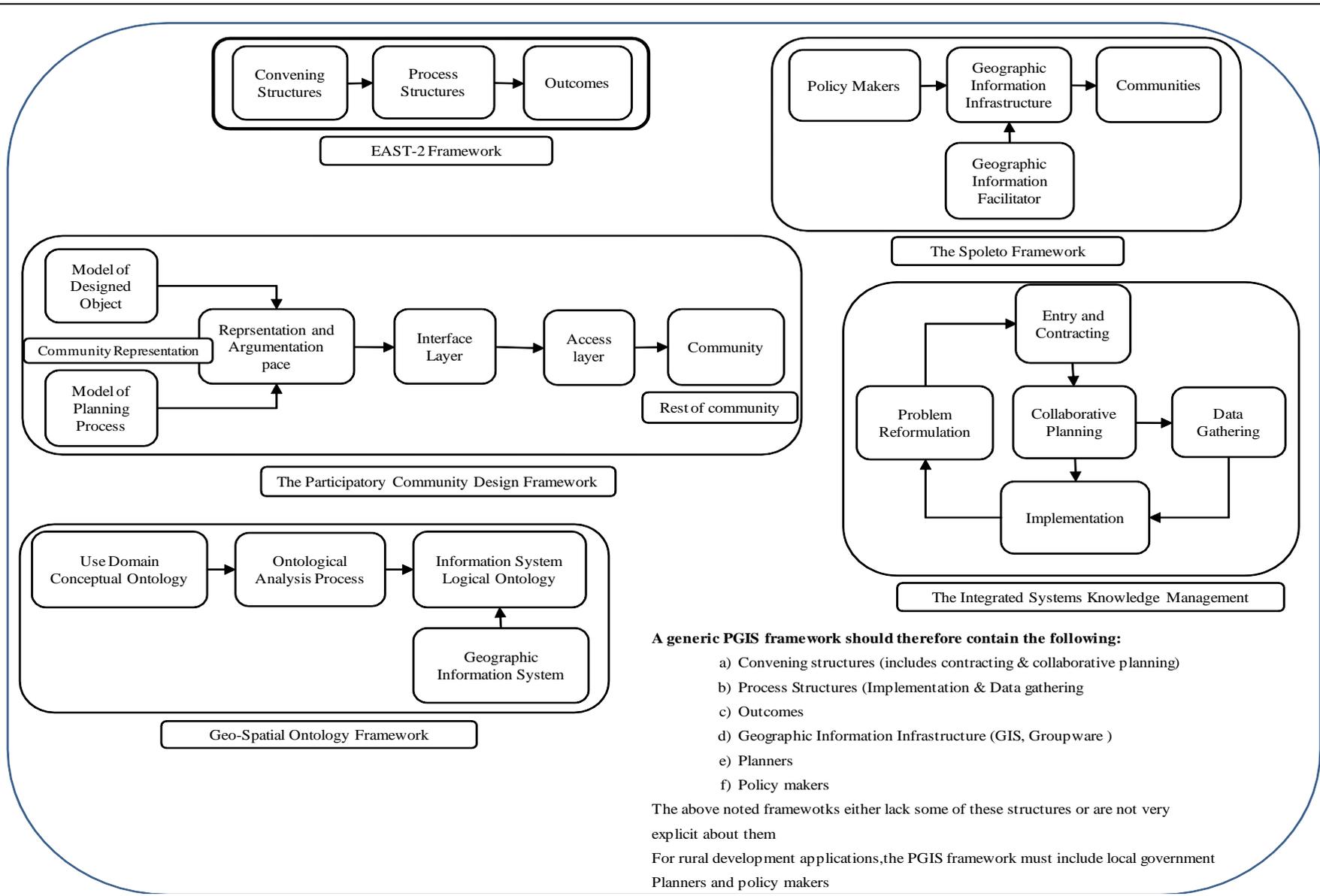


Figure 4.1 Summaries of the Conceptual PGIS frameworks

Therefore, the exemplar PGIS framework components will be compared with those of the conceptualized PGIS framework. The perceived and therefore expected components from the conceptual PGIS framework are, the convening which is led by the village leadership, the facilitation, the participatory learning, the data structuring to create the database and to create the PGIS prototype, community feedback, the PGIS prototype review and evaluation and the community output.

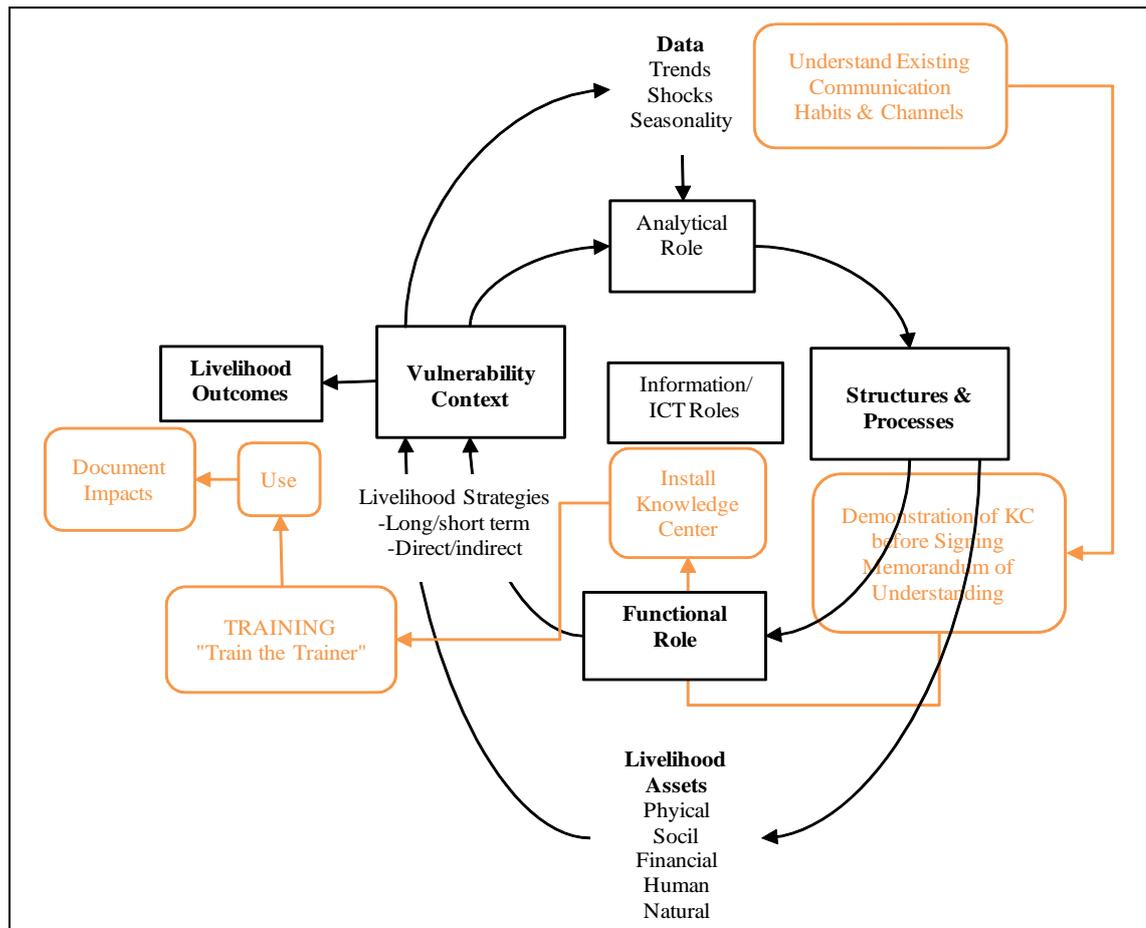


Figure 4.2 The Duncombe framework (black) and the Kanungo framework (Orange)
Source; Duncombe 2006 and Kanungo 2004

4.1.1 PGIS Components from the EAST-2 Framework

The Enhanced Adaptive Structuration Theory -2 (Nyerges, Jankowski, and Drew 2002) provides the main building blocks because it outlines the convening, the process and the output constructs (Refer to Section 2.7.1). The building blocks of the EAST-2 framework which are compared with a conceptualized PGIS framework are: a) *power and control* which were interpreted to be leadership roles, these correspond

with the anticipated leadership roles, b) the *convenor*, this has been identified as the facilitation role, c) *group participant influence* which corresponds with the training component, d) the *PGIS influence* would be used to represent the PGIS artefact, e) the *process constructs and group processes* were identified as the participatory learning components and finally f) the *outcome constructs*, these are clearly required components in both frameworks however, the EAST-2 framework differentiates task outcomes from process outcomes, which were are not so differentiated in the conceptualized PGIS framework. The process construct in the EAST-2 framework focuses on the participation activity itself, because its main focus is evaluating the participation. It therefore does not become explicit about the capabilities and empowerment elements as they relate to improving living standards directly. In contrast, the conceptualized PGIS framework is crafted specifically to support the livelihood activities of the community.

Overall, the EAST-2 framework outlines the PGIS components that would be useful to include in PGIS framework that supports rural community development. Nonetheless, the EAST-2 PGIS framework has a number of weaknesses too. The link between the convening constructs and the process constructs is uni-directional. It does not show the iteration that is expected to occur with the need to evaluate the planning decisions when the processes do not produce the expected outputs. In addition, there is no link between the outcomes and the convening constructs, this implies that there is no monitoring or evaluation of the outcomes. Lastly, the process constructs are focused mainly on assessing the participation process and will therefore be limited in supporting the learning and the knowledge creation which is required to support the initiation of livelihood activities. The EAST-2 is also silent about the data analysis and database design and the preparation of a prototype, which should be included to facilitate the evaluation process too. Consequently, the EAST-2 framework does not indicate an evaluation of the PGIS artefact impact in supporting the community livelihoods.

4.1.2 PGIS Components from the Spoleto Framework

The Spoleto framework (Rugg 2001) was presented in Section 2.7.2. This framework too is compared with the conceptual PGIS framework. The components of the Spoleto

framework (SF) which were compared with the conceptual PGIS framework were: a) the G.I. (geographic information) infrastructure, b) the G.I. facilitator, c) the problems, d) individuals, e) communities and f) the policy makers. By positioning the GIS infrastructure and the problems between the policy makers and the community, the Spoleto framework serves as a clearly recognizable ontology for a rural development process which is supported by the political institutions. The SF components are intended to support dialogue between the policy makers and the community, the dialogue needs to be a strong component of a PGIS process too. Consequently, the SF clearly identifies the main components of a PGIS framework but because of the goal of outputting a development plan, the roles and the processes are different from those that are aimed at supporting the development of the livelihoods of rural communities at the household level.

Ultimately the Spoleto framework is a planning support construct. When it is compared with the conceptualized framework, it is noted to leave out the community facilitation and instead it focuses on the GIS artefact facilitation. Therefore, the SF does not show the training or learning components which are necessary for building the various capacities that are required by the community. Also, because it focuses on outputting a plan, the Spoleto framework does not refer to any outcomes, it focuses mainly on the planning aspect. The role of the facilitator is limited to mediating the geographic information language, whereas the facilitation role should cover the whole of the participation process.

The Spoleto framework is also silent about the data analysis, the database design and the production of the PGIS prototype. Also as a consequence of its focus on planning, the SF does not show the development of a PGIS prototype and the community testing and evaluation of the PGIS construct. However, the SF is explicit about the structure of the GIS artefact and its placement between the policy makers and the community.

4.1.3 PGIS Components from the Geo-Spatial Ontology Framework

The geo-spatial ontology (GSO) (Sieber and Wellen 2007) was presented in Section 2.7.3. Its main components are: a) the community, b) the geographic information system (GIS) designer, c) data gathering, d) development of the PGIS. Therefore its main focus is on the development of a PGIS artefact. Although this seems to be of limited use to a PGIS process that supports rural community development, it does

have components that are worth appropriating to a rural community development PGIS framework. The GSO is more explicit about the problem solving process because it seeks to ensure the achievement of its goal. It considers the real world domain and is explicit about how the structuring of the information system that subsequently supports this real world should contain representations of the real world domain. It should contain much detail about the development of a PGIS prototype since it is focused on the development of the PGIS artefact.

Although the GSO is rather compact in its discussion of the PGIS intervention components, when it is analyzed in detail, it does contain a number of components that are would be useful to include in a PGIS framework for rural development. The community component for example, should contain the facilitation and the leadership roles. The data gathering which the GSO considers to be the strong participation component should therefore contain an element of training in order to facilitate the communication that is necessary to effect the collaboration work. Again, although the GSO is silent on the details with regard to the development of the GIS artefact, it must involve the data analysis, the database design, the development and evaluation of the GIS artefact. Otherwise, how would the framework be used to determine whether the incorporation of the community needs has been achieved? Although the GSO has its limitations it does outline a broad framework which is expanded upon by the EAST-2 and Spoleto frameworks. A consequence of its goal to output a PGIS construct is that it is not explicit about the use of the knowledge and the various outputs and outcomes it should induce the people to produce.

4.1.4 PGIS Components from the Participatory Community Design Framework

The Participatory Community Design (PCD) (Pipek et al. 2000a) framework was presented in Section 2.7.4. The PCD places computer mediated planning between the planners and the community. It outlines the following PGIS framework components: a) model of planning process, b) model of the designed object, c) the user interface, d) tools to interface with both the plan and the designed object and e) the community. Although the PCD is not explicit about the outputs, the planning process model and the designed object model, which the community members are allowed to interact with, do depict the potential outputs. The PCD focuses on the interaction processes and the hardware and software tools which facilitate these processes. The PCD uses

advanced information communication tools which would not be available in the rural areas. Therefore, although the PCD outlines the familiar PGIS components such as the PGIS artefact, the facilitation, the community and the planners, its contribution is more on the conceptual principles of the participation process, rather than on the suitability of its components.

The PCD outlines a clear case for the role of groups in decision making, where the groups provide an avenue for representing and promoting the interests of the community (Thorp, Stewart, and Heyer 2005). What is not explicit in the PCD is the immediate feedback which results from the argumentation among the participants, between the planners and the community and between the community and the interactive communication models which are presented.

The PCD as it is presented legitimizes the placement of a development object among a community. This activity is similar to placing a PGIS framework among a rural community. It recognizes the need to present a platform that facilitates the input of the community, for this purpose it is strong on the construction of the technological interactive tools and should therefore be strong on the data analysis, the database design and the development of the user interface. However, as a largely urban intervention, it is weak on the community facilitation components and the training. It assumes that the community members have these competencies or where such training is provided it is limited to learning to operate the technology, rather than learning how to appropriate the technology to local community applications. The PCD therefore does not depict any outputs.

Nonetheless, the PCD contains components that should be incorporated in a PGIS framework for rural applications despite its urban bias, because it points to the necessity for the community members to have empowering skills if they are to contribute to the activities in their communities. The evaluation component in the PCD is closely integrated in the participation arrangements. If for example, the planning and designed object models are not adequate to empower the community to participate successfully, then that very result provides immediate evaluation feedback on the effectiveness of the intervention tool. In fact, the modelling component of the PCD is its strongest component, because it visualizes the landscape objects and thus

presents a realistic construct that the community members can relate to and therefore respond to.

4.1.5 PGIS Components from the Integrated Systems for Knowledge Management Framework

An overview of the Integrated Systems for Knowledge Management (ISKM) is presented in Section 2.7.5. The ISKM outlines five PGIS framework components, entry and scoping, collaborative planning, data capture, implementation and feedback loops. The ISKM should be particularly useful for supporting learning, knowledge generation and institution building. The institution building is particularly important for the development of the leadership and facilitation components, which in rural communities have become weak due to enhanced central government development intervention. The ISKM is robust in agenda setting and monitoring and evaluation. These are important areas of participation that ensure that a given development intervention addresses the issues and concerns of the community. The ISKM, as a planning support tool, contains all the concepts used in standard planning procedures, identifying the problem, setting the problem solving goals, collecting data, identifying the best option, implementing, evaluating and adjusting the interventions based on the evaluation. In this sense the ISKM contains broadly, all the conceptual PGIS framework components, but the processes are not targeted at solving failing livelihoods.

The main limitation with the ISKM is that it is a process for handling broad planning and management issues, consequently individual and smaller group outputs are not specified. The ISKM also emphasizes the understanding of the situation, which although important does not show the way forward after the issues have been clarified and the participants have been trained. As a consequence of its focus and its methodologies, the ISKM also does not refer to an information system construct. Consequently, it does not have the information system data analysis, database design and the development of the PGIS prototype. Nonetheless, the noted ISKM framework components should be useful for a rural community development PGIS framework.

4.1.6 PGIS Components from the Sustainable Livelihoods Approach Framework

In contributing to the theories about the role of information communication technology to development, Duncombe (2006) used the sustainable livelihoods approach (SLA) (Brocklesby and Fisher 2003; Carney 1999). He transformed the SLA into information system format in order to study the use of information technology by rural micro enterprises in Botswana. The five components of the SLA that Duncombe used are: a) the community;s context of vulnerability, b) community members' assets, c) the development institutions which support the community, d) the adopted community livelihood strategies and e) the outcomes of the adopted livelihood strategies. The SLA design structure is similar to the Spoleto framework design, the difference is that in this case it is the development institutions that are positioned between the community and the achievement of livelihood goals. However, when the development institutions use information technology to mediate the support function, then the designs are the same. When the SLA is transformed into information system format the following components are outlined: a) vulnerability context of the poor, b) participatory assessment c) pro-poor application of information and d) action through the transforming structures and processes, e) access to resources and receipt of assistance by the transforming structures and f) data trends.

The SLA in information systems (SLA-IS) format outlines the problem analysis, participatory problem solving, the production of information to base action on and the use of the development institutional support to implementat the community livelihood strategies. The process then cycles back to the evaluating the state of the data. The participatory assessment would cover facilitated community mobilization and training, which are the first components of the conceptualized PGIS framework. These also embody the analytical components and the production of information. A strong component of the SLA-IS is that the community assets are combined with the produced information in order to develop the livelihood strategies. The livelihood strategies then feedback into the vulnerability context and thus are evaluated for their impact in addressing the vulnerability context.

The SLA-IS contains relevant components that need to be included in a community development PGIS. The main limitation with the SLA-IS is that the difficult components such as the data analysis and the development of the information system

construct are hidden behind the analytical, structures and functional roles. It is not clear about who carries out these functions. If the more difficult functions are all carried out by the support institutions, then this is not a sustainable situation.

4.1.7 PGIS Components from the Information Systems for Emancipation

The Information Systems for Emancipation (ISE) framework was presented in Section 2.7.7. Its main components are the village leaders, the community, the knowledge centre users, the installation of the knowledge centre, training, use of the knowledge centre and documentation of the impacts of the use of the knowledge centre. The ISE therefore contains the components that need to be included in a community development PGIS and its vocabulary reflects the rural environment. As an information system the ISE is designed in a similar manner to the proposed conceptual PGIS framework. However, there are a number of concerns with the ISE. It is focused mainly on the use of the information and not in its creation. Although the community is consulted to provide their data needs, the development of the system is carried out separately and then installed. The training is conducted specifically for the use of the knowledge centre. The training component is therefore weak. The structuring of the knowledge centre is not part of the process. The adding of value to the compiled information is carried out by the central hub of the system. Nonetheless, most of the components of the ISE components are included in the conceptual PGIS framework.

4.2 Structuring and the Description of the Generic PGIS Framework.

4.2.1 The Structuring of the PGIS Framework

Based on the presentations in the preceding section, this section uses the PGIS components in the presented frameworks and some of the PGIS framework structures in order to build the generic PGIS framework. The EAST-2 framework contributes most of the PGIS components but does not have a clear structure. The Spoleto framework contributes a clear structure and the expected interactions between the components but does not show all the components as explicitly as the EAST-2 framework. The contribution of the GSO is largely on specifying the importance of the contribution of the community in crafting the information system that eventually supports the knowledge building processes. The ISKM contributes the feedback loops

to the implementation and convening processes which are required to continually monitor and adjust the implementation processes. The PCD contributes mainly in the placement of modelled communication and interaction constructs which should promote participation. The SLA-IS and the ISE contribute to refine the structure of the generic PGIS framework since they are also information systems.

The resultant structure of the generic PGIS framework hereafter referred to as the Rural Community Knowledge PGIS framework (RCK-PGIS), which was produced is shown in Figure 4.3. The Spoleto framework was used as the main structuring frame of the RCK-PGIS, so that the PGIS artefact and the facilitation are placed between the community and the livelihood outcomes. The flow of the process is from the left and the outputs are placed at the right. The intervening space contains the facilitation, the processes and the feedback loops to the policy makers, to the processes and to the convening constructs.

Overall, the RCK-PGIS is considered to be a social learning system, which uses anchors for stabilizing the learning. These anchors are the problems that are being addressed by the community and the PGIS infrastructure. The anchors are used to rationalize the problem solving and to support the data, information and knowledge acquisition processes. The facilitation occurs at several levels. The leadership is responsible for facilitating community wide activities. The management of the whole process is facilitated by a combination of community and specialist facilitators. The facilitation also occurs between individuals and groups as they interact to share knowledge and carry out the tasks. The monitoring and evaluation components are important not only in managing and informing the implementation, they are also required components for recognizing the longevity of processes and the creation and management of sustainability.

4.2.2 The Description of the Rural Community Knowledge PGIS Framework.

The narrative of the RCK- PGIS framework is presented as follows. At the convening stage, the local leadership realizes the value of knowledge and collective action in securing community level goals and services which are likely to improve the living standards of the households. The leadership then works with a local team of community facilitators in order to mobilize the village community and prepare them

for collective action. In considering its needs, the village realizes the importance of improved communication and learning as critical to the knowledge acquisition process. Specifically, the village community realizes the need to acquire new ways of communicating and working with knowledge and to make use of the wider more modern livelihoods context. Since information communication technology (ICT) is currently the main and most effective communication tool, this becomes the option that the community chooses, and they specifically choose the PGIS as their ICT instrument. The choice for the PGIS is based on the observation that it offers more practical convenience. This is because it has the capability to concretize and externalize the livelihoods mental constructs and visualize them spatially. It presents the community livelihood objects in their natural landscape layout, so that the village community can easily associate with the presented information. The PGIS would also serve to anchor, focus and visualize the learning experience and it should aid the problem solving strategies.

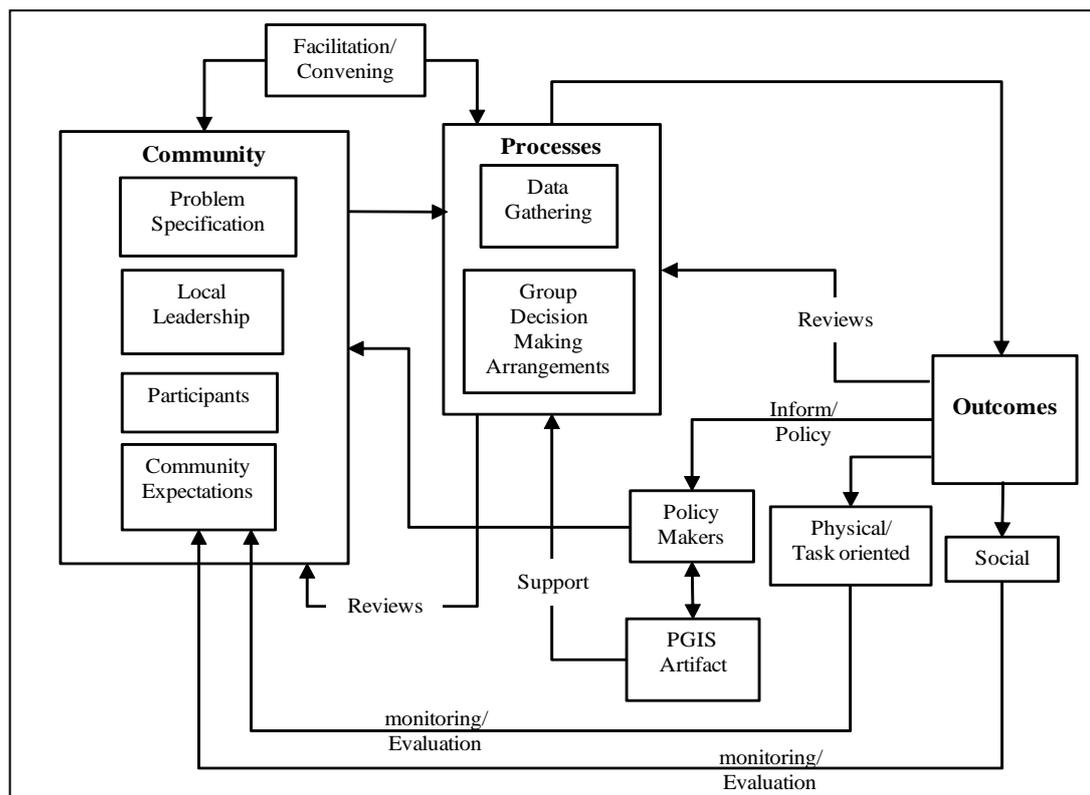


Figure 4.3 The RCK- PGIS framework

In deploying the RCK-PGIS however, the community needs to be aware that it is much more than just computer hardware, software and data. The RCK-PGIS represents an information system infrastructure. The PGIS infrastructure is composed of people who have agendas and have prepared procedures to use the hardware and the software to collect, process and analyse geographic information. These activities are used to create knowledge and to use it to support the development of livelihoods. Some of the data and the procedures come from the local government structures and other community development institutions (CDIs). The CDIs should include the institutions which support agricultural production, tourism and other natural resources based livelihood activities, small and micro enterprises (SMEs), small informal businesses and others. Most of these institutions are either part of government or are supported by government. This explains the inclusion of the policy makers component of the RCK-PGIS framework. Also related to the deployment of the RCK-PGIS process is the need for a specialist facilitator. This is represented by the facilitation/convening component. The specialist facilitator is also needed at the convening stage. This is because there is need for the specialist facilitator to become involved in the community mobilization, since the community will be mobilizing to learn how to deploy the PGIS process.

When the required actors and resources have been procured, the learning then begins. The learning should be a special type of learning, because it needs to get the community jobs done. The learning should impart skills and empower the households to engage in productive livelihoods. The learning would also either identify the need to or enhance the livelihoods supportive infrastructures, such as water, electric power and communication services. The other livelihood structures include business support services and reviewed strategies for the CDIs to support the community livelihood activities. The learning constitutes the process component of the RCK-PGIS framework and represents the actual work which needs to be done. Overall, this process should build the PGIS infrastructure and provide exemplars of knowledge creation. The ultimate goal of the RCK-PGIS is to create knowledge and facilitate its varied reconstructions and application to secure individual or group livelihoods.

The outcomes of the RCK-PGIS form an important component of the framework. It provides proof of the success of the activities of the framework. These outputs are used to evaluate the effectiveness of the RCK-PGIS in supporting the community

livelihoods. The other output of the RCK-PGIS is the data, information and knowledge which are stored to support their continued use. Some of the outcomes of the RCK-PGIS process cannot be planned for. They emerge from the activities and the problems that are raised by the need to implement the conceived solutions. Some of these emergent outcomes are, land use planning, facilitation for knowledge input and management and the need to restructure existing institutions or introduce new ones. The land use planning becomes necessary to cater for the implementation of new projects whose designations are not included in current land use plans. The knowledge input and management capabilities need to be learned in order to generate the demand that is needed to sustain the RCK-PGIS infrastructure.

4.3 Chapter Conclusions

This chapter covered the development of the PGIS framework. It was developed from a synthesis of the PGIS frameworks presented in Chapter 2. These were synthesized into a generic PGIS framework which included: a) the convening component which was composed of the village community, the local community development institutions (CDIs), the community development worker (researcher) and the PGIS construction task, b) the local government structure, c) other CDIs external to the community, d) other stakeholders and e) the link to central government, which could be through the local government structure or through the other CDIs and the outputs. Finally, an overview of the draft generic PGIS framework was presented.

From the discussion of the PGIS frameworks a number of observations were made. The implementation of the PGIS frameworks showed a process pattern that was repeated in all of them. This pattern outlines the collaboration work between an external agent and the community, where the structure of the community is recognized and used to support a community participation process. The participation process is carried out within a training program. In some frameworks the training is not made explicit, however it is clear that without an element of knowledge sharing between the external experts and the community, there cannot be meaningful communication or participation. All the frameworks refer to the generation of knowledge and there is indication of the need to deploy the procured knowledge to secure meaningful livelihoods. Overall, the outcome of the process to develop a rural community development PGIS showed that there was good correspondence between

the planned activities of the proposed RCK-PGIS framework and the rural community's institutional structures and knowledge generation processes. The main task would be to carry out the training in a manner that would produce the expected benefits to the community and thus prove the worthiness of the RCK-PGIS process.

CHAPTER 5 RURAL COMMUNITY KNOWLEDGE PGIS IMPLEMENTATION

This chapter presents how the Rural Community Knowledge PGIS (RCK-PGIS) framework was implemented for the research study site of Tshane village in Botswana. The implementation is discussed within five broad areas, community mobilization, planning and conducting the training programs, building the knowledge content repository and developing an application prototype, feedback and evaluation of the PGIS prototype and documenting and assessing outcomes.

5.1 Overview of the Rural Community Knowledge PGIS Implementation

The implementation of the Rural Community Knowledge PGIS framework involved six broad activities: community mobilization, planning and designing training programs, conducting the community training, mapping base map layers and determining the sampling frame, creating a knowledge content repository and feedback and evaluation.

The community mobilization was concerned with the entry into the village community and convening with the leadership in order to introduce and initiate the project. The planning and designing of the training programs was intended to involve the community in guiding what needed to be learnt with regard to the building of a map based information system. This activity also provided the opportunity to align the learning strategy to the community's way of learning, which was mainly experiential. The mode of training which was adopted was on the job type of training whereby the practical component of the learning was also used to generate the required project output. The training was followed by a brief period of determining the way forward for the community. This was intended to assist the community to think of a way forward and was related to the future sustainability of the project. The collected data were processed, analysed and used to create a PGIS prototype which was based on a selected set of the community livelihoods. Based on the social survey and attitude scale data and other activities which were carried out with the community, the data that were considered relevant to the village information requirements were compiled into knowledge repository. The results of the mapping and the social survey together with the PGIS prototype were then reported back to the community. This was

intended to provide feedback and to involve the community in charting the way forward for the initiated village project. The feedback and the documented records of the outputs which were achieved during the implementation of the PGIS were used to evaluate the implemented PGIS framework.

5.2 Community Mobilization

The community mobilization included the entry formalities and the arrangements that resulted with establishing the research management team. The arrangements also included securing a convening location and selecting the village trainees. The last component of this activity involved identifying the user needs and the required data.

5.2.1 Convening the Research Management Team

The village system was aligned more with the central government structure than with the local institutions structure. It worked through either the village development committee (VDC) or with the village councillor, the choice of which one to use depended on the reason for the meeting. Rural community development issues were handled by the VDC. The researcher reported to the VDC, which in turn presented the researcher to the tribal office. After the approval of the project, the chief assigned the coordination of the incoming research project to the VDC. The VDC convened a village meeting on behalf of the chief at which the rest of the village was informed about the researcher and the research work which was going to be carried out in their village, what the objectives of the project were and how they were expected to participate.

Overall, the adoption of the knowledge for human development approach and the view of human development as improving the living standards at the household level created a strong bond between the researcher and the community. The introduction of the major activities of the project covered a number of activities. These included the initial training of the VDC, the training of a village work force, the data gathering and the community feedback workshops.

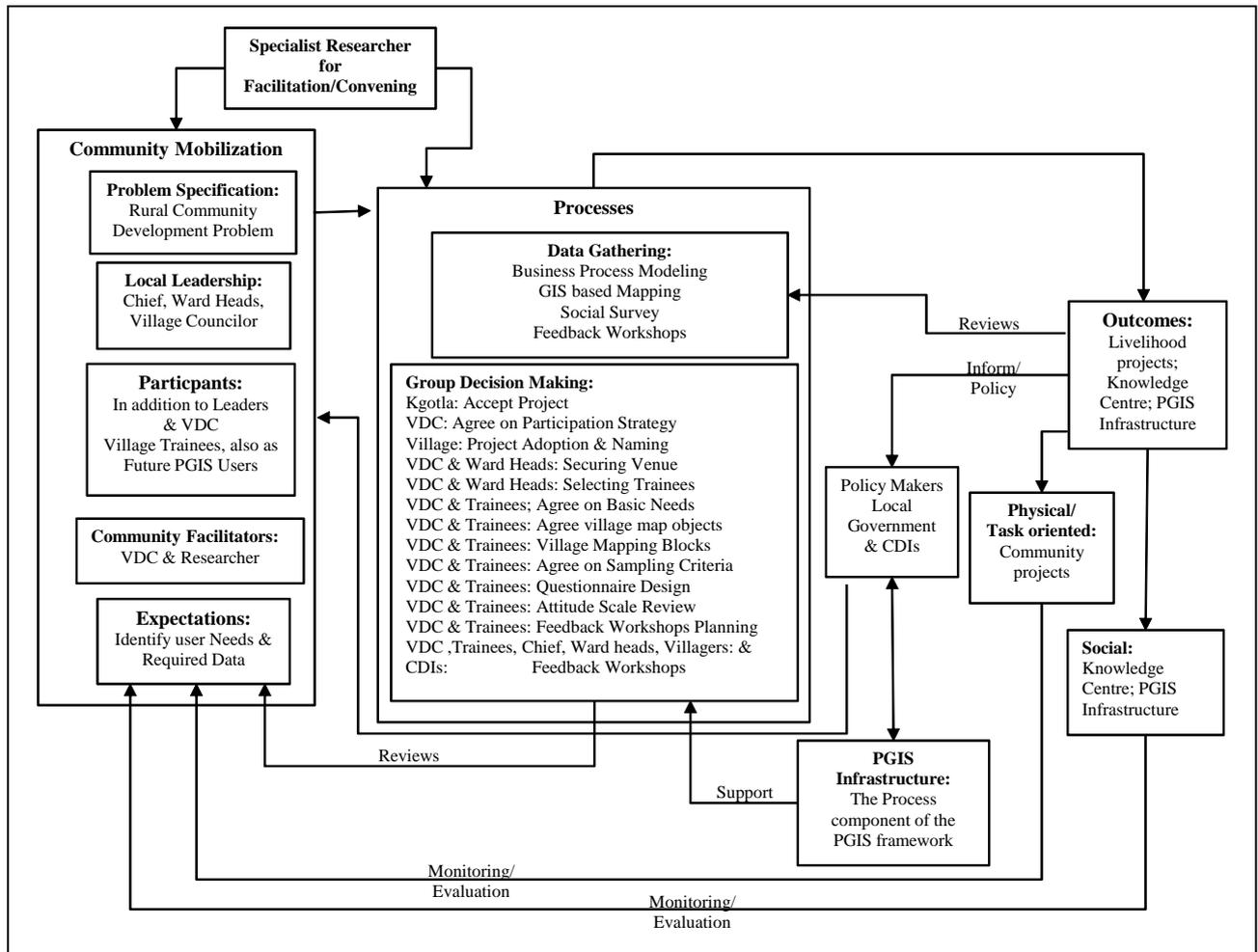


Figure 5.1 The research methods

5.2.2 Arranging for Project Co-Management

In order to work closely with the researcher on the project, the VDC agreed on a participation rota of two VDC members per day. This arrangement would have worked out well since the VDC was made up of ten members. However, only six VDC members were able to participate on a full time basis. Fortunately, because of the initial training that had to be carried out in order to impart basic information to the VDC, all the six VDC members became involved daily in all the activities for the first four months, and only three VDC members could continue for the remaining five months of first field trip. From the chieftainship, one of the ward heads was selected by the chief to become part of the project management, this arrangement was made in order to keep the leadership informed of the project activities. Since the ward headman could not participate as actively as the VDC, it was agreed that he should take part in the daily end of day activity summaries.

5.2.3 Securing a Convening Location and Selecting the Village Trainees

The researcher informed the VDC that the Department of Environmental Science of the University of Botswana had loaned the research project ten personal computers (PCs). The VDC was requested by the researcher to find a convening location where a temporary computer laboratory could be set up. The VDC was able to secure one of the class rooms at the village primary school. In addition, the VDC assisted the ward heads to select 18 village trainees. The plan was to have two trainees per PC, and the tenth PC was used by the VDC and the researcher. The VDC advised the ward heads to select candidates from each village ward. The names of the village trainees were submitted by the ward heads. Originally 55 names were submitted for the initial list. The final selection was made by the ward heads, and 16 trainees attended the first day of training. Ultimately, 15 trainees attended the training from the second day up to the first four months, and 11 trainees continued for the rest of the field work, which was five more months.

5.2.4 Identifying the User Needs and Required Data

In developing an information system, which is what a PGIS is, the standard procedure was that the information that was needed to support the operations of a business were elicited from the owners of the business and the employees (Hevner et al. 2004; Robey, Welke, and Turk 2001). Within a rural livelihood social system (Wenger 1998) there was no formal business entity. The community needs were extracted from social interactions. In this case, the community needs were sourced from a number of activities. These were, the initial VDC training, the village trainees personal business process modelling projects, the GIS mapping, the social survey data, the feedback workshops, the knowledge structures building workshops and the knowledge centre financial proposal workshop. Therefore, the user needs were compiled after the first field work and verified during the second field work. These activities are shown in Figure 5.1 as the data gathering and the group decision making activities.

5.3 Plan and Design the Training Programs

5.3.1 Training Components and their Planning

The training was planned around the participatory development of a PGIS. The training involved five main components, basic computing skills, business process

modelling, basic GIS skills, basic social survey skills and basic skills in creating knowledge structures.

The organization that commissioned the task in this study was taken to be the VDC. Since in this case the VDC was not familiar with the process of developing an information system, the training started with the VDC members, so that they could obtain the capacity to participate more meaningfully and so that they could also assist with the subsequent training of the village trainees. However, the VDC received only a broad impression of the five training components due to time constraints and received most of their basic training when they assisted with the training of the village trainees. Therefore, this section focuses on the training which was conducted for the village trainees.

5.3.2. Training on Basic Computing Skills and Business Process Modelling.

The basic computing skills competence imparted the basic computer skills and information communication technology terminology which the trainees needed in order to understand the PGIS process activities. The learning outcomes were: a) trainees knowledgeable about the basic computer hardware components, b) trainees able to start and shut down the computer properly, c) trainees able to type, d) trainees able to use standard software applications, such as Microsoft Word and Excel and e) trainees understanding what folders and sub-folders are and saving files in them.

The business process modelling imparted knowledge on how modern livelihoods were conceptualized, and it provided an overview of the whole process of securing such livelihoods. Although the business model was used for the training and was linked with the PGIS process, the model worked well to include links with other social, economic and political institutions as well. For example, the identification of potential competitors in a business area which was being ventured into included using a GIS to identify the market and the competitors. The business planning included reference to funding institutions, both government and non government and a number of government institutions were mapped. The learning outcomes were: a) participants able to use the computer program development logic as a livelihood planning strategy, b) participants able to develop a mission, vision and objectives for their personal projects, c) participants able to reason out business inputs, processes and outputs, d)

participants able to produce draft business plans and e) participants able to think about implementing their personal projects.

5.3.3 Basic GIS Skills Training

The training in GIS covered concepts on fixing position and demonstrated the use of this concept to fix the position of landscape features and thus produce maps. GIS based maps were contrasted with conventional paper maps. The GIS maps represented the landscape as layers of thematic land attributes which could be combined as required to produce specific thematic maps. The digital colour aerial photographs of Tshane village were used to demonstrate the source of map data, and their georeferencing further stressed the need for proper ground positioning of landscape features when maps were produced. The training included actual georeferencing and the creation of map layer themes from the aerial photographs using on-screen digitizing. However, the mapping task was distributed among team members in order to ensure sufficient involvement by all trainees. This necessitated dividing the village into map blocks and provided the opportunity for group decision making when the activity was carried out.

The on-screen digitizing produced a preliminary in house village plots map, which did not show some of the plots which could not be detected from the aerial photographs. Therefore, the training also included field mapping activities in order to map the additional village plots data. The trainees also practised the use of existing data and learnt the value of seeking existing data before venturing to create data for their projects. In addition to mapping the additional plots, the field mapping was used to compile the basic plot data. This activity served to introduce the non-map data component of the GIS mapping.

The post field work training focused on the processing of the data collected from the field. For the mapping, this involved creating the village map layers from the field work data and the derivation of the infrastructural data from existing digital map files. The creation of the map layers introduced the participants to the ArcView and ArcMap GIS software. The basic data processing that the trainees carried out included editing the map internal tables and their field derived plot attribute tables. The training also included joining the plot attribute table to the village plots. This was followed by

practise sessions on selecting and labelling features by attributes. The trainees also learnt how to produce map layers from lists of coordinates.

The learning outcomes included the capabilities to conceptualize map features, to use GIS software, to georeference, to plan a mapping exercise, to do on screen digitizing, to do field mapping, to scan, to update a digital map, to improvise on how to carry out interviews and to conceptualize the database concept. Ultimately, the trainees learnt to recognize the computer based information systems as variations of their own traditional information systems.

5.3.4 Basic Training on Social Survey Skills and Creating Knowledge Structures

The training on the social survey was used to introduce skills on problem solving. Specifically, it was used to test the level of understanding with regard to the research project purpose and objectives. The sequencing of eight research project concept papers was used to test the information structuring abilities of the trainees. This was followed by a review of a draft questionnaire, its field testing and finalizing. The field testing provided the trainees with the opportunity to learn the art of interviewing. After the questionnaire testing the trainees agreed on a common way of conducting the field interviews, from entry and introduction to leaving the interview site. The learning outcomes imparted basic capabilities to design and field test a questionnaire. It also imparted the skill to conduct conversational interviews and fill a questionnaire. Other skills which were obtained included using the questionnaire to design digital table structures and to create forms which were used to enter data. The social survey also introduced the knowledge building activity and served as a good base for understanding and creating the knowledge structures.

The component of training which covered creating the knowledge structures was aimed at imparting awareness about the knowledge that the community members and the community development institutions had. The knowledge structures were externalizations of the knowledge contained in the minds of the holders of such knowledge. This included the village community members and the development institutions. The successful execution of this activity contributed to increased involvement by members of the community when they realized that their knowledge made them valuable members of the community and the research project. The

creation of the knowledge structures was planned around two main activities. First, an outline of what needed to be known first in order for an individual to have expertise in carrying out a task in a given area was presented. Second, the task execution process was then presented in flow diagram form in order to visualize how the individual knowledge sub-objects were structured to support the task execution process. The knowledge structure revealed the thinking around the task execution process. Some of the trainees were trained to use a knowledge content structuring software in order to convert the paper drafts produced at the workshops to computer format. The learning outcomes here included: a) the acquisition of basic capabilities to structure a group decision making process, b) the realization of the need to be explicit when articulating internal knowledge so that the product could be useful knowledge content for other community members, c) the acquisition of new ways to structure individual thinking and to provide the mechanism by which the community members could share their knowledge content.

5.3.5 The Learning Strategy

The initial strategy was to use brief lectures to provide overviews of concepts and use demonstrations to portray contextualized and productive practical application. The idea was to plant base knowledge first so that this knowledge could support the understanding of more detailed information, essentially a constructivist approach (Merrill 2001). However, it became clear that most people were struggling to cope. Subsequently, the training was planned around and based on what the field work needed to achieve, thus switching to a more experiential approach (Kolb, Boyatsis, and Mainemelis 2000) and a bias toward andragogy (Hase and Kenyon 2000). The learning sessions were planned on a daily basis and the movement forward was determined by the absorption capacity of the slowest learner. This was essentially similar to criterion referenced instruction (Mager, 1988). This approach was necessary because each individual was expected to comprehend enough and to acquire the skill that was needed to carry out the research project tasks and produce reliable output. This was the basic thesis of the research. The learning cycle that was used is depicted in Figure 5.2 below.

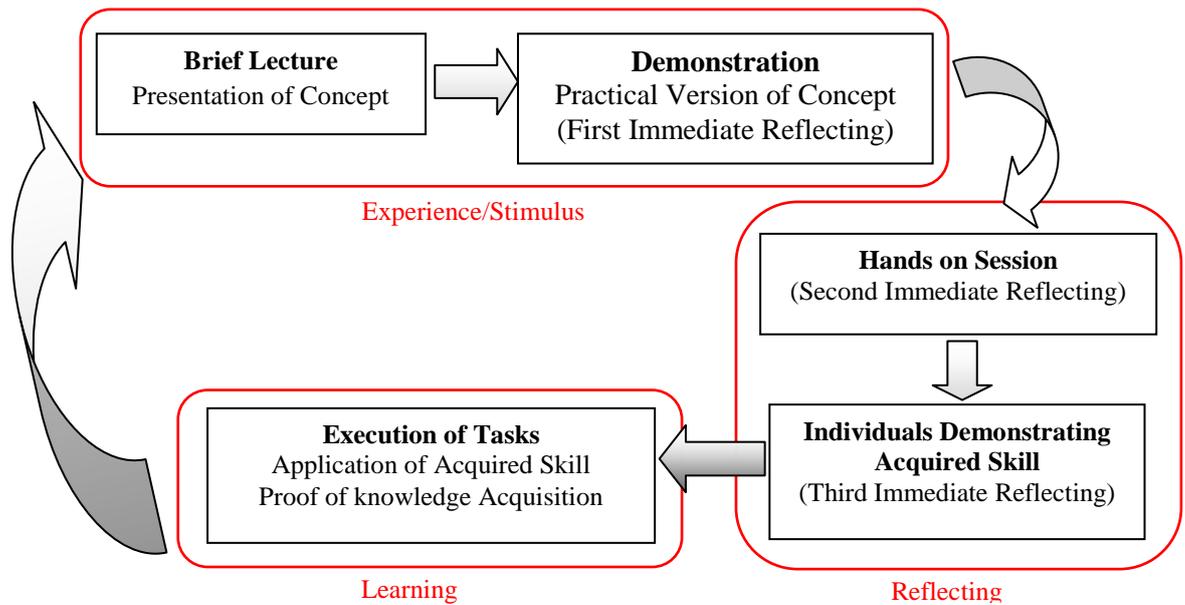


Figure 5.2 The adopted learning process in Tshane research

Although this strategy was initially an instinctive response to a field situation, it corresponded to some configurations of the experiential learning cycles. For example, it could be simplified into the Brathay 3-stage learning cycle (Do-Review-Plan/Apply). It could also be broken down into the Kolb 4-stage learning cycle (Concrete Experience-Reflective Observation-Abstract Conceptualization-Active Experimentation) (Baker, Jensen, and Kolb 2005) or it could even be considered to be a variation of the 5 components Race Ripples Model of Learning (Wanting-Needing-Doing-Making Sense-Feedback, Race 2005). Essentially, all the sections that follow represent outputs that were created by the field training sessions. Therefore it is difficult to separate the training from the field work, because the training was the implementation mode of the field work. Using this learning approach, three main training components were carried out, the village trainees individual livelihood projects, village plots mapping and determining the sampling frame and questionnaire design and the social survey. The social survey also included the administration of an attitude scale.

5.4 The Community Training

5.4.1 Basic Computing Skills

The basic skills which the trainees needed to have before any work involving computers was carried were: familiarity with the basic computer hardware and

terminology, basic computer hardware set up, which was the ability to connect the basic components of a simple stand alone computer system, proper password based switching on and proper shut down procedures, the windows environment and how to open, minimize, maximize and close windows, typing, windows explorer and naming and saving files, Microsoft Word, Microsoft Excel, Microsoft PowerPoint. Microsoft Word was also used to create text documents and to create illustrations, basic skills included adding shapes and inserting images. Microsoft Excel was used to create simple tables and to enter simple formulas. For a week, the daily training was preceded by a routine of 15 minutes of start-up and typing tutor practice. The practical sessions were based on actual required products. For example, the introduction to Microsoft Word involved typing hand written drafts of personal project proposals. Microsoft Excel was used to design a class list table, thus introducing the digital table concept and the associated terminology. Windows explorer was introduced when personal folders and sub-folders for the respective applications needed to be created in order to save the files. The files were then named properly and saved. This on-the-job type of learning was used for all the subsequent training.

5.4.2 The Business Process Modelling

One of the goals of the field data collection was to inform the information system data analysis process (Shelly, Cashman, and Rosenblatt 2006). The data collection activity itself was carried out with the aid of what is referred to in this research as *individual project based on-the-job training*. Personal projects and computer workstations were used to anchor the learning (Shyu 2000). Thus, right from the beginning of the training, each individual community team member conceived a real and practicable project that they developed during the course of the training. This approach follows the principle of self-determination by acknowledging that personal attributes and differing levels of need underpinned the pursuit of goals (Ryan and Deci 2000b). This then influences individual behaviour as individuals had their own specific projects.

The process of developing these individual projects provided the opportunity for the varied learning opportunities that arose because of the need to plan or implement the projects to completion. This was also an essential component of adult learning (Hase and Kenyon 2000) which justified relevance by emphasizing direct application after the procurement of training. The direct practicability requirement was also supported

by the functional context theory (Davidson-Hunt and Michael 2007) whereby the training activities related directly to those in the application domain. In addition, the learning strategy used activity theory (Jonassen and Rohrer-Murphy 1999; Cole et al. 2005), and problem based learning (Barojas 2004). This research highlighted that learning much more than any other component of the participation process, is the most important input to empowering the individuals to attain adequate levels of self determination. While it is not necessary that the facilitator had full knowledge of most of all learning theories, it was important that he have familiarity with those that become evident when individuals were engaged in learning. Social development theory and social learning theory (Schusler, Decker, and Pfeffer 2003) also became important as a number of trainees relied on the subsequent assistance of fellow trainees to complete their tasks and thus learnt in the process.

The development of the individual projects eventually passed through six stages: the project vision, the initial one page project description summary, first draft poster, field assignment supported second draft project poster, project details and business calculations and project business plan. There were 11 projects altogether: i) free range chicken production, ii) buying chicks, raising them and selling, iii) brick moulding, iv) goat rearing, v) building construction, vi) tailoring, vii) software engineering, viii) hardware support, ix) wireless internet services, x) wireless network services and support and xi) selling computers and other hardware components. A simple graphic was used to depict the project vision. Figure 5.3 below shows the design that was used to represent the three main components of the computer program development logic (CPDL) which was used to inform this activity. This basic design was also used as the generic project vision.

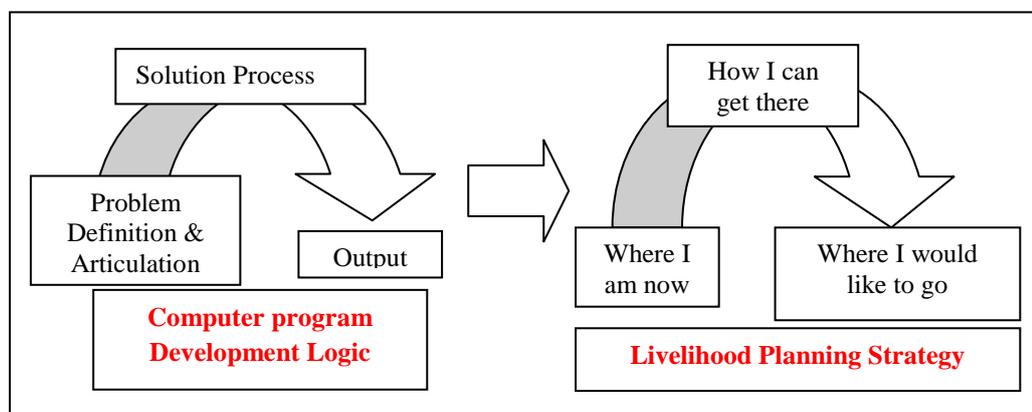


Figure 5.3 Computer program development logic as a livelihood planning strategy used in Tshane village

Using the project vision as a guide, each community team member outlined the undesirable situation in which they placed themselves, visualized a desired future state and determined how they planned to achieve that future state in regard to their personal circumstances and livelihood. This outlined a typical problem based learning scenario (Jonassen and Strobel 2006). The project description was then used to explain the project vision. Even at that basic level, the project description provided a clear opportunity to understand the thinking strategy which was required to accomplish the task, because the specification of the processes required detailed and unambiguous inputs. In this way both the data and the processes were identified. In order to facilitate further planning and work on the project, the community trainees also added appropriate graphics to the project vision in order to further substantiate their projects. The team also carried out field assignments in order to obtain more appropriate imagery and additional data for their projects. The last stage of the project poster required each project owner to represent all the basic activities which were required to achieve given outputs complete with attendant costs. This introduced the trainees to basic business planning. Part of this work is shown in Appendix A.

The business plan was the last project output. Based on a provided business plan template, each trainee was guided to complete business plan entries for their projects. The last stage of the project poster and the business plan clearly identified the database objects, the processes and possible relationships. Subsequently, the researcher added the trainee outputs to a pool of database objects from which the tables, fields, relationships and rules were created. The researcher also developed a Microsoft Excel based template which the second group of trainees used to simulate production for various scenarios of their projects. This template was referred to as the *cyclic arc of self actualization* (CASA) and is presented as Appendix B.

5.4.3 Mapping Base Map Layers and Determining the Sampling Frame.

The village plots map layer was one of the base data layers and represented the core dataset upon which the geographic database was founded. In addition, the village plots were used to determine the population from which the sampling frame was drawn. The village plots were digitized from colour aerial photographs which were obtained from the Department of Surveys and Mapping (DSM). An existing digital line map of Tshane village (also obtained from the DSM) was used to georeference

the aerial photographs before the digitizing was carried out. On-screen digitizing was used to create a polygon feature file for the village plots. Two versions of the ESRI GIS software were used. ArcMap 9.2 was used to georeference the aerial photographs before they were digitized and later to update the preliminary map. The actual digitizing was carried out using ArcView 3.2. The reason for this was that there was only one copy of ArcMap 9.2 whereas ArcView 3.2 was installed on all the personal computers. This enabled all the class members to have the opportunity to learn how to use the software. In order to facilitate participation by all community team members, the trainees divided Tshane village into seven blocks and a team of two trainees was assigned a block to map. The team used a projected image of Tshane village to divide the village into the seven blocks (Figure 5.4).

The first task was to do in-house mapping for the plots whose boundaries were clearly visible on the photograph of the village. The second task was to do field mapping for the plots which have been allocated by the Land Board but whose boundaries did not appear on the aerial photographs. These included the plots which were not fenced and those which were fenced but whose boundary could not be discerned from the aerial photographs. The field mapping involved obtaining field measurements for the plot boundaries and the passages in between the plots. The measurements were used later to plot the missing plots on the aerial photographs.

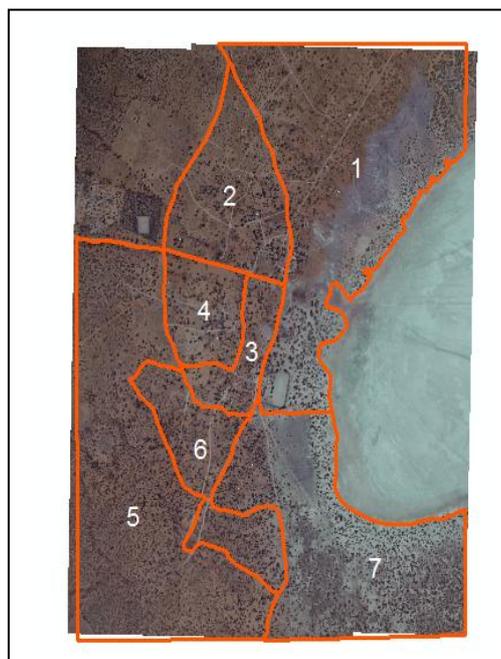


Figure 5.4 Tshane village divided into seven blocks

In order to ensure that the field plotting would be done properly, the field work plotting exercise was practised first before it was actually carried out. The pre-field plotting exercise also served to introduce the concept of mapping accuracy and the need for exercising particular care in taking the measurements as accurately as possible. Since there was only one distance measuring wheel, the plot dimensions were measured by pacing. In order to check the accuracies obtained by each person, the measuring wheel was used to obtain test measurements for the standard 5m passage that is kept between the plots and the standard plot size of 40m by 40m. The strides for normal walking paces were measured for all the trainees. Each person then practised taking the measurements and converting them to actual ground distance in metres. A simple differencing technique was used to compare the test measurements with those obtained by pacing and thus demonstrate the concept of accuracy. The actual accuracies were calculated later using the root mean square error.

The actual ground measurements were then converted to printed photograph measurements and sketched onto the photograph. Reference objects were used for orientation purposes and to establish the corner points of the plots as accurately as the situation allowed. The map scale concept was crucial in mapping between field and image coordinate spaces. Therefore, rigorous measurements and unit conversion drills were carried out first before each team ventured out to the field on their own. During the field mapping some basic data was collected for all the plots. This data included the type of fencing, the number and type of houses in the plot, and whether the plot contained any of the basic utilities (water, power, telephone) or not. Other additional data such as number of persons per plot, were added later when the sample size was determined.

Subsequent to the field plotting, the field updated printed photographs were scanned, georeferenced and overlain with the original plots polygon file in order to update it. Each team edited the polygon feature attribute table and numbered the plots for their block. Since the team used the same set of photographs and one polygon file in the ArcMap software, there was only one updated polygon file. However, the additional plot attributes which were compiled from the field were still in separate team tables. The process of determining the population, the sampling frame and finally the sample was done separately per block at the separate ArcView workstations. This is discussed in more detail in the next section.

5.4.4 Questionnaire and Attitude Scale Designs, and the Social Survey

A draft questionnaire was used to introduce the questionnaire design concept. The draft questionnaire was subsequently reviewed and tested in a number of class discussions and group work. The questionnaire was also tested on the community, reviewed, corrected and finalized in class discussions. The actual field testing of the questionnaire was done at the same time as field map plotting. The community team then personally administered the questionnaire.

The questionnaire review process was guided by a set of three questions: a) what does a good living standard mean b) what do we consider and c) what do we do about those who are still not able to improve their living standard? Three groups were convened to work on this task. A poster that was produced by one of the groups is shown in Figure 5.5. After determining the meaning of a good living standard, the target households then became those that did not meet this criterion. The questionnaire was built around determining what questions needed to be asked in order to identify the households which were still living in poverty.



Figure 5.5 Tshane village: Determining what good living standard means

The criteria that were used to select the target households was based on two main characteristics: a) single roomed structures (both mud and brick walled) which served as the main houses and b) households where the ratio between a room and number of persons was smaller than 1:2, which was the guide that was used by the

Botswana National Housing Policy (Government of Botswana 2000). The process of selecting the sample was carried out in two main phases. At the first phase the plots which were considered to be up to standard were identified and excluded from the population. The empty plots were also identified and excluded from the population as well. The plots which remained from the first phase represented the population. The second phase used the selection criteria to refine the population further into a sampling frame. The team then used the data compiled during the field mapping and their knowledge of the households and also conferred with each other in order to determine the number of people living in the households. They then compared the number of people and the houses in the plots to determine the room occupancy ratio. Where the house types were difficult to remember, ArcView was used to zoom in on the plot in order to identify the house types. Ultimately, the sampling frame was divided by seven (number of teams) and the resulting number of households was distributed among the teams so that the owners could be interviewed.

With regard to the derivation of the attitude scale, the same process which was used to finalize the questionnaire was used. A draft attitude scale was used as a sample of what an attitude scale was and the type and format of questions that needed to be asked. The trainees first tested the questions on themselves. This was followed by a class discussion and the correcting of the initial draft to produce a final attitude scale. The attitude scale was not tested on the community. The trainees administered the attitude scale through personal interviews.

5.4.5 Basic Spatial Data Processing and Analysis

After the social survey a short training was conducted on how to integrate the mapping and the social data within the GIS. This involved linking the basic village plot data which were compiled during the field mapping with the respective village residential plots. The village plots data records which were compiled at the field were assigned the plot feature identity numbers of their respective plot features. The externally produced table was then joined to the village plots file, thus the village plots features then contained the data which indicated the house types within each plot and the number of people who lived in the household. Using this information a simple query was used to identify all the plots where the house type was the lowest grade or where the ratio of the number of people to a room was less than 0.5. The sample size

determined in this way compared well with the sample size which was determined manually. Ninety five households were selected manually and 97 were selected using the GIS query. Each pair of trainees was given a complete set of data to practice with.

In addition to selecting the sample size, the trainees practised labelling the village plots with different attributes. Even such simple analysis presented information in a more revealing way because the information was placed where it applied, and the distributions discerned revealed certain social patterns in the village. For example, it clearly showed which parts of the village portrayed the highest concentrations of poor housing. This part of the training was intended to demonstrate the generation of knowledge and its potential usefulness to the village community development effort.

5.5 Village Community Way Forward

As the review of the literature identified, in many participatory development projects, empowerment and improved livelihoods are not demonstrated. Cleaver (1999) notes that participation in development projects was a paradox and that empowerment and improved livelihoods were not demonstrated as outcomes, neither were the outcomes evaluated for their effects to produce consequences, whether positive or negative. However, with regard to this research, at the end of the nine months of field work in Botswana, the community had responded in two ways. First, they had chosen to emulate the research project's knowledge for human development concept, by pronouncing and naming a knowledge centre they wished to establish. Second, the other community members were awaiting their turn to enrol into the initiated training program. Consequently, as a way forward, the community requested for and were donated second hand computers by one government ministry. In addition, the VDC had begun to upgrade their office so that it could eventually be used to house the community knowledge centre. The community then began planning for the second set of village trainees.

5.6 Creating the Knowledge Content Repository

This stage involved two main activities, the creation of the shelter and goats prototype and the compilation and integration of the knowledge content. These two components constituted the knowledge content repository. The creation of the prototype involved the development of a geographic database and a user interface. The system

development life cycle (Shelly, Cashman, and Rosenblatt 2006) was used to guide the production of the geographic database. The integration of the knowledge content was part of the process of customizing the ArcMap user interface.

5.6.1 The Shelter and Goats Prototype

The two components of the prototype were the geographic database and the user interface. The creation of the geographic database involved compiling both the map and non map data. For the map data separate datasets for the shelter acquisition and the goat rearing were built and topologies were created for them. The spatial reference was a combination of the World Geographic System (WGS) 1984 datum and the universal transverse Mercator (UTM) zone 34 south projected coordinate system. A standard tabular database was created for the non-map data. This activity involved requirements modelling, conceptual data modelling, logical data modelling, the creation of the database in the Microsoft Access database management system and the importation of the tabular data into a personal geodatabase in ArcCatalog.

The community requirements were derived mainly from the social survey data by considering the responses to the issues which the community felt strongly about. The basic logic followed in determining the requirements was that the requirements were interpreted in ordinary language as what was needed by the community members. What was needed by the community was then deduced from what was most lacking. The social survey data were processed to provide the numerical summaries which were used to indicate the needs expressed by the highest percentages of responses. However, the trainee expectations and the business process modelling which were based on these expectations also revealed essentially the same set of needs. The workshop which was convened to prepare a project proposal for the village knowledge centre also revealed the same set of needs. This stage was followed by the conceptual data modelling.

The conceptual data model was considered to be the layout of the objects which supported the various livelihoods in the village. The themes included, the village plots, basic data about the plot owners, types of shelter built within the plots, livestock (ownership, types and uses), arable land (ownership, use and crops grown), water sources for both domestic and livestock uses, varied types of energy used, veldt

products which were gathered and used to support livelihoods, health, information, knowledge, income sources and living standards. However not all the themes were used to produce the livelihoods conceptual data model, the main building blocks used were, the village plots, the plot owners, the livestock, the arable land, income sources and the supporting infrastructure (roads, power lines and water reticulation pipe lines). An assessment of the coverage of the core themes within the questions was made and the livelihoods conceptual data model was created. The conceptual data modelling task was carried out in two stages. The first stage created a livelihoods conceptual data model for all the village livelihoods. The second stage created a smaller conceptual data model for the livelihood objects which were relevant mainly to the sampled community. These were the acquisition of shelter and the rearing of goats. This was done in order to reduce the workload to a manageable proportion.

Whereas the conceptual data model presented the livelihood objects and their relationships in ordinary language and was meant to facilitate more general dialogues, the logical data model began the process towards a more technical database creation and management language. It required more information about the objects to be included and was concerned about creating the structure which would be implemented in the actual creation of the database (Date 2005). The logical data model required the explicit qualification of the tables and their attributes. It also required the identification of the key columns which would be used to link the tables as guided by the processes of the actual activities in the real world domain. This required the identification of the processes involved. The dataflow diagramming technique was used to derive the lowest level data flow diagrams (DFDs) from which the process descriptions were derived. The basic understanding here also came from Wang (2004) who considers that computer programs support thought processes and that such thought processes were involved in problem solving. The DFDs were used to identify the main data items and these were used as the fields that defined each table that was required.

In the case of shelter, the envisaged scenario was that a village community member needed to have decent shelter and that there were a number of activities which the community member needed to carry out. These included applying for land from the Land Board, fencing the plot, building the house and connecting water and power. With regard to the goat rearing, the rationale was that the goats had been noted to be

easy to keep and that they multiplied fast. Thus a community member was expected to be able to obtain the goats, build a corral, raise the goats to a certain optimum number and then start selling them in order to make a living out of them. The information which has just been outlined contained the objects and the relationships that were needed to create the logical data model. The next stage was the building of the database.

The geographic database was built using ESRI's ArcGIS software suite (ArcMap, ArcCatalog and ArcToolBox) and Microsoft's Access database management system software. A geodatabase project profile was created in ArcCatalog in order to contain the geographic database objects which were created. Although it was possible to create the attribute database tables in ArcCatalog, Microsoft Access was used instead since it offered more control in designing the tables than ArcCatalog. This was because as a full database management system, it contains more latitude in defining the attribute data types and qualifying the field properties. Once the tables had been created, the form wizard was used to create the data entry forms. The tables were designed in Microsoft Access and then imported into the ArcCatalog geodatabase. This was easy to do since the relational database management system in the ArcGIS software is also Microsoft Access.

5.6.2 Compiling and Integrating Other Knowledge Content

The development of the geographic database and the shelter and goats prototype covered only part of the knowledge content that was intended to support the community livelihoods. The other data sets which were compiled included: a) the business process models, b) the business plans, c) the application forms which had been converted to computer format, d) records of the development of the village knowledge centre, e) the knowledge structures which were created at the community workshops, f) the voice recordings, g) the video files h) digital photographs and i) the literature on various themes. The combined datasets formed the knowledge content repository (KCR).

The prototype was created by customizing the ArcMap user interface. However, due to lack of programming experience, only a very simple customization of the ArcMap user interface could be carried out. The basic design which was followed used some

of the concepts of the generalist metaphor. Based on this the prototype was envisaged as two map documents, that is shelter acquisition and goat rearing, and storages of the basic data. This data included information and knowledge which was compiled during the research project. The generalist metaphor relied on the village community's familiarity with a wide range of the community's subject matters. In this case, it was assumed that the community language contained a vocabulary that was adequate enough to facilitate the use of its terms to search for the knowledge content which was contained in the KCR. The user interface was created by removing most of the tool bars from the ArcMap user interface except the main menu, tools and standard tool bars. An additional tool bar was created and populated with the tools that enabled access to the stored data and to software which was used to aid in the creation of knowledge and the management of both knowledge and community communications. In order to facilitate public wide access to the village knowledge centre, a webpage was created which was planned to be accessed through a wireless network in Tshane village. The envisaged structure of the operating community PGIS infrastructure was a radial network of computers. The VDC office served as the hub and the periphery was made up by the village wards.

Access to the data was planned to be in three ways. First, a number of the datasets and media such as policy documents, business plans, voice recordings and video clips were hyperlinked directly to the households and institutions in the respective village plots and institutions map layers and could be accessed through these map layers. Second, since the datasets were archived, they could also be accessed in the normal way by navigating to the respective folders and opening the files. Third, the data could be accessed through a web page.

With regard to supporting a number of activities in building knowledge, such as collaboration work, communications, data processing and analysis, a number of basic freely available software formed part of the KCR. These included ArcView 3.2 GIS software and Cmap Tools which was used for creating knowledge objects. Other KCR components were: a) the KPlan software which was used to manage the communication (calendars, notes and activities and contacts) and to facilitate access to the documents where the Microsoft Office applications were not available and b) the Dia software which was used to support the creation of conceptual data models. In

essence the KCR was set up to support people to work together in order to build and share livelihood experiences.

5.7 Feedback and Evaluating the PGIS Process

A second field trip was carried out in order to provide feedback to the village community. Five workshops were conducted. First, the results of the social survey and attitude scale were reported. These were presented by the village trainees in the local language. One VDC member who was proficient in translating between the official languages (Setswana and English) and the local Setswana dialect (*Sengologa*) served as the main facilitator at the workshops. The villagers provided written responses and those who could not, presented their inputs to the trainees who then recorded the inputs. Every community member who attended the workshop provided written input. This was effective in making all workshop attendants voice their opinions. The use of the local language made the workshops lively and interesting for all the participants. At the end of the workshop the participants were required to make suggestions for the way forward.

The second workshop was used to obtain input about what the village development committee (VDC) and the village trainees had learnt from their experience with the research project. These participants were also requested to indicate their way forward. The VDC and the trainees were provided with forms which they filled to provide the required input. The third workshop was convened for the community development institutions. In this case too, the institutions were provided with forms to fill in order to provide their input. The main information which the forms solicited were, institution's main mandate, relationship with other institutions, services provided, legislation used, policies used, community development capability, research project support options, institution's threat to the achievement of the research project objectives, institution's stakeholders, and areas of conflict with the other institutions.

The fourth workshop was convened to produce knowledge structures. The village community and the development institutions first produced tabular summaries of what their services were and what basic facts needed to be known in order to understand their services. Secondly, illustrations were produced on how the services were provided and the role the community was expected to play in the processes. The tabular summaries and the illustrations of services constituted the knowledge

structures. The fifth workshop which was convened was concerned with planning the way forward for the establishment of the village knowledge centre. Four outputs were produced: the mission and vision statements, the objectives and the activities of the objectives. The activities of the objectives were intended to be the activities that could carry the community forward during the period when the formal research project was being finalized.

The evaluation was carried out in two ways. First, an evaluation of the components of the PGIS framework was carried out based on the activities carried out and the outputs which were obtained at each PGIS process stage. The rationale for carrying out such a type of evaluation was to provide information that could be used to assess the research vigour (Nyerges, Jankowski, and Drew 2002). The basic aim was to score the level of participation as an indicator of the empowerment level reached at both individual and collective levels. An evaluation criteria used by Beierle (1999) was used to effect a three score rating. A score of 'one' represented the acquisition of capability which was not sufficient to empower action. A score of 'two' represented the acquisition of capability that was likely to empower action and a score of 'three' represented the acquisition of capability which ensured the empowerment to act. In order to make firm conclusions, the three scores were collapsed to two. The score of 'one' represented the acquisition of insufficient capability and therefore indicated non sustainability and was given a decision choice of zero. The scores of 'two' and 'three' represented acquisition of sufficient capability and therefore indicated sustainability, and were given a decision choice of 'one'. The outcome of two logical options resulted with four sustainability options. This is shown in Table 5.1.

Ultimately however, some of the outputs could not be scored but were interpreted to have either sustainable or non-sustainable consequences. In addition to the evaluation performed by the researcher, the same evaluation criterion was carried out at the project site. In that case, the level of achievement of goals was checked. A template was created for this purpose which the community members filled and appears as Appendix 3.0. The evaluation was done by seven village trainees, one VDC member and four ward members. The evaluation made by the researcher was then compared with the evaluations made by the community.

Table 5.1 Capability scores and sustainability ratings

Individual Capability	Collective Capability	Community Empowerment	Interpretation	Explanation
0	0	No	Non sustainable	Both components not sustainable
0	2	Yes	Sustainability	Community development represents collective work, strong collective capability was taken to indicate awareness of weak individual capability and the need to compensate with collective contributions
1	0	No	Non sustainability	Poor collective capability meant failure to work cooperatively, individual successes were shielded from communal benefit and the community as a whole suffered
1	1	Yes	Sustainability	Both components sustainable, this was the most ideal outcome

5.8 Chapter Conclusions

This chapter discussed the methods which demonstrated how the RCK-PGIS process was used to anchor the learning that was facilitated by the researcher and the VDC in order to work with the Tshane village community. The work created both spatial and non spatial data which were subsequently used to construct the PGIS prototype. The training included: a) basic introductions to computing, b) business process modelling, c) basic GIS mapping skills, d) questionnaire design, testing and the social survey, e) feedback workshops and f) the construction of the knowledge structures. The methods also covered the issue of the way forward for the village knowledge centre, the design of the database, the development of the PGIS framework and the evaluation of the PGIS process.

A number of conclusive observations were made. First, although the actual work with the community was both mentally and physically challenging, it was made worthwhile by the lively involvement of the community members. It became clear that when there was mutual respect between collaborating partners, the power imbalance was neutralised by the contribution of ideas and knowledge by both partners. Second, the training imparted the skills to carry out the research tasks successfully. It made the data collection easier and faster. The information which was collected reveals the sharing of closely held knowledge. The level of honesty of the

answers which were provided could not be obtained by an external investigator alone. This indicates that with more experience, the community would be able to determine the cause of its apparent acquiescence with regard to the improvement of livelihoods at the household level.

The third observation is that with regard to the data structuring, the community provided enough information to support the conception and development of the shelter acquisition and goat rearing PGIS prototype. The important point to note in this case is that all the data that were collected relates to the community's objectives. Despite the fact that the actual data structuring was carried out away from the community, they nonetheless felt they contributed by specifying what the prototype should include. The fourth observation was that the evaluation strengthened the participation. This was because the community members realized that their involvement was not meant to provide information only. Their interaction with the information that they had provided and the need to move forward with it created a sense of ownership, pride and appreciation for being included in the research activities. The last observation is that the particular attention which was paid to the community members who developed and progressed with the project, raised awareness that the community members were expected to respond to the challenge of improving their living conditions themselves. These expectations were made explicit by frequent references to the way forward with regard to the individual community member project, the issues raised by the social survey and attitude scale and the village knowledge centre.

Overall, the implementation of the RCK-PGIS proved that the strategy worked and that the community members could respond and act to achieve livelihood outcomes. Some of the results that are worth mentioning at this point are the institution of the village knowledge centre, the preparation of the VDC offices to house it and the institution of the village training programme. The task that was less successful was involving the community development institutions in the research project activities and the livelihood projects that were created by the community. The other component which need following up is the actual operationalization of the RCK-PGIS and the community development institutions are expected to play an important role.

CHAPTER 6 RESULTS AND DISCUSSION

The results are discussed in two parts, the outcomes of the implementation of the Rural Community Knowledge participatory geographic information system (RCK-PGIS) framework are discussed first, and these are followed by the presentation of the final version of the RCK-PGIS framework. Based on the components of the final version of the RCK-PGIS framework, seven outputs and outcomes are presented. Therefore, this chapter presents outcomes on the convening, the facilitation, the data gathering and group decision making processes, the development of the PGIS prototype and knowledge content repository, the testing and evaluation of the PGIS prototype and early attempt to operationalize the RCK-PGIS infrastructure for community use and creation of community outputs. The seventh component is the overview of the final version of the PGIS framework. At this chapter of the thesis, there was need to be more explicit about how the central terminology of the PGIS framework was used. The PGIS framework was used to refer to the network of components, sometimes the phrase PGIS process was used. The PGIS infrastructure was used to refer to an instantiation of the individual components of the PGIS framework. The abbreviation PGIS, when used on its own referred to the information technology artefact.

6.1 Outcomes of the Convening Process

This activity was carried out by the tribal leaders (chief, ward herds and village councillor) and the village development committee (VDC), the researcher assisted the VDC with the overall facilitation of this process. This activity therefore covers the first components of the PGIS framework, namely the leadership and the facilitation. The results of the leadership roles will be presented first, although it was difficult to dissociate the involvement of the VDC from the leadership activity since it was the executive component of the leadership structure. The tribal leaders were involved in receiving and approving the research project, initiating and facilitating the convening of the village public meetings, facilitating the acquisition of the resources and services and mobilizing the community for collective action. This represented the first outcome of the village leadership, which was re-instituting the community development function and creating a revised view of the village setting.

6.1.1 Leadership Outcomes

The activities that the leadership were engaged in were the problem verification, the review of the solution modelling, community mobilization, securing of a convening location and selecting the village trainees. Subjective scoring was used to judge the level of acquisition of capabilities for both individuals and the leadership collective. A score of ‘one’ represented the lack of capability, a score of ‘two’ represented some capability and score of ‘three’ represented successful acquisition of capability. Table 6.1 shows the results of the scoring.

Table 6.1 Levels of capabilities attained at the convening processes of the PGIS framework

	Chief	Ward Heads	VDC	Councilor	Collective capability
Problem Verification	2	2	3	2	2.25
Solution Modeling	2	2	3	2	2.25
Community Mobilization	3	3	3	2	2.75
Convening Location	2	2	3	2	2.25
Selecting Trainees	3	3	3	2	2.75
Individual capability	2.4	2.4	3	2	
Individual of involvement	Empowerment ladder rungs				
1	no		1		non
2	partly		2		tokenism
3	yes		3		empowerment

The problem verification involved discussing and agreeing on the problem articulation draft which was presented by the researcher. The recognition of the lack of knowledge was readily acknowledged by the chief, the VDC and village councillor. Based on this, the involvement of the leadership in the problem formulation was given a score of two. The reason for this score was that the leaders had not initiated the project but were aware of the problem. The review of the solution modelling was also given a score of two because the leadership welcomed a project which aimed to involve the participation of the community up to the household level. The community too responded positively to being recognized as knowledgeable and therefore valuable members. One VDC member revealed how widespread the interest in the project had

become in Tshane. An extract of the speech she gave at the University of Botswana is presented below.

Gone jaana re bulegile ditlhaloganyo ko Tshane....Ke setse ke itse gore nka golaganya dipudi le dikgomo tsame jang le computara....Bontsi ja rona ko Tshane re bone mosola wa project e. Mme ebile ba bulegile ditlhaloganyo gore mme ebile kamoso, ke tlile go dira se le se. (Legeru 2007)

This is translated as follows:

At the moment our minds have been opened in Tshane....I know now how to link my goats and cattle with the computer....Many of us in Tshane have realized the value of this project. Moreover, the people's minds have been opened, they have begun to imagine certain futures and to note that I am going to do this and that. (Legeru 2007)

The highest scores were obtained for community mobilization, securing the convening location and selecting trainees. This was mainly because these were well within the capabilities of the leaders and did not involve any use of capital resources. The community mobilization momentum was enhanced by the visit of the researcher's supervisor. The community went to the *kgotla* (village public meeting place) to see him, but they turned up in unusually large numbers for a *kgotla* meeting for both his reception and his farewell. This was good for the participation of the community regardless of their reasons for attending. It was also useful for drawing out the ward heads who were reacting slowly to the research project activities. The visit underscored the importance of the involvement of what the community considers to be higher authority in supporting the community initiatives. The participation by what was locally perceived as a higher cast of person, made the community activity more real and worthwhile and contributed to the improved participation. The workshops particularly benefited from that particular visit, because the *kgotla* attendances were unusually high too.

The selection of the trainees and the convening venue represented an important part of the PGIS process. The quality of the trainees contributed to the successful completion of the PGIS building stage. The basic requirements for a convening venue also contributed to the successful completion of the PGIS building activity. The basic

requirements for an appropriate PGIS process venue were a dependable electric power supply, for a hot desert environment a basic requirement was air conditioning, not just for personal comfort but mainly for the safe keeping of the computer equipment. For the safe-guarding of the equipment itself there was need for a secured facility. The primary school venue met all these requirements. The classroom door was fitted with steel burglar bars and the windows were very high off the ground, the school premises were guarded at night, the classroom had ceiling fans and the power cuts were not common.

The problem verification and the solution modelling were only slightly outside the tokenism rungs of the ladder of empowerment. Nonetheless, this was not taken to be a lack of empowerment but rather a lack of adequate experiential knowledge and supportive resources to initiate action. A speech by one of the ward heads at the research projects's inception at the *kgotla*, revealed part of this knowledge lack. The speech refers to the researcher (translation immediately below):

Kgang e e leng monate mme ga e monate nate, ya go phaka dijo, ke gore re tsaya gore ke yone number one. A kere o bona gore ke rutegile jang, jaaka ke ne ke go bolelela mong waka...ke itse go aga matshelo...ke gone go ruta motsomi wa ditlhapi gore tlhapi e ka bolawa jang, e seng go bona hela di bewa fa...ke ne ke amogela rre ka atla tsoo pedi, ke bo ke ikuela mo go bagaetsho gore a re mo amogeleng ka go mo tshologa....re anywe sepe mo go ene, le ene re mo amuse gore Tshane o simolotse go rileng, go rileng...boikuelo jame e ne e le gore a e re se se buiwang, re se tsibogele...(Kalantle 2007)

A pleasing issue but not so pleasing, the practice of receiving food rations, what we take to be priority number one. I am sure you realize the education I have picked up, as I had told you my Lord....I know how to make livelihoods....that is how to teach people to fish, unlike being given fish constantly. I was receiving you warmly to this gathering sir and appealing to my fellow community members that we should welcome you by participating in large numbers....so that we can benefit something from you, and that you too should know the history of Tshane from us and how the village was

formed....my appeal is that we should heed whatever he shares with us.
(Kalantle 2007)

The metaphor of fishing refers to the necessity to acquire productive skills but does not refer to any sources for such skills, how to access them and what in fact fishing entails. Nonetheless, the village leadership revealed that they had an adequate supply of wisdom. Three months after the research project had begun they communicated their wish to emulate the research project by developing a village project. Subsequently, at one of the *kgotla* meetings, the village community gave the village project the name “*Mashego a Lobu*” Knowledge Centre”, which means “The Pan’s Blessings” Knowledge Centre. The vision, mission and objectives of the *Mashego a Lobu* knowledge Centre are presented in Appendix 4.0. The institution of the knowledge centre represented the second output of the leadership. The establishment of a village project was a clear indication that the village leadership was assuming ownership of the project. They took pride in announcing that it was no longer Mulalu’s project. They took every opportunity to announce the research project at all the *kgotla* meeting which were convened for visiting officials.

The village leadership was also able to produce two other outcomes. In planning the way forward, one of the priorities for the leadership was to ensure the continuance of the initiated village training programme, because a number of community members were awaiting their turn to enrol in the training program. The village leadership was assisted by the researcher to secure seven second hand computers from the Ministry of Finance and Development Planning. The second priority was to plan for the building of the knowledge centre. The VDC and the village trainees were requested by the village leadership to practice their newly acquired skills and to produce a draft proposal which could be developed into a funding proposal. The original draft of the *Mashego a Lobu* Knowledge Centre proposal is presented in Appendix 5.0. This will be discussed in more detail under the VDC outcomes. All the leadership inputs and outputs were facilitated by the VDC and the researcher.

Ultimately, five outcomes resulted from the activities of the village leadership, the re-institution and crystallization of the leadership’s community development function, the institution of the village knowledge centre, the institution of the village training program, acquisition of computers for community use and the formalization of the

planning for the way forward for the village community. In considering these five outcomes, this research project concluded that the village leadership exhibited the appropriate leadership qualities to support the sustainability requirements of their role. They led the VDC and the community, and created a vision and an anchor for the community's way forward. Nonetheless, for all the leadership activities, the VDC and the researcher played important facilitation roles. The critical role of the facilitation function is discussed in more detail under the outcomes of the VDC facilitation role.

6.1.2 Outcomes of the VDC Facilitation

Within the PGIS framework, the VDC's main function was to facilitate, energize and maintain the flow of activities of the participation context. This activity highlighted the critical importance of the facilitation role and represented the first outcome of the VDC involvement. It was difficult to score this activity but it was interpreted to have non sustainable individual capability and sustainable collective capability. This was because the VDC was weak with regard to individual capabilities but strong as a team. The VDC was therefore involved in all the components of the PGIS framework. However, the VDC also had its own specific outputs. The second main output that the VDC created was the communication framework (Figure 6.1) which needed to be in place for the leadership to play its role in leading the community participation process. This activity was also not scored but was interpreted the same way as the preceding activity with regard to the non sustainability of the individuals but strong team effort. A closer look at Figure 6.1 reveals that it contained five of the seven components of the PGIS framework, the missing components being the PGIS and the outputs.

Figure 6.1 shows the central role that the VDC played as the institution which was responsible for the village development activities. Overall, the figure identified the core institutions and how the VDC functioned among them. The Tribal Administration (TA) was identified as the ultimate authority in the village whose main role was to approve and oversee the activities which the VDC was mandated to implement. The VDC roped in the input of the community development institutions (CDIs) by either inviting them to the VDC monthly meetings or inviting them to be the resource persons at the public meetings. The VDC also linked with the District

Council through a village based Social and community Development (S&CD) office and also through the village councillor.

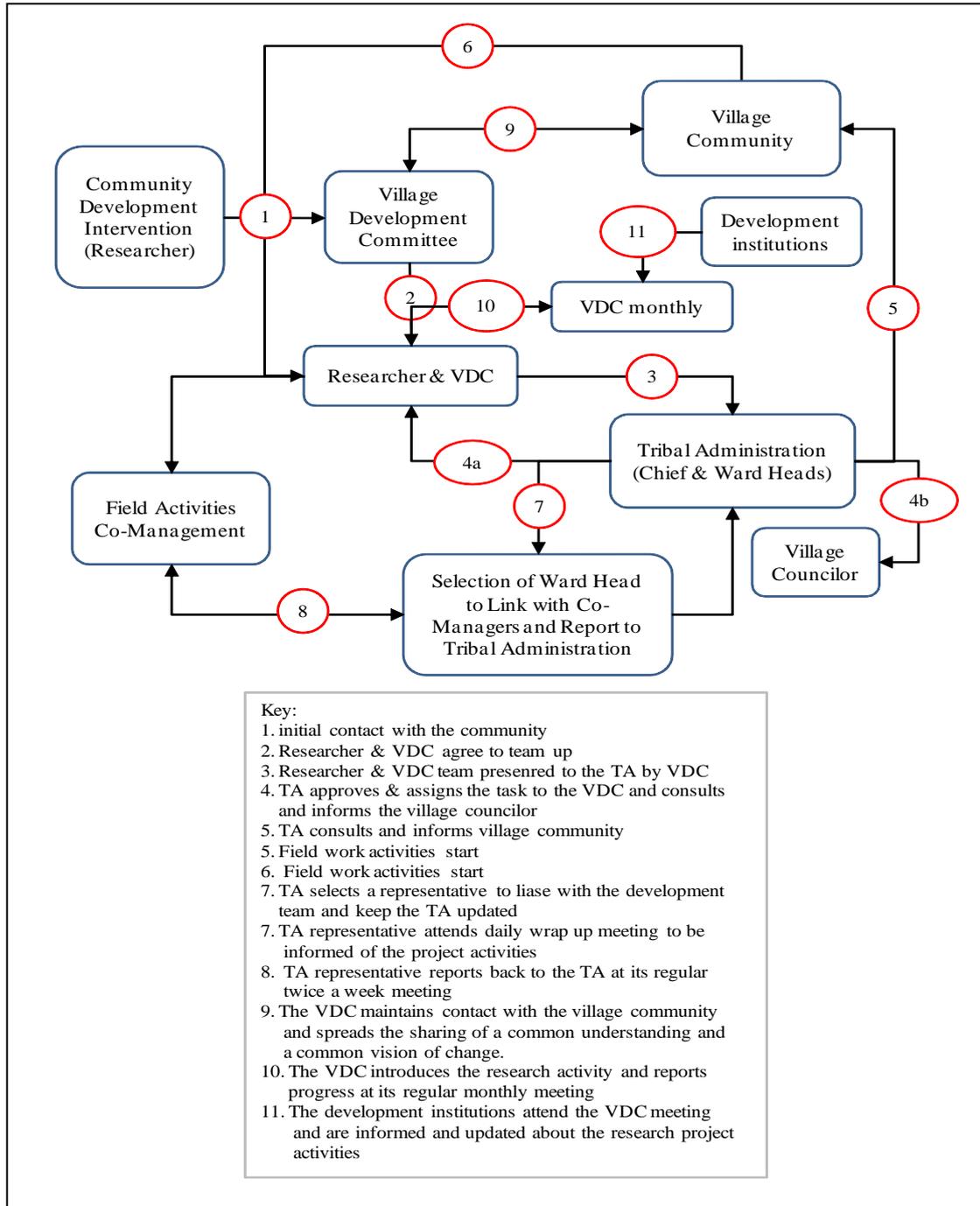


Figure 6.1 Involvement arrangements and agreements at the convening stage

However, despite its central role in village development, the VDC occupies the lowest rung in the local government organizational structure. This is the case mainly because its office bearers are the ordinary village members, often elderly, and of low educational and training backgrounds. Compared to the central government staff, the VDC members are more rural and consequently considered to be less knowledgeable. The VDC therefore receives limited respect from those higher up in the government hierarchy. These attributes tended to limit what the VDC could achieve and therefore had negative implications upon how effective it could have been in facilitating the participation context and actors. However, like the village leadership, the VDC proved that it did possess the wisdom to carry out the facilitation mandate of the PGIS process. This was demonstrated when it carried out the task which was assigned by the leadership to plan the way forward for the proposed village knowledge centre. This became its third major outcome.

The VDC employed the assistance of the village trainees in order to prepare a plan for the way forward for the village knowledge centre. The result is presented as Appendix 5.0. The cyclic arc of self actualization (CASA) was used as the template to produce the plan, thus the VDC and the trainees used the ‘input-process-output’ model to prepare the plan. The VDC proposed a separate body to run the knowledge centre and considered that the trainees should form a part of that body. This proposal was considered to be an instance of knowledge construction and constituted another VDC outcome. This activity was also interpreted to have non-sustainable individual capability but sustainable collective capability. Based on the *Mashego a Lobu* proposal outline and the proposal for an additional body to manage the daily activities of the village knowledge centre, the researcher identified the core organizational components and developed a flat management structure (Figure 6.2)

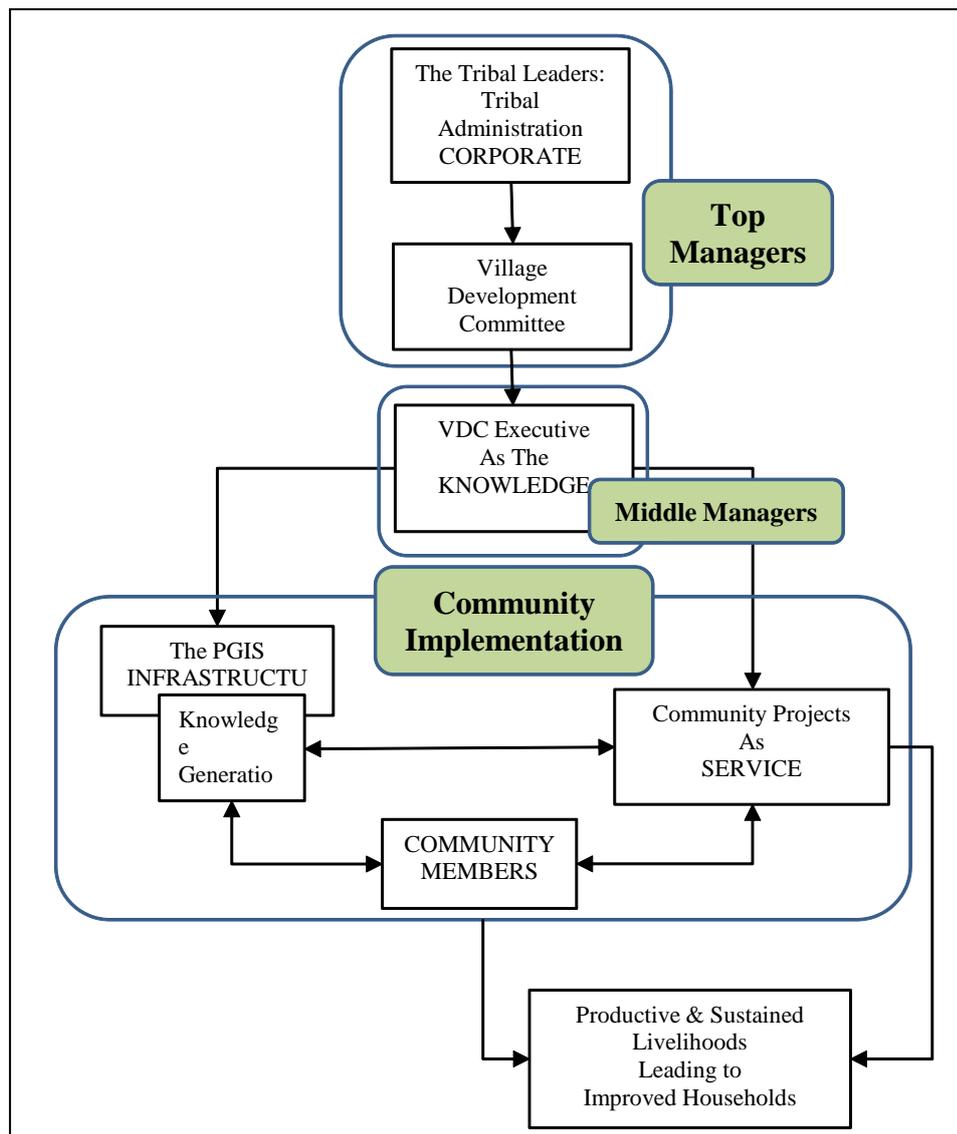


Figure 6.2 The Mashego a Lobu Knowledge Centre Organizational Structure proposed by the VDC and the village trainees

In Figure 6.2, the organizational structure is made up of three main components, the top management, the middle management (knowledge workers) and the implementation of development projects by the community. In this way, the VDC devolves direct involvement with the community to the knowledge workers. When the VDC proposed a specialist executive body, which would be responsible for the implementations of the various community initiatives, it effectively removed the influence of an unfavourable hierarchical position from which the main VDC body operated from. This structure may appear to have the traditional vertical

organizational rendition, however when the VDC operated more with the top level management, this left the knowledge workers to work directly with the community. This effectively removed the lengthy administration communication paths which are common in vertical organizational structures. This structure became very effective because it placed the PGIS infrastructure in the public domain and facilitated the community members and community development institutions to come together and to work cooperatively to create and distribute knowledge, as well as become involved in the implementation of the various forms of knowledge.

The specific members of the community who functioned as knowledge workers were the trainees and the VDC. Through their advantageous positions, the village chief and the village councillor were also part of the knowledge working group. The knowledge workers from the community development institutions sector included officers from the following departments: a) Animal Production, b) Crop Production, c) Tshane Primary School, c) Meteorology, d) Wild Life and National Parks, e) District Administration, f) District Council, g) Land Board, h) Culture and Youth, i) Local Enterprise Authority, k) Prisons Services, l) Police Services, m) Village Library Services, n) Clinic and Health Education, and o) Social and Community Development. Once the top managers were in their positions, the knowledge workers were facilitated to support the data gathering and group decision making processes. The knowledge workers generally supported the activities which began the process of creating the other components of the PGIS infrastructure.

The fifth outcome that the VDC produced was that it refurbished its offices in order to prepare them to serve as the knowledge centre facility. The storeroom which was disproportionately much larger than the main office was planned to host the computer laboratory. The smaller storeroom windows were removed and replaced with much bigger ones. The windows and doors were secured with burglar bars. The office which till then had no electricity was wired in preparation for connecting electric power. In addition, the VDC bank account which had been dormant for many years was reactivated in order to finance the office refurbishments. The VDC bank account was reactivated also to facilitate more direct interaction with financial donors or other financial institutions. Like the other activities, this activity was considered to have non-sustainable individual capability but sustainable collective capability.

With regard to estimating the sustainability of the VDC facilitation role, the conclusion which was reached was that when the VDC's strong collective capability was matched with an empowering external facilitation, which was the basic objective of this research project, the VDC facilitation role was considered to be sustainable. The capability of the individual members of the VDC was generally weak because of low educational levels and limited specialist training. However, the practical based work of the VDC made them very knowledgeable about local activities. When the research project implemented experiential and constructivist learning, the VDC was able to perform its role successfully because it used its existing knowledge base to appropriate new knowledge to local applications.

The role of the external facilitation was noted briefly in Section 6.1.1 where it was not viewed as necessarily negative. The facilitation work requires much behind the scenes preparatory work, which in this research project was carried out by the researcher and the VDC. This facilitation and participation enabling task which preceded and underpinned the successful running of the collective work required much extra work time, which many of the community members did not have. The researcher noted that even where such facilitation could be internal, there was still need to assign dedicated facilitators. For example, because the workshops were held at an unsecured public meeting place, the meeting place had to be set up and equipped every day. While the participants convened at 09:00 am, the trainees met between 07:30 am and 08:30 am everyday to set up the convening location. Apart from the extra time needed for preparatory work, there was need for an individual or number of individuals who would not be engrossed in the daily activities themselves. These individuals would be free to keep a firm view of the bigger picture and intervene to keep the activities on track by constantly planning for the way forward.

The limitation of the VDC to lead the facilitation role on its own was noted on a number of occasions. When the VDC needed to manage the village trainees in the absence of the researcher, the attendance fell visibly. Figure 6.3 shows the attendance record and what happened to the attendance of the trainees when the researcher was absent. What also became evident during the training classes was that there was limited tendency for the trainees to recognize or accept one of their own as a leader worth listening to or following.

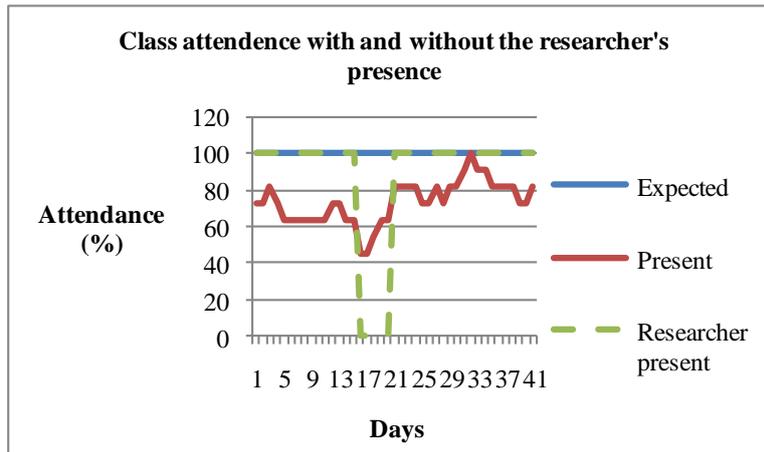


Figure 6.3 The last forty one days of the first field work

Also, after the first field trip, the VDC had agreed with the trainees to meet once a week to keep the village knowledge centre initiative active, but they met for less than a month. The VDC had also been expected to convene another group of village trainees, but this was not done until the second field trip, when the researcher assisted with the running of the training. In addition, during the second field trip, a village steering committee was convened to renew activities on the village knowledge centre. However, by the third field trip the steering committee had never met and had for practical purposes disbanded. Therefore, this research concluded that until the VDC's limitation to facilitate the activities of the village knowledge centre was removed, external facilitation was critical to the sustainability of the village's PGIS infrastructure.

In concluding on the outcomes of the convening stage of the PGIS process, two other components of the PGIS were identified. The five outcomes of the leadership and the five outcomes of the VDC facilitation had in the process introduced the link with the community and the need for a PGIS facility. What was also important to note was that two organizational structures were produced: the overall administration structure and the administration structure for managing the *Mashego a Lobu* Knowledge Centre.

6.2 Outcomes of the Data Gathering and Creating the Knowledge Content Repository

This section was concerned with compiling the data and creating a knowledge content repository (KCR). This was carried out in five stages. The first, part covers the data gathering stage of the PGIS process. The outputs of the community development institutions and the required map data are presented next. The third part covers the non-map data and the fourth part covers the shelter acquisition and goat rearing components of the PGIS prototype. The fifth and final part is concerned with integrating the rest of the compiled data into the PGIS prototype in order to complete the creation of the knowledge content repository. The data gathering component included the business process modelling, GIS based mapping, social survey and attitude scale and the input of the community development institutions.

6.2.1 Outcomes of the Business Process Modelling

With regard to the business process modelling, a subjective rating was used to assess outcomes over 19 activities, refer to Appendix 5.0 for the details about the individual activities. The grades were presented in ratio form and ranged from zero to one. A final formal assessment test was also given and the percentages obtained were reduced to ratio form in order to compare them with the output of the activities, refer to Table 6.2. The two results were then plotted (Figure 6.4). A two period moving averages trend line was fitted for the activities graph. The analysis of the output levels was based on performance based evaluation criteria, which relates performance at training to the actual performance at the work place or other application domain. The performance output levels were therefore expected to be very high, and they were except for candidates 3, 4, 5, 7 and less so for candidate 9. The results of the formal assessment test were also expected to be very high. These results were better than the performance outputs, although the outputs for candidates 2, 4 and 10 were on the lower side. A score of less than 70 percent was considered to be insufficient capability. Therefore, individual capability was obtained for 72.72 percent of the trainees for the task performances and 100 percent of the trainees for the formal test. The collective capabilities averaged at 76.82 percent for the task the performance and 82.45 percent for the formal test.

Table 6.2 Performance indices for the village trainees

Trainee	1	2	3	4	5	6	7	8	9	10	11
Output level	0.94	0.95	0.54	0.62	0.71	0.82	0.51	0.97	0.73	0.82	0.84
Final assessment	0.83	0.77	0.92	0.70	0.83	0.89	0.83	0.91	0.83	0.73	0.83

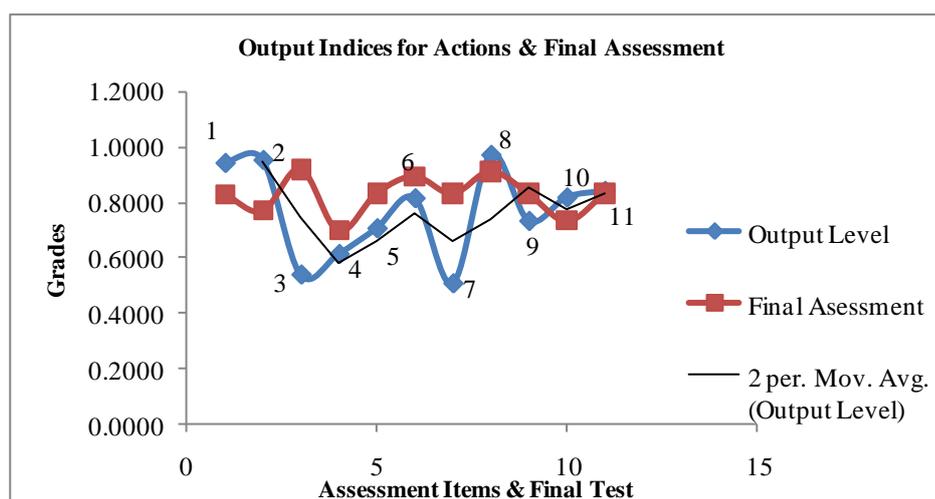


Figure 6.4 Output indices for activities and final competency assessment test

The results of the final assessment indicate that overall there was a general gain in knowledge. When the performance of tasks was compared to the final assessment, it showed that 72.72 percent of the candidates indicated improvement in performance. This was particularly evident for candidates 3, 4, 5 and 7 who had performed poorly in the task performance activities. The task performance also showed a gradual decline with time as indicated by the trend line and it indicated a staggered but slow increase in the levels of involvement and the generation of outputs. This showed a maintained interest and slowly increasing performance in the activities of the project. These results indicated that the experiential form of training achieved the outcomes, that is, it had imparted knowledge and skills, even to the weakest members of the trainees. After the business process modelling, a Microsoft Excel based template called the cyclic arc of self actualization (CASA) was created by the researcher to simplify the business production scenarios, and is presented in Appendix 2.0.

Since the ward heads and the village development committee (VDC) had selected the village trainees on the basis of affiliation to the wards, this research sought to

investigate whether these village institutions had any influence over the performance of the trainees they had selected. The involvement of the ward heads was assessed by noting the incidences of attendance at the project public meetings. The grading ranged from lowest frequency which was graded as one to highest which was graded four. These were then reduced to fractions (0.25-1) and compared with the trainee output indices and their post training outcomes. The VDC was graded similarly but according to their participation rates in all the research project activities. The post training outcomes were obtained from personal interviews. The results are presented in Table 6.3 and graphically in Figure 6.5, however Figure 6.5 has excluded the candidates who had withdrawn.

Table 6.3 Involvement of the ward heads and their effect on performance of trainees in Tshane village

Id	Ward	Ward Head	VDC Support	Output Indices	Participant Performance	Post Training Activity
1	Coloured	0.50	0.75	0.00	Less active, withdrew/3 months	Welfare jobs
2	Ga-Kgala	0.50	0.25	0.71	Active, had a plan	In computer course
3	Ga-Kgala	0.50	0.75	0.97	Active, had a plan	Aquired 20 more goats
4	Ga-Kgala	0.50	0.75	0.94	Active, had a plan	Applied and got hired
5	Ga-Moriti	1.00	1	0.00	Distracted, withdrew in a week	None apparent
6	Ga-Moriti	1.00	1	0.54	Active but not focused	None apparent
7	Ga-Moriti	1.00	1	0.62	Active but not focused	Small building project
8	Ga-Thaga	1.00	1	0.95	Active, had a plan	Brick moulding work
9	Ga-Thaga	1.00	0.75	0.82	Active, some focus	Became VDC secretary
10	Ga-Thaga	1.00	0.75	0.84	Active, had a plan	Went back to soldier duty
11	Ga-Moriti	1.00	1	0.51	Active but not focused	None apparent
12	Ga-Maehadu	1.00	0.5	0.73	Active but not focused	None apparent
13	Ga-Maehadu	1.00	0.5	0.82	Active, had a plan	Upgrade results & Train
14	Herero	0.25	1	0.00	Active, but withdrew/3 months	Truck driver
15	Herero	0.25	1	0.00	Active, but withdrew/3 months	None apparent

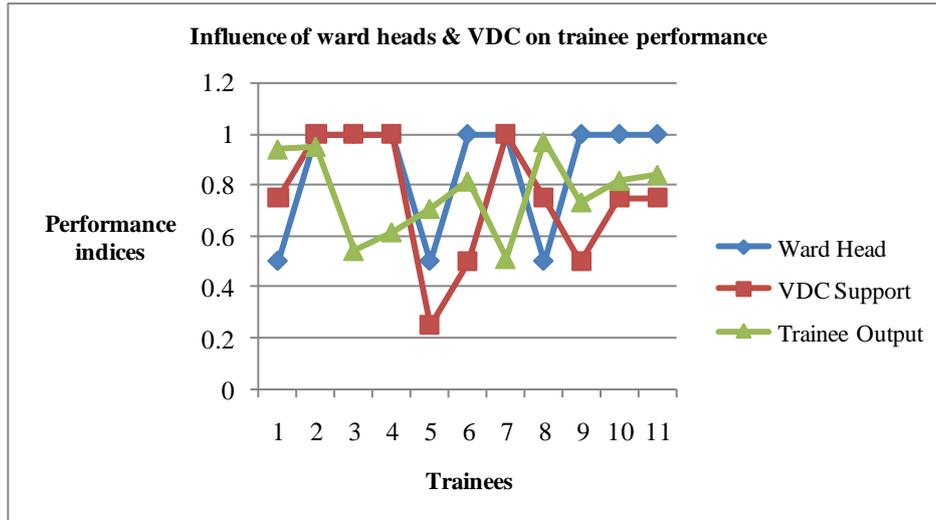


Figure 6.5 Influence of the ward heads and the VDC on the performance of the trainees

The data suggests that there was no relationship between the performance of the trainees and the VDC support. This was because the trainees were not accountable to the VDC, they were more accountable to the ward heads who had selected them. There was some influence of the ward heads over the performance of the trainees and this was more evident from candidates 5 to candidate 11. Within the noted range of the graph, high ward head inputs corresponded with high trainee performances, while within the same part of the graph, the VDC inputs were generally low. Table 6.3 shows that some trainees have had very good support from both the ward heads and the VDC but have not shown any post training outcomes or withdrew from the training. This indicated that the success of the individual really depended on the individual and not on somebody else.

After completing this part of the training, the candidates had acquired a number of competencies: a) basic computing skills, b) become familiar with basic business planning procedures such as business vision, mission and objectives, c) the candidates had used Microsoft Excel to perform business calculations, d) the candidates had used Microsoft Word to produce business plans and e) the business data objects and the business planning had introduced the candidates to the logic of the various business tables and briefly to the database concept. The last competency became useful when the candidates were engaged in the GIS based mapping activities.

The positive outcomes which were realized in terms of the way forward after the training were that one trainee secured employment, the second trainee started her brick work project and the third trainee applied for and acquired twenty more goats for her project. In Figure 6.5 these are the trainees that had scored the highest marks on the performance activities and whose performance marks were higher than the formal final assessment test. These were also the candidates who exhibited the following characteristics: a) came with clear expectations, b) stuck to their expectations, c) had a clear purpose for their involvement, d) had the clearest view of their way forward, e) were encouraged by the development of a conviction that their projects were possible to achieve and f) that they had the capability to implement them.

The business process modelling activity began the first training to groom a select group of people who subsequently became the PGIS users. It imparted basic computer literacy and the appropriation of the computer tool to support livelihood activities. This grooming task continued with the GIS based mapping and the social survey work which followed it, and it represented the constitution of the PGIS users' component of the PGIS infrastructure.

6.2.2 Outcomes of the GIS-based Mapping

Whereas the business process modelling covered the problem based learning aspect of anchored learning, the GIS-based mapping component of the training began the actual information technology artefact based anchored learning. The outcomes that are discussed in this section are the mapping accuracies for both in-house and field mapping activities and the thematic map layers themselves. The in-house mapping involved digitizing the information from the aerial photographs. The field mapping involved scaled field sketching which was also supported by the aerial photographs. The thematic map layers which were produced included the residential plots, the roads, the water and electric power lines, the public water points, the goat kraals and the institutions. The thematic map layers are important because they provide an impression of the local livelihoods and form the link with other external data sources. In this way, the GIS based mapping created the basic frame upon which the knowledge content was compiled.

It was important to determine and state the accuracy level of the geographic data sets which were produced because it is standard procedure to do so and guides the use of the data. Ultimately, the spatial accuracy of the data determines the integrity and validity of the results of the subsequent spatial analysis that is performed on the data. However, in this case the accuracy was also of particular interest to the institutions which provide the basic utility services. The utility institutions use such village plot layouts to plan the water, power and telephone line networks. This research was aware that the Land Board was also looking for a solution for its land management system. So far a Tribal Land Information Management Systems (TLIMS) had been designed and implemented. However, its database still remained largely under populated and required the data such as the one that was compiled in Tshane village. The production of this data for the whole country had remained problematic and devolving the task to the local community, and assuring the quality of the data which has been produced, provided one solution option.

Two mapping accuracy assessments were used. The first accuracy assessment was carried out by the GIS software itself in the process of performing the georeferencing of the aerial photographs. The GIS software accuracy assessment used the root mean square (RMS) method to evaluate the differences in location between locations of objects on the aerial photographs and their corresponding locations on the ground. The mapping accuracy from the field mapping was assessed by performing a manual version of the GIS software RMS method. The georeferencing was done independently for the seven village blocks which were demarcated. The results are shown in Figure 6.6. The results show that the outer village blocks (Blocks 1, 6 & 7) have lower accuracy than the relatively more central village blocks (blocks 3, 4 and parts of blocks 2 and 5). The accuracy ranges from 0.89246m for block three to 2.02849m for block one. This level of accuracy corresponds to map scales which range from less than or equal to 1:1000 to less than or equal to 1: 6000 with an accuracy level of 0.7m to 3.0m respectively. The obtained accuracies were within these limits.

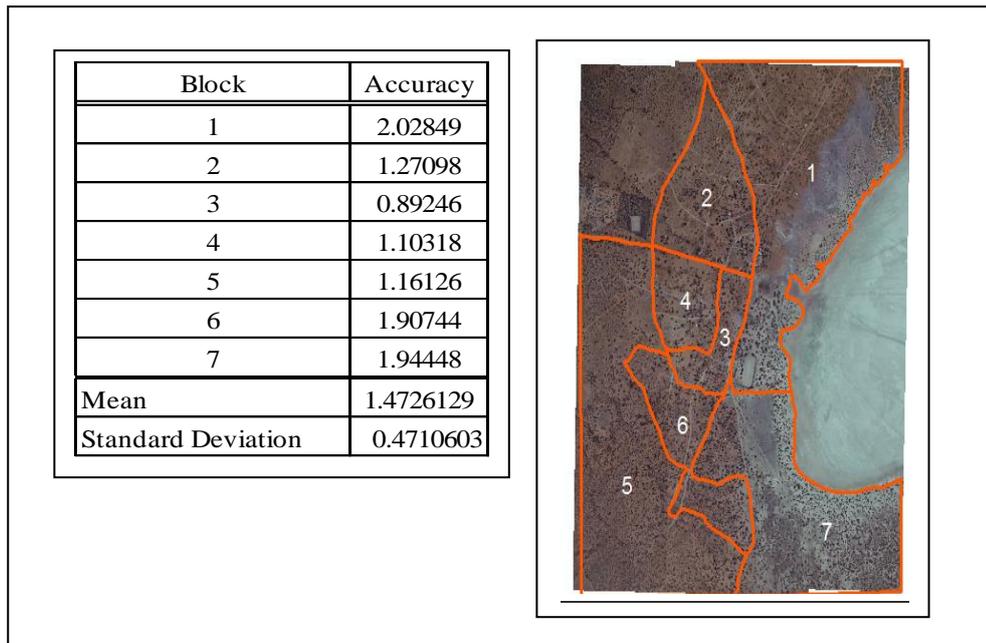


Figure 6.6 The accuracies obtained when georeferencing the aerial photographs

A comparison of the field mapping accuracies obtained by the field mapping teams over the village is shown in Figure 6.7. Most of the accuracies fall around 3m. There are a number of points around the 4m mark and the values beyond the 4m mark were considered to be outliers. However, a more formal presentation of the accuracies is shown in Table 6.4, except for block one, 80 percent or more of the measured plots have an accuracy of less than three meters. This compared well with the pre-field mapping practice accuracies which averaged to 2.8133m. The residential plots layer specifically, was demonstrated to the Land Board and was deemed to have acceptable accuracy.

Table 6.4 Percentages of points under 3m of accuracy

Block	No of plots	Frequencies			Percentages		
		>3m	1.6-2.8	0-1.5	>3m	1.6-2.8	0-1.5
1	51	14	17	20	27.4510	33.3333	39.2157
2	28	7	7	14	25.0000	25.0000	50.0000
3	4	0	2	2	0.0000	50.0000	50.0000
4	15	2	3	10	13.3333	20.0000	66.6667
5	29	1	5	23	3.4483	17.2414	79.3103
6	38	5	17	16	13.1579	44.7368	42.1053

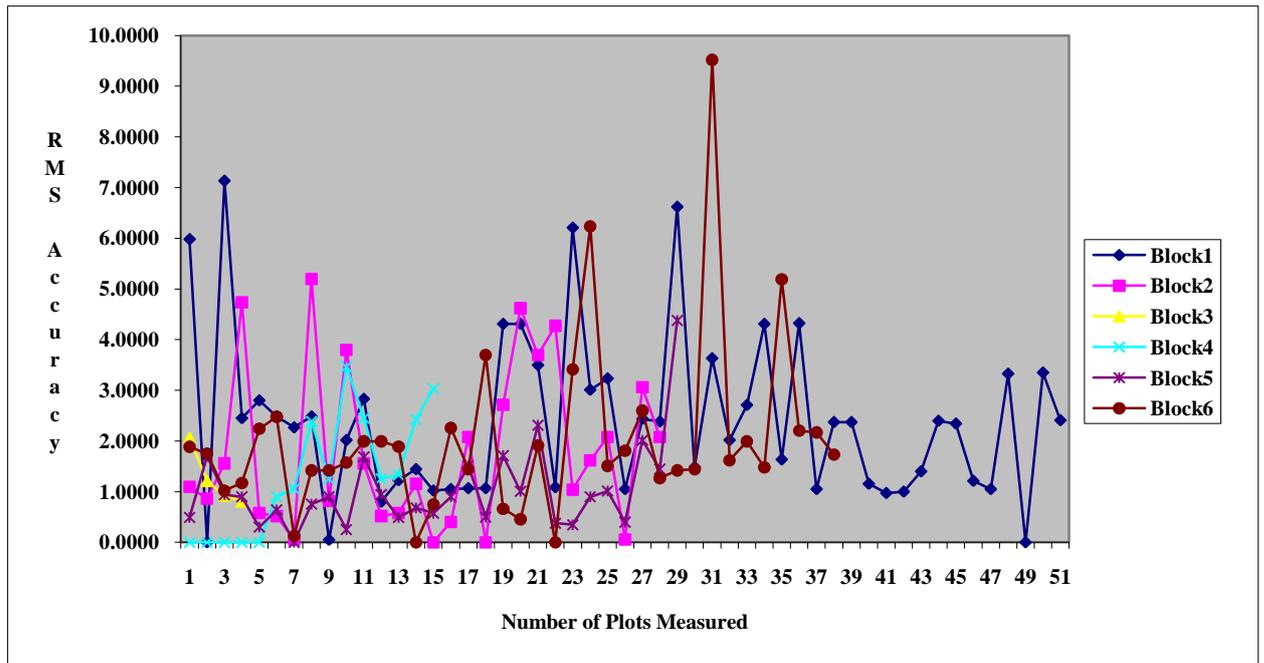


Figure 6.7 Comparing field plotting accuracies obtained at the various blocks in Tshane village

The water and power lines were plotted at the field through what the author referred to as image guided field based cognitive positioning. In standard survey practice, positioning of new features relies on the known positions of existing reference features. For practical purposes it was much easier and relatively quite accurate to estimate the positions of features which were between reference features if the reference features were not widely separated. For example, the positioning of half a millimetre mark between the millimetre marks on a common ruler is quite accurate. In cognitive positioning, the aerial photograph showed the location at which the individual stood, while within the village, there were numerous reference features which at a large photograph scale were quite visible. It became relatively simple to choose the closest reference features and then apply a combination of vision and mental estimation of distance to position either a water line or a power line. Although at the time there was no access to either a survey accuracy global positioning system receiver or existing maps to assess the accuracy, this type of accuracy was expected to be quite high and to be better than one meter for most of the positionings.

At the end of the GIS-based mapping, the trainees had acquired basic competencies in: a) georeferencing, b) on screen digitizing, c) spatial data accuracy, d) scaled field sketching, e) designing tables, f) scanning, g) map updating, h) spatial data

processing, i) linking spatial and non spatial data and j) performing simple spatial queries. These were basic PGIS user competencies which the trainees needed to build up on so that they could subsequently assist the other community members in using the PGIS. The next activity provided the output which was used to create the tabular data which was subsequently linked to map layers in order to display and analyse it.

With regard to individual and collective capabilities which this part of the training had imparted, it was concluded that both had been achieved. As discussed in Section 6.1.1, acceptable levels of individual and collective capabilities were used to constitute sustainability. The individual marks for the formal assessment were used to assess the acquisition of individual capabilities (Figure 6.8). Trend lines such as the one depicted in Figure 6.8 were used to identify the problems areas for each trainee. For performance based assessment, the problem areas were considered to be those where the marks which were obtained were less than seventy percent (Scaled range 3.5).

Except for the candidates who were weak on the theoretical aspects of the training, which were trainees 2, 4 and 10, the rest of the trainees obtained individual question marks which were below 70 percent for a maximum of six questions out of the twenty nine questions which were set. The field mapping activities were also used to identify evidence of knowledge construction. Table 6.5 shows that each team pair used the acquired mapping procedure differently and provided a typical example that knowledge does not exist in readily packaged form, and that it is reconstructed. If the trainees could be retained within the village, then the PGIS infrastructure's users' component would be sustainable. With regard to collective capability, the VDC and the trainees worked successfully as one group to agree on and divide the village into the seven blocks, the georeferencing was also done on one computer, so the teams assisted each other and achieved acceptable levels of spatial accuracy as team members.

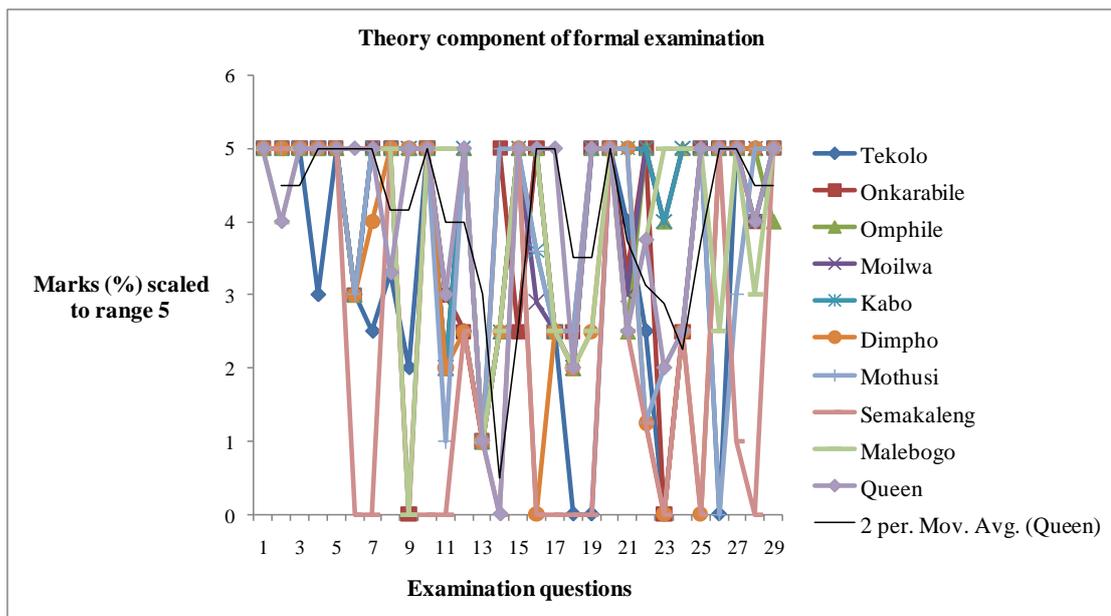


Figure 6.8 Theory component of trainees performance marks at the final assessment

Table 6.5 Field plotting methods

Block	Team	Field Plotting Method
1	1	Field measurement, conversion and plotting as the measurements are made
2	2	Field measurements and draft plot layouts on A4 paper, conversion and plotting at the lab
3	3	As Block 1, but the measurements are available
4	4	As Block 2 but conversion and plotting at the site
5	5	As Block 2
6	6	As Block 2
7	7	As Block 2

More specifically, the residential plots map was subsequently used to settle the disagreement between the Land Board (LB) and the villagers with regard to the location where the Land Board was allocating the residential plots. The LB was allocating the land outside the village whereas the villagers wished to fill in the remaining spaces within the village first. The LB could not allocate land on the spaces within the village because some of that land had been allocated before but had not been developed, most of it not even fenced yet. The probability of double allocations over the same piece of land was high. In response to this, one of the trainees who was also serving as a land overseer, worked with the ward head and they used the residential plots map to identify the non allocated land which is shown in green in Figure 6.9. The LB was then able to allocate the land. This was further evidence that

the knowledge and the tools were being appropriated and used to construct knowledge and provide local solutions.

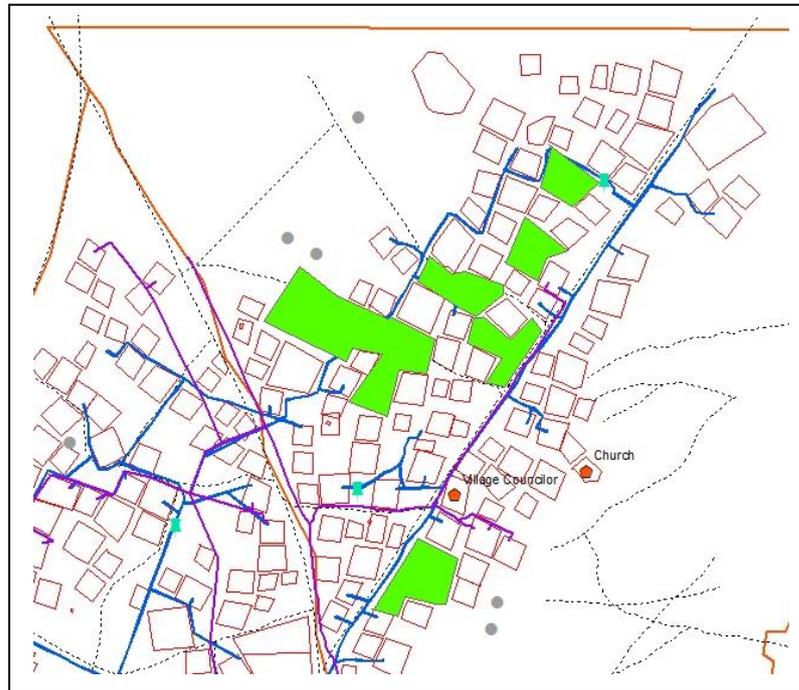


Figure 6.9 Non allocated land spaces between the residential plots in Block 1, Tshane village

6.2.3 Outcomes of the Social Survey and the Attitude Data Gathering

The social survey and the attitude scale continued the learning which was used to acquire the capabilities to compile the community knowledge. This activity represented the problem solving part of the community training and presented the opportunity to agree on a common understanding of the problem and the solution. In order to test the level of understanding of the research project objectives before the administration of a questionnaire, the trainees and the VDC were divided into groups and asked to sequence eight concept papers. This was four months after the project had started for the VDC and two months for the trainees. The VDC group achieved 100 percent success, two trainee groups attained 25 percent success and one trainee group attained 50 percent success. At the formal assessment test, nine months after the project had begun, two questions which related to the research project objectives were asked. Only one trainee attained a mark that was less than 70 percent on one question, and again only one trainee attained a mark that was less than 70 percent for the second question. The average mark for the first question was 88 percent while the

average mark for the second question was 75.5 percent. This indicated that almost all the trainees understood the research project objectives at the end of the first field work.

The trainees also produced group output which was intended to provide a guide to the questionnaire design. The groups outlined shelter, adequate supplies of food, dignified clothing and access to health services as the basic needs at the household level. A reproduction of one of the group work is shown in Figure 6.10. The trainees used their acquired problem solving strategy to rationalize the community development solution. At this point, the community needs became explicit and these together with the social survey data were used to produce the community requirements. In addition to the four mentioned basic needs, Figure 6.10 refers to other needs, including employment, livestock and business ownership. The other groups included access to water and electric power as needs as well. These needs were used as the community requirements with the complete list of requirements shown in Appendix 8.0. The additional requirements it contained were education, knowledge and training. This indicated that the trainees provided 70 percent of the community requirements information. The 70 percent was considered to be within the empowerment level.

The discussion of knowledge for community development created awareness of the internal beliefs that the people held and used as knowledge. For example, with regard to shelter, 48 percent of the sample agreed that since life was difficult, a mud hut provided adequate shelter, while 46 percent disagreed. This result showed that poverty was used to justify poor housing. These internal beliefs explained why people were not uncomfortable with their low standard shelters and why it took a long time for the shelters to improve. Some of the issues from the social survey that the community felt strongly about were converted into attitude scale format and compared for the situation before the second field trip and the situation after the second field trip. The results are shown in Figure 6.11. The numbers 'five' and 'one' represented 'strongly agree' and 'strongly disagree' respectively. Figure 6.11 shows that the concerns about money, employment and shelter have remained high.

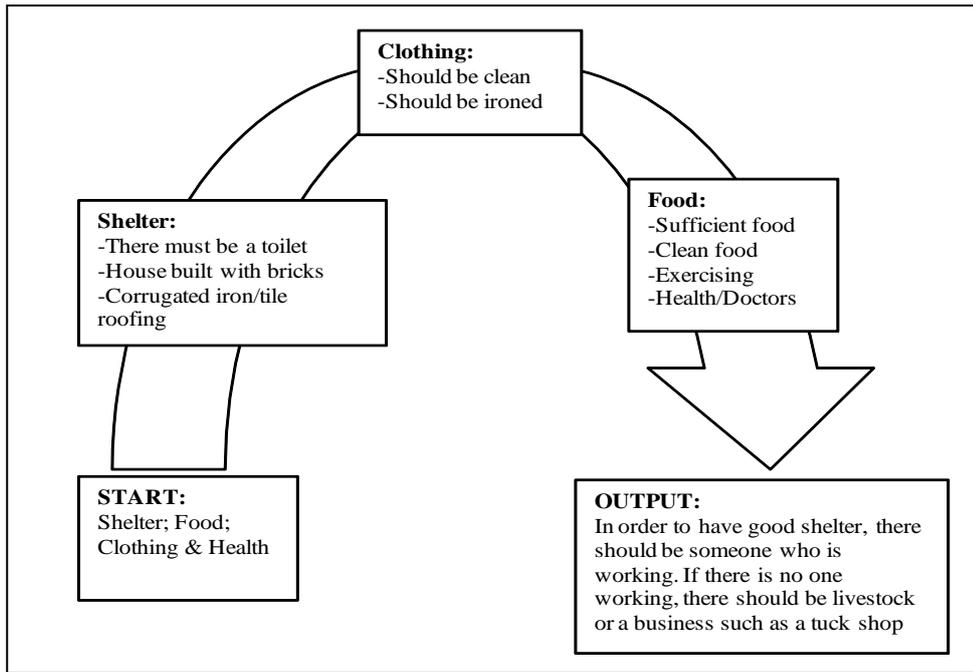


Figure 6.10 Basic needs outlined by the VDC and trainees in Tshane village

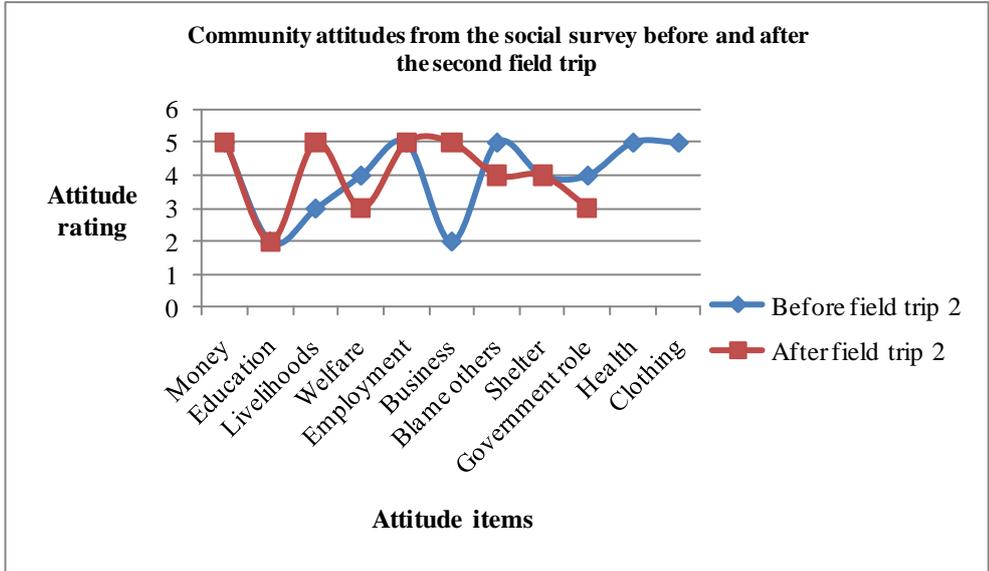


Figure 6.11 Comparison of community attitudes derived from the social survey results before and after the results were fed back

The “before field trip 2” situation represents the initial condition when the questionnaire was administered, this is before the feedback workshops were conducted. At that stage there was no information about the community’s views with regard to the living standards. The “after field trip 2” situation represents the community’s response to its own previous views at the feedback workshops which followed the administration of the questionnaire.

The appreciation of traditional livelihoods as more appropriate livelihood options has increased. The focus on welfare as a livelihood option has decreased while the appreciation of businesses as possible livelihood options has increased. The community still blames something else for their poverty situation but the level of blame has gone down from strongly agree to just agree. The community is also rethinking its belief on the role of government as indicated by neutral stance that was taken after the second field trip. The results showed a positive influence of the research project in the thinking of the community. This should support a more lively interaction with the information and knowledge that is contained within the PGIS. This change in the thinking of the community augers well for the sustainability of the PGIS infrastructure because it induces the community to not only voice out their concerns but to also offer suggestions on the solutions. The attitudes therefore were considered to be the knowledge that the community members used to make their everyday decisions.

The results of the specific attitude survey that was carried out in Tshane village are shown in Figure 6.12. This selection of attitudes was compiled from a larger list by taking the attitudes where there was around 80 percent agreement, but it also included special cases where there was strong disagreement. The results showed largely unchallenged strong agreement with most attitude statements except for ‘blaming others’, ‘shelter’, ‘clothing’ and having ‘given up’. For a number of attitudes, the community members had begun to rethink their beliefs as shown by the neutral stance they adopted. However, the beliefs on money and shelter have remained unchanged here also. The “after feedback” in Figure 6.12 refers to the community’s reflection about its own initial attitudes which were captured during the administration of the attitude scale. The community’s second views about their attitude was then plotted and compared with the initial attitude responses.

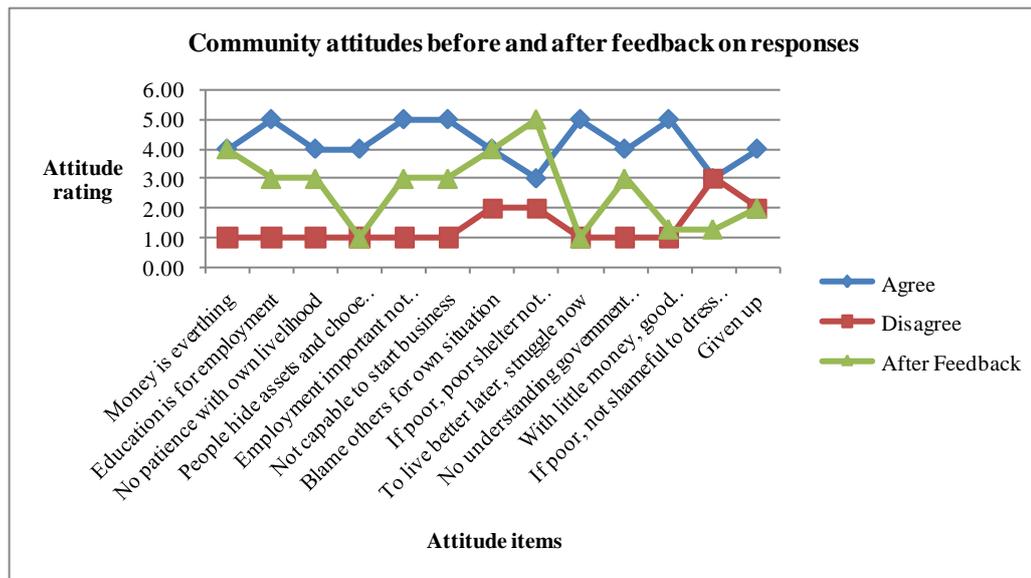


Figure 6.12 Attitudes: initial response and response after feedback workshops

The high value that the community ascribed to money resulted from focusing almost exclusively on formal employment as a source of livelihood. The promising development was that the community had begun to rethink the focus on formal employment and to consider businesses as livelihood options. The community also felt strongly about shelter. The response became very clear that the elderly people agreed that there was little respect for decent shelter. They noted that the building of shelter remained the responsibility of the elderly even though they have become older, poorer, less healthy and therefore no longer able to either build new shelters or refurbish the old. This was made more problematic because the cost of building had gone up. The community also recognized the contradiction of sponsoring a luxurious lifestyle with welfare support.

The community had also begun rethinking the role of government. They noted that people were not functioning at their full potential because of the welfare system, which had made people reluctant to seek productive employment. The persisting poverty was also linked to the community's failure to think of a way out of poverty. They noted that the people were making the effort to improve their living standards because they realized the need to do things for themselves. Overall, the research project had succeeded in imparting knowledge and had caused the community to

engage in self-reflection. These results can be used to provide better insight into how the community members were rationalizing about their livelihoods.

The outcome of the social survey and attitude scale data activities was to enable or enhance a cognitive and constructivist community outlook, which was needed to interact with the PGIS infrastructure. In conjunction with the business process modelling, these activities created awareness that the community development work involved other actors beside the village community and the PGIS. This knowledge was used to rope in the community development institutions, which constituted another PGIS infrastructure component.

6.2.4 The Development Institutions

The community development institutions (CDIs) were part of the PGIS framework and served to support the community development activities. The institutions were involved at the convening, the data gathering and the output stages of the PGIS framework. However, their participation needed more facilitation as it turned out. The institutions were divided into two groups: the village institutions and the institutions which resided outside the village. The village institutions are shown in Figure 6.13. This figure shows the institutions whose functions the village community did not know. Very few people did not know about the village councillor and the member of parliament, yet over 40 percent of the community did not know the village institutions. The best of the better known village institutions was the village development committee (VDC). Surprisingly, over 75 percent of the people who were sampled did not know the functions of the chief and the ward heads. The link with a particular institution was determined by the benefit a community member derived from the relationship. For example, the links with the VDC, the social and community development office, the village health committee and the community home based care linked the community members with the welfare system.

The main institutions which were involved at the convening stage of the PGIS process were the chief, the village ward heads and the VDC. At the convening stage, the CDIs were expected to participate in understanding an incoming development initiative and to use their field experience to advise on the agenda setting. The institutions responded poorly at the inception of the research project and the few that responded to

the invitations provided minimal input. The CDIs were therefore not as useful as they could have been at the convening stage, this was because the CDIs were trained to deliver the development projects which were implemented by the community. Therefore they did not have the strategies to help the community to develop their own projects. Figure 6.14 shows the other development institutions and was used to understand how the CDIs related to each other.

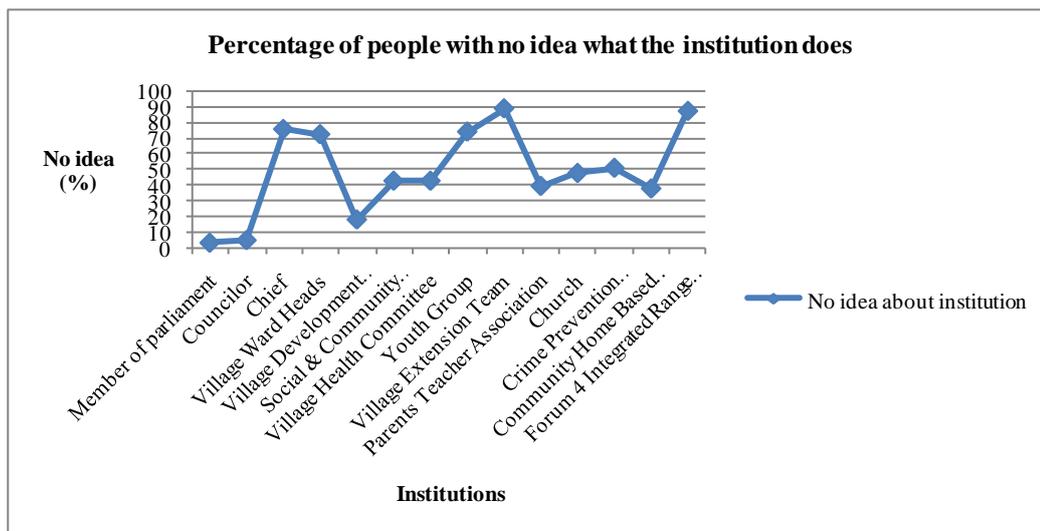


Figure 6.13 Level of perception of what the village institutions do

Six institutions provided the input that was used to create Figure 6.14, these were Tshane Primary School (TPS), Health Education Unit (Health Edu), District Officer Development (DoD), Animal Production (Ani Prod), Tribal Administration (TA) and the Department of Wildlife and National Parks (DWNP). All of them have links with the VDC, which was at the centre of the network as shown in Figure 6.14. Figure 6.14 also showed that each institution dealt mainly with those institutions it shared common interests with. The direction of the arrows indicate that the main institution controlled the interaction and without this prodding, there was no interaction back from the related institutions, they simply provided a requested service, beyond that there was no interaction. The VDC to which these main institutions linked was largely a receiver of services and played no role in linking the institutions, yet it was in a good position to do so.

The result of this arrangement was that where the rural community was largely inactive, the CDIs focused mainly on their office duties and their activities did not relate to those of the community they were there to serve. These institutions functioned best when they provided services in their own fields. This became evident when they participated in creating the knowledge structures for the services they provided. This arrangement conformed to how the officers in these institutions were trained. They were providers of expertise not participants in community initiated development projects. The CDIs therefore performed satisfactorily at the data gathering stages of the PGIS process when the mode of participation fitted their mode of operation. The CDIs also performed well in checking the community output and providing technical advice. This was the case with Animal Production, the Land Board, Crop Production and the Department of Wildlife and National Parks (DWNP).

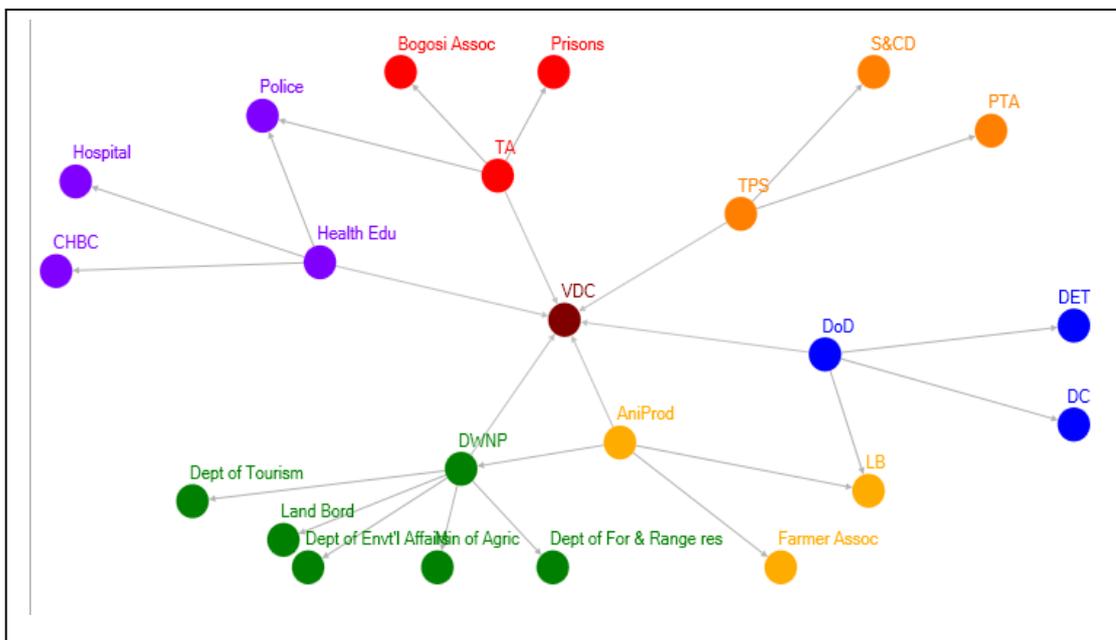


Figure 6.14 The working relationships among the community development institutions

The Animal Production unit provided technical advice on the goat rearing project and assisted with additional output calculation parameters which made the goat rearing calculations more realistic. The Land Board provided input on the spatial accuracy of the village mapping and commended the potential usefulness of the map data. The DWNP provided advice on how to legalize one community member's village based trophy craft, and provided the application forms which needed to be filled and the

basic procedure of operating such a sensitive wildlife product utilization business, no matter how small it was. The Crop Production unit commented on the usefulness of the GIS tool and expressed the desire to learn it since it provided a solution to a problem they had. The research noted that the CDIs could be relied upon to support the community projects if their participation was planned to fit the way they operated. However, the sustainability of the community-CDI relationship relied mainly on whether the community members produced output that could demonstrate the CDI's contribution. This was the case with the goat project which the Animal Production unit was currently taking a keen interest in. Some of the CDI officers were overworked and had limited time, but there was evidence that some of them felt underemployed and complained that the communities were not making use of them.

6.2.5 The Map Data to Support the Acquisition of Shelter and Goat Rearing

The map layers which were compiled to support the acquisition of shelter are shown in Figure 6.15. They included the residential plots, the public water points, the village blocks, the water and power lines, the institutions and the roads. The residential plots map layer was used as the core map and the social survey and attitude scale data were linked to it. The residential plots map layer also guided the locations and alignment of the water and electric power lines and most of the household decisions were made at the households.

Overall, the residential plots map layer was the main avenue through which the community data, information and knowledge were communicated. The link with the other external data was effected through the residential plots' layer. The power and water lines portrayed the distribution of these social services throughout the village. The links to the residential plots identified those who had access to these services and those who did not. These accesses were used to assess the adequacy of the shelter contained in a given plot. The spatial layouts of the line networks were also used to assess how equitable the distributions were. The presence and distribution of the public water points were associated with the presence of the poorer households because the better off households were connected to the village water pipeline network. The public water points were also buffered to indicate the household catchment area for each of them. The institutions were used as sources of information and services.

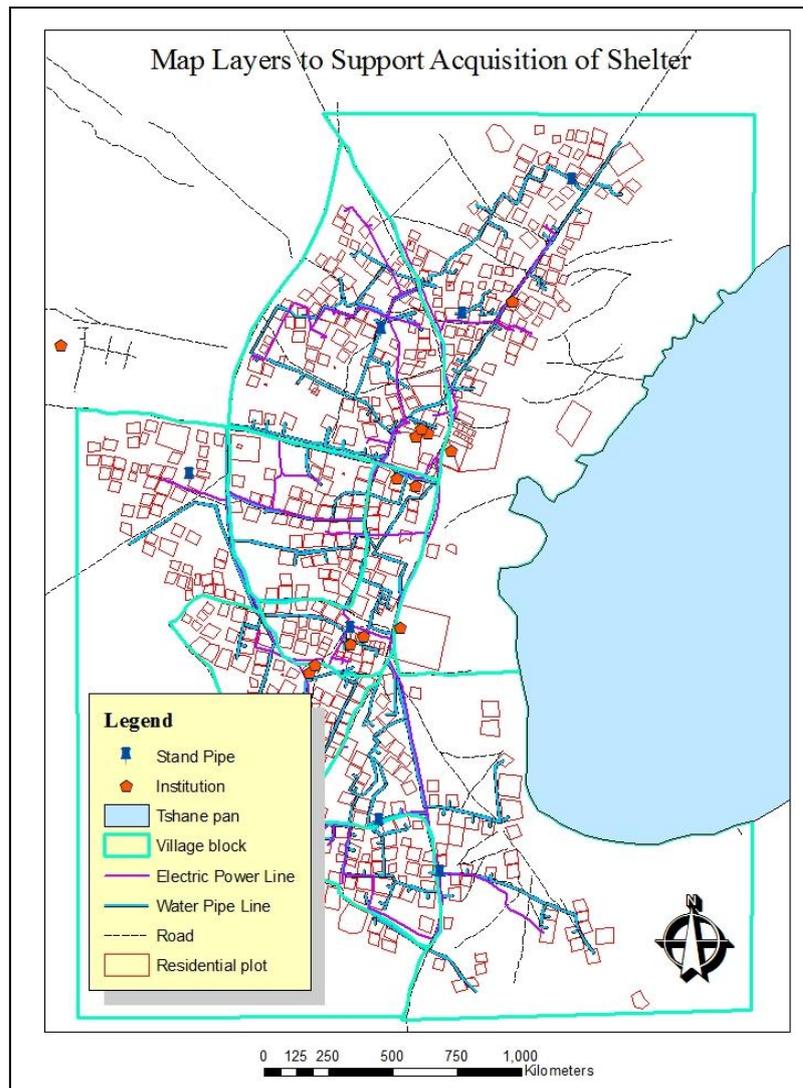


Figure 6.15 Map layers to support acquisition of shelter

The map layers which were compiled to support the goat rearing are shown in Figure 6.16. The village area and the rangeland were mapped at different scales and integrating the two meant that the village area could not be shown in detail. Therefore, the village area was indicated by a five kilometre radius circle. This showed the extent to which the goats would reach during their grazing. The shades of green on the map indicate the average vegetation cover (AVC) of *acacia mellifera* (Ame), an acacia tree species that was commonly grazed by the goats. The internal table that was part of this map layer also allowed the display of other tree species that the goats browsed on, grass cover, tree heights and a combination of tree and shrub densities.

The map also shows distributions of boreholes which have been drilled, and around the villages especially, shows the ones which have water quality data which were

compiled in May 2003. The darker green of the smallest squares show the areas which were sampled to provide the vegetation data. The lighter green small squares in between the darker green ones represent areas where supplementary vegetation observation data were collected. The public water points are included here again because 19.7 percent of the social survey sample indicated that they used water from the village water supply to water the goats. The institutions are included again here to provide information and services with regard to the goat rearing. The ranches are included to indicate other livestock management options which may be available to the community. There is a range fencing development program in the current agricultural policy that the communities can choose to adopt. When they do, such a map could be used to identify the areas that still contain sizable amounts of grazing.

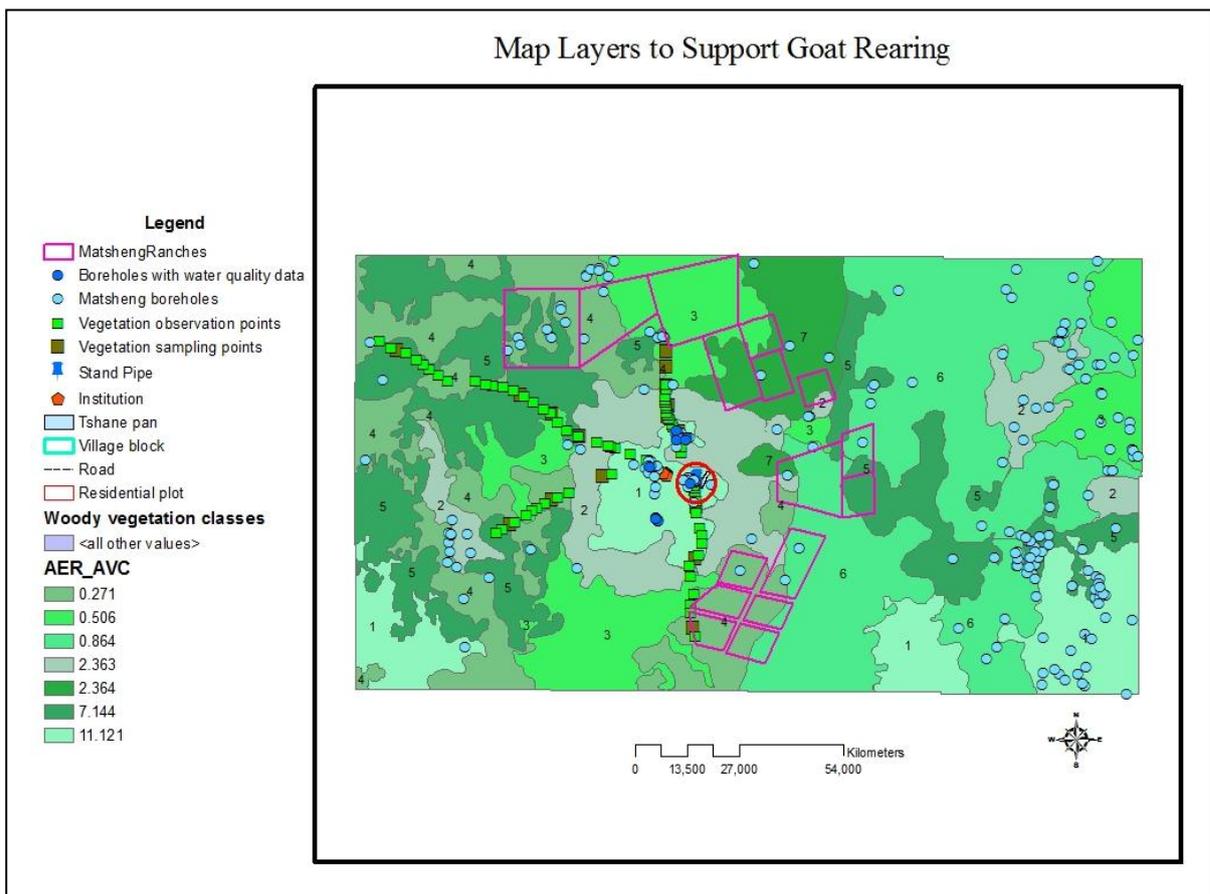


Figure 6.16 The map layers to support the goat rearing

6.2.6 The Non-Map Data to Support the Acquisition of Shelter and the Goat Rearing

This activity represented the tabular database design component of the PGIS process. It formed part of the process of creating the PGIS prototype which was subsequently demonstrated at the community site. The tables were derived from the social survey data and the shelter acquisition and goat rearing process models respectively. Four tables were produced from the social survey. The tables produced were, the basic household data for the household heads or representatives, the income sources, livestock ownership and arable land ownership.

From the process models, seven tables were produced for the acquisition of shelter and six tables were produced for the goat rearing. The process models from which the tables for both the shelter acquisition and the goat rearing datasets were derived, were produced from a data model which is depicted in Figure 6.17.

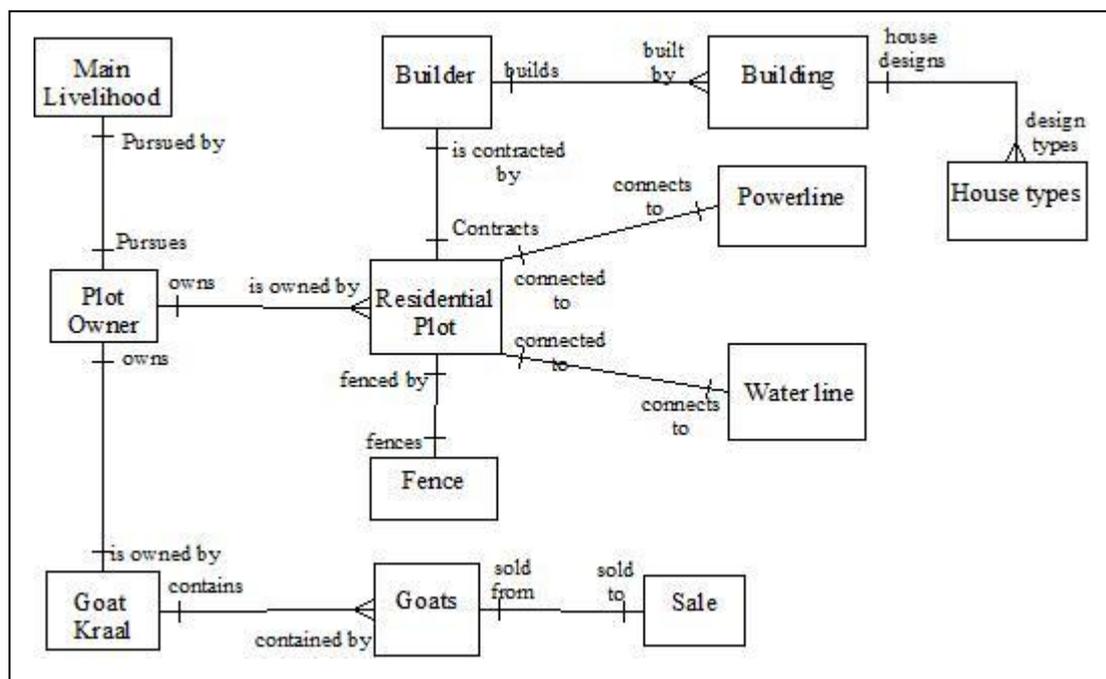


Figure 6.17 The conceptual data model for shelter acquisition and goat rearing

From those broad process areas, more detailed data flow diagrams were developed in order to determine the processes which were involved in the depicted flows of data. The data attributes which were used in these data flows were used to produce the

tables. For the shelter acquisition process, the seven tables which were produced were: a) building contract, b) building cost details, c) building plans, d) inspection request, e) the inspection, f) labour costs and g) building stages tracking. For the goat rearing, the six tables which were produced were: a) goats acquired, b) community livestock sales, c) request pledge, d) sales advert, e) livestock numbers and f) livestock ownership.

The data set for the acquisition of shelter was used to demonstrate the use of the PGIS to support the development of a household plot, from the application of a plot to the finished house. The activities which the dataset supported were, assessing the suitability of a site within the village, planning to build, modelling the house building costs, applying for land and building. The dataset for the goat rearing was used to demonstrate the use of the PGIS to support the goat acquisition, raising, selling and range management considerations.

6.2.7 Assessing the Acquisition of Shelter

A suitable site was deduced to be the one which was favourable with regard to access to water and power services. A suitable site was also considered to be one where the site itself was pleasing. To assess access to the water and power services, the water and power line map layers were displayed to show the distribution over the whole village. A pleasing site was considered to be one where the site was within a well built area. The interpolation procedure in GIS software was used to create a house type surface using the village plots map layer, the third dimension was the type of main building the plot contained. Both sampled and non-sampled residential plots were used to create a surface map. The surface was then labelled with both the house type and the sex of the plot owner. The sex of the plot owner was used to identify the sex of the potential neighbour and to highlight the gendered nature of the poverty. The result is shown in Figure 6.18. The green colour shows the poor housing and the shades of light brown show the better housing. Figure 6.18 showed that poor housing was prevalent in blocks one and seven and the bottom part of block two. The pink lines show the power lines and indicate that block one, the top part of the village has the least reticulation. The blue lines represent the water line distribution and shows better reticulation over the whole village.

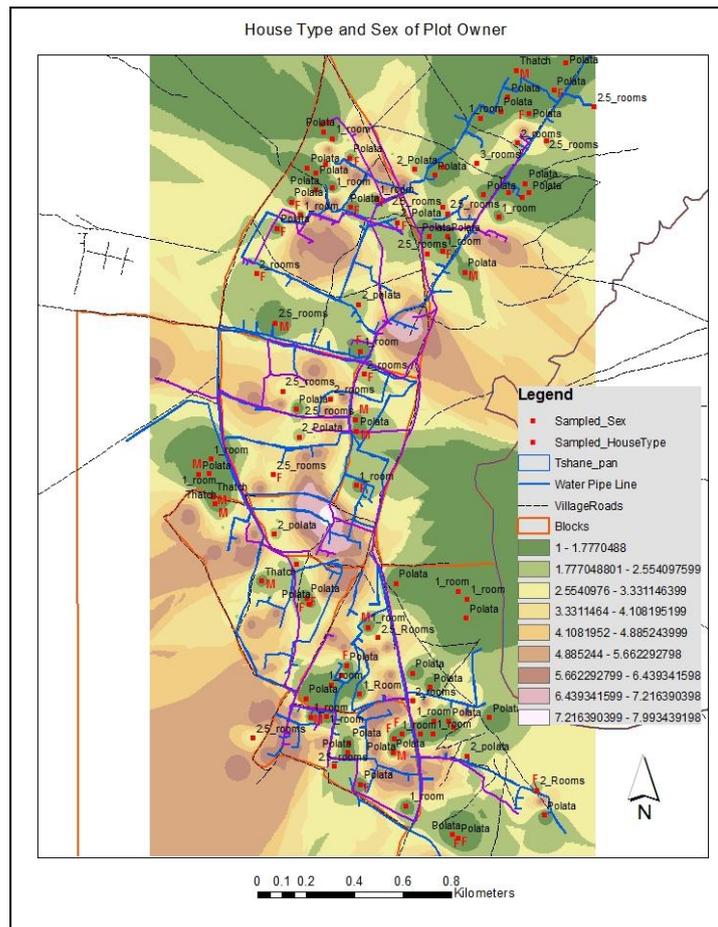


Figure 6.18 House type and sex of plot owner

When a community member planned to build a house, the PGIS was used to produce simple house plans. Quite often within the village the houses were built using the builder's mental plans. The PGIS contained scanned copies of existing plans which were edited to produce the building plans of different house sizes. In order to produce a plan, an existing larger plan was displayed and a suitable component of the plan was clipped off and finalized into a new separate plan. This is shown in Figure 6.19. The plan was then used to estimate the cost of building the house. The next stage was securing the funds to build the house. This is discussed next under the modelling of the costs of building.

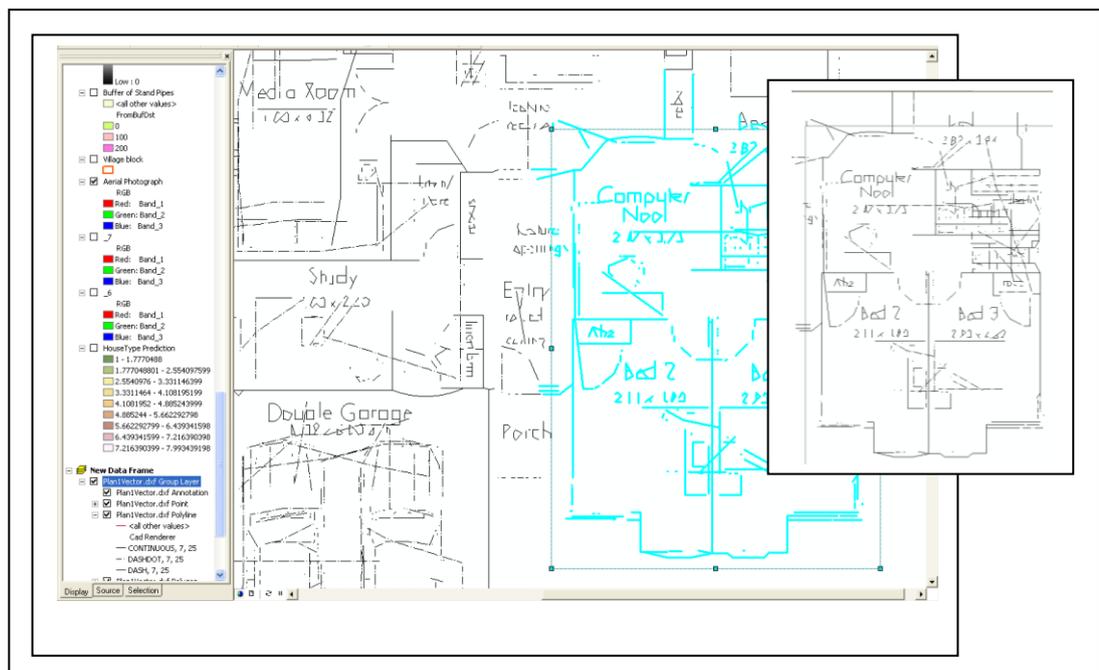


Figure 6.19 Creating a building plan

The house building model was focused on the labour costs and how the affordability of the building costs could be assessed. For the sampled population, most of the households occupied the plots whose main house sizes ranged from one room to three rooms. In all of Tshane village, 68.53 percent of the households have main house sizes in the one room to three rooms range and 47.96 percent of these were sampled. A common three roomed house was referred to locally as a two and half roomed house. The labour costs for building these houses were obtained from the local builders. Two tables were presented to assess the acquisition of shelter. Table 6.6 shows the house size to be built, the labour cost and the repayments amounts and Table 6.7 shows the same table reformatted for graphing purposes.

Table 6.6 Repayment amounts and number of year to complete payment

		1 person	1-2 people	1-3 people	1-4 people	1-5 people
HouseType	TotalCost	P50/month	P100/month	P150/month	P200/month	P250/month
NoRooms	Building	Repay Years				
1 room	4400	7.33	3.67	2.44	1.83	1.47
2 room	8800	14.67	7.33	4.89	3.67	2.93
3 room	11700	19.50	9.75	6.50	4.88	3.90

Whereas Table 6.6 was easier to interpret for a community member, it was also easier to read the same information from a graph rather than from a table, but Table 6.6

could not be graphed from the way it was structured. Table 6.6 was then reformatted so that it was easier to graph and was presented as Table 6.7. It was then plotted and presented as Figure 6.20

Table 6.7 Repayment Amounts and Repayment Times for Common House Types

RepayAmount	RepayTrendLine	1 Room RepayTime	2 Rooms RepayTime	3 Rooms RepayTime
600	1	7.33	14.67	19.50
1200	2	3.67	7.33	9.75
1800	3	2.44	4.89	6.50
2400	4	1.83	3.67	4.88
3000	5	1.47	2.93	3.90

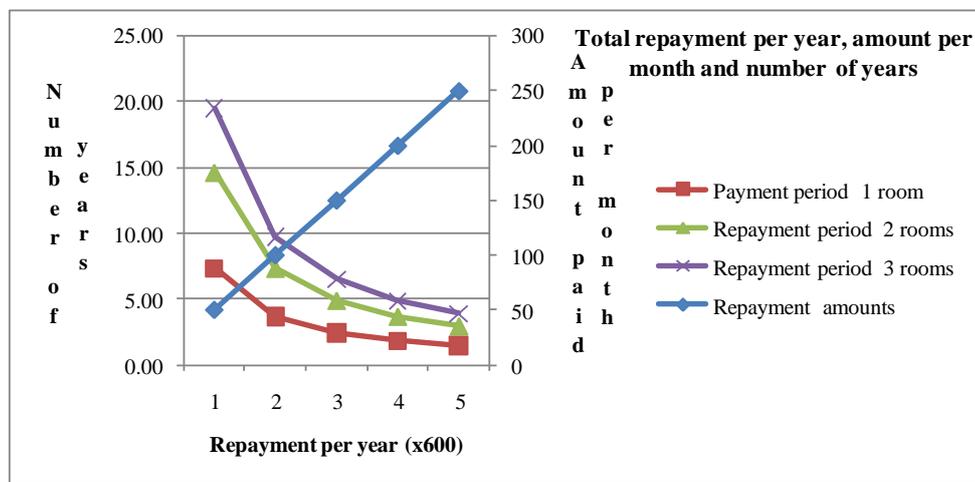


Figure 6.20 Repayment Times for the Common House Types and Repayment Trend Line

Figure 6.20 showed that although it took one and half to seven years to build a one room structure, most people could only afford the seven year period. A three room structure which was closest to the minimum number of rooms a four member family should have, took twenty years to build, thus it became out of reach of many families, again because it would not be affordable over a shorter loan period. The cost of fencing was estimated from the circumference of the plot and the cost of a 30m roll of fencing as indicated below.

$$\text{Cost of fencing} = \frac{\text{circumference of plot in meters}}{30\text{m}} \times \text{cost of 30m roll of fencing}$$

The circumference of the plot was obtained from the plot's internal table record. Once the building costs were determined, the application for land could be made.

One land allocation process which was facilitated by the PGIS mapping was presented in Section 6.1.4 and illustrated in Figure 6.9. The village plots map layer was used to identify the open spaces, so that the Land Board could allocate the plots there. This part of Section 6.2.7 presents the allocation of land under the traditional system that the land board used.

When a community member applied for land using the traditional system, the procedure was that i) the incumbent identified a preferred location, ii) conferred with and secured agreements from the surrounding neighbours, iii) consulted the local land overseer and confirmed the availability of the space, iv) filled an application form that contained the names of the neighbours who were consulted, v) got the form signed by the land overseer and finally vi) lodged the form with the Land Board. Figure 6.21 shows that the PGIS assisted the applicant to search for a location (item i), to identify the neighbours (part of item ii), and provided an application form (item iv) and the other activities could only be carried out by people on the ground. When the land was allocated, the building could begin.

With regard to the building process the PGIS was used to store and display the building stages information as the building process proceeded. This was used to support the building stages checking component, and was also used to support the monitoring and verification of completed stages for inspection and payment records. The photographic records of the building stages were obtained from the building site and hyperlinked to the respective record in the residential plots map layer. This is illustrated in Figure 6.22 where the building foundation and the brick work up to roofing level are shown. When the building was completed the water and the power services could be connected.

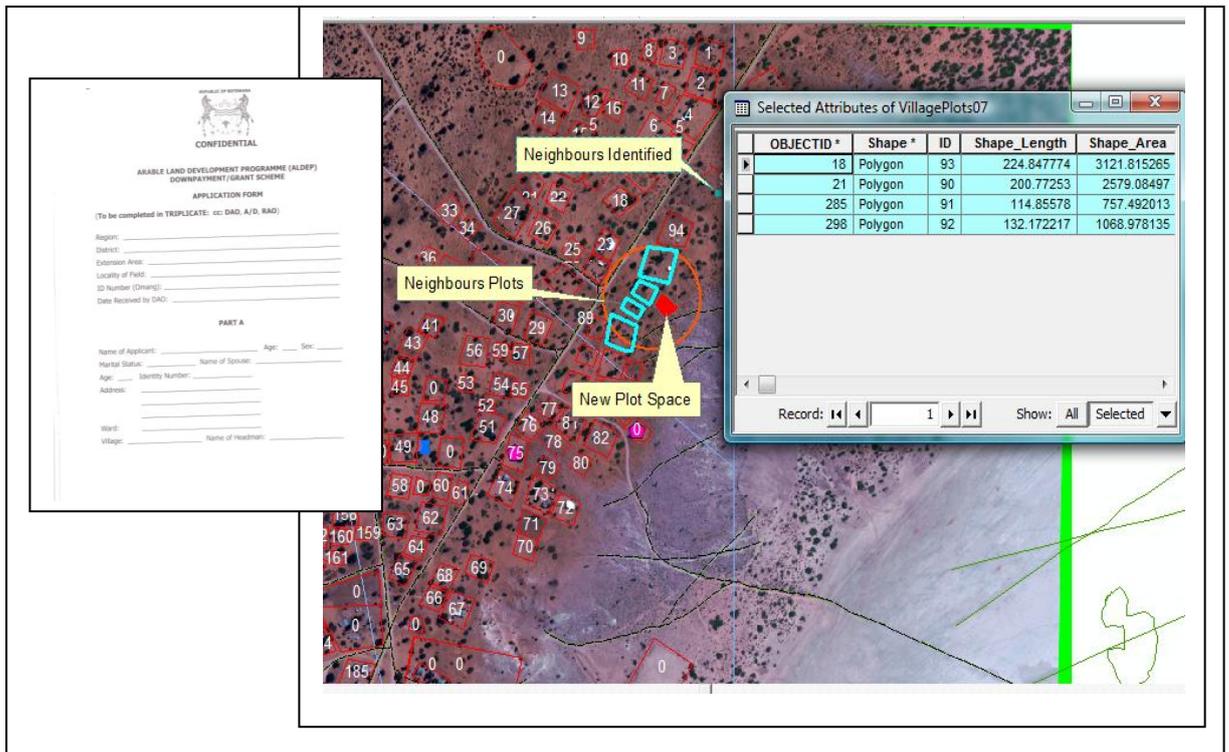


Figure 6.21 How the PGIS can support the application for a residential plot

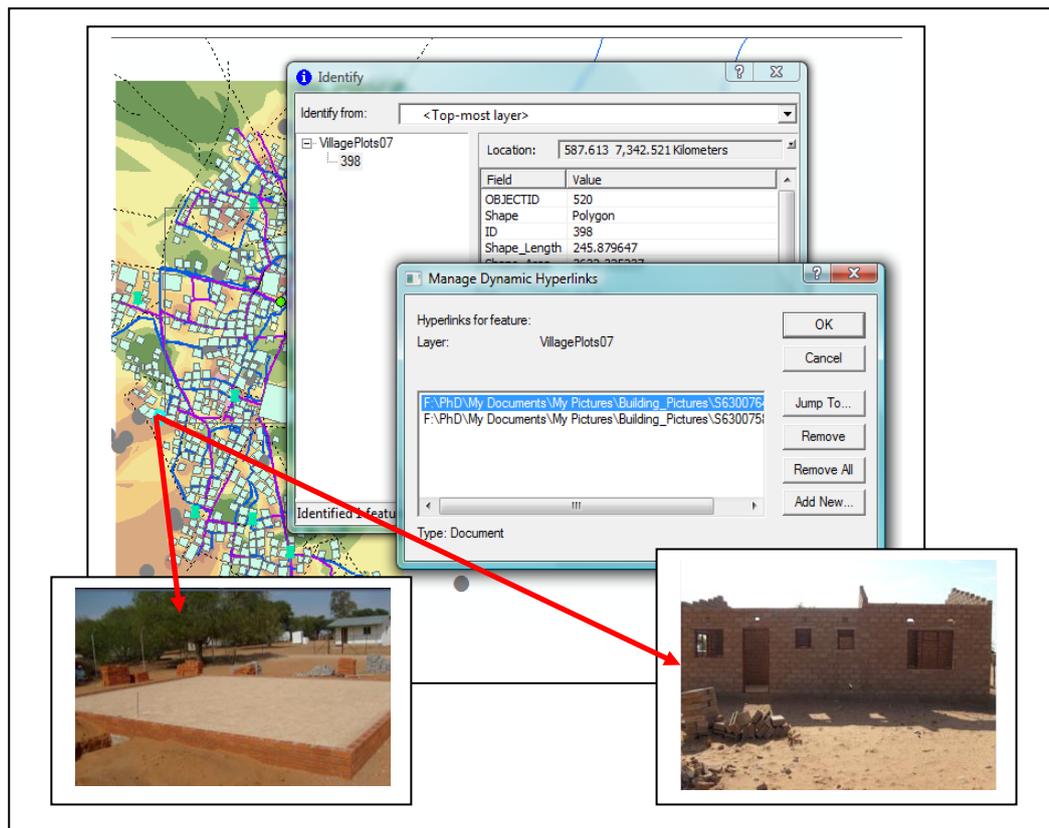


Figure 6.22 Supporting the building process with hyperlinked building site imagery

The water lines map layer was used to select the sampled plots in order to determine which ones had access to water (Figure 6.23), 25.77 percent of the plots were selected. This confirmed the suspicion that although the distribution of the water pipe line network appeared to be evenly distributed over the village, many of the poorer households were not connected to the District Council water line network. Also, with regard to access to water, buffers were created around the public stand pipes. The buffers were created around these water points at 0-100m, 100-200m and 200-300m. The results showed that most of the plots fall within the 100-200m distance from the public water point. In order to assess the accessibility of the individual plots from the public water points, a spatial join was created between the sampled plots and the public water points, the results show only 5.26 percent are located within 50m of the public water point, 11.58 percent are 10-100m away, 45.20 percent are 101-200m away, 66.32 percent are 20-300m away, 85.26 percent are 301-400m away, 95.79 percent are 401-500m away and the rest are more than 500m away.

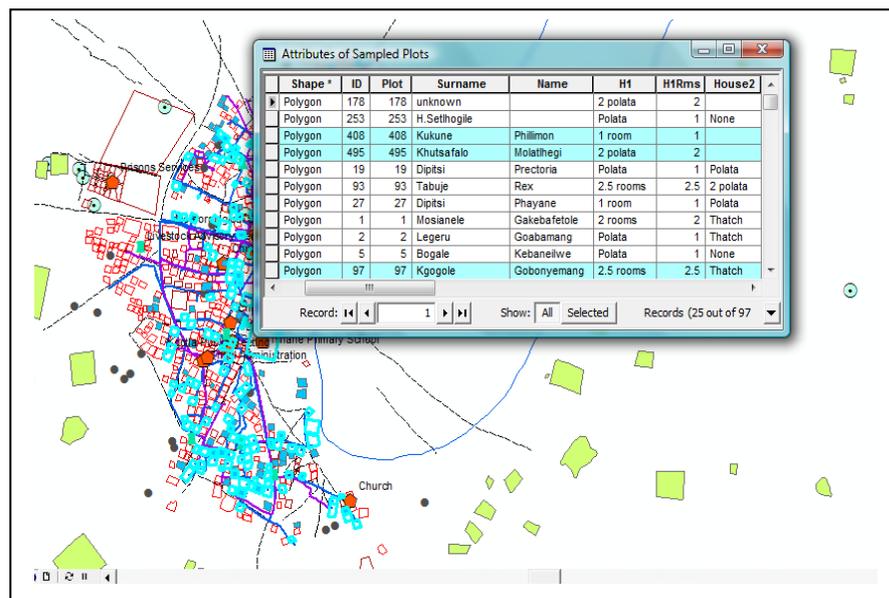


Figure 6.23 The sampled plots connected to the water line

Overall, the results showed that most of the village plots were close to the water lines. Specifically, 25.0 percent were within zero distance, 62.0 percent were within 25m, 84.0 percent were within 50m, 96.0 percent were within 100m and only 4.0 percent were within 100 and 174.458m. The distribution of the power lines was not as extensive. The PGIS determined that 9.0 percent of the plots were within zero distance, 35.0 percent were within 25m, 48.0 percent were within 50m, 72.0 percent

were within 100m, 88.0 percent were within 150m while 12.0 percent were between 150 and 370.24m. Thus the use of the PGIS provided more specific information about access to water and revealed that access to the water and electricity needed to be improved.

6.2.8 Outcome of Modelling the Goat Rearing

The goat rearing was selected as the more viable option for the poorly resourced community members compared to owning cattle. The response from the sample showed that 27.78 percent noted that the goats were easy to raise and 33.33 percent indicated that they multiplied fast. In addition 14.81 percent noted that the goats did not wander far and therefore were comparatively easier to manage than cattle. Based on these responses two goat production modelling processes were carried out in order to determine whether the goat rearing was a realistic livelihood option. The first modelling scenario used 50 goats as the starting herd and the second used less than 50 because an estimate of the goat numbers showed that the average goat herd size in the village was 20 goats.

A kidding rate of 70 percent females and 30 percent males was applied. This information was supplied by the village team participants who had obtained the information from their agricultural demonstrator. The goat project trainee proposed to sell 90 percent of the output. The results showed that the farmer would sell 30 female and 15 male goats after 10 months. This production model was held constant for simulating the output of the following two ten monthly periods. The result is presented in Table 6.8. The income generated was then calculated by using the selling price of P500.00 (Botswana pula, currently about 1/7 of \$1AUD) for the male goats and P400.00 for female goats. The relationship between time (in months) and income generated were then plotted (Figure 6.24). When a poverty datum line of two dollars per day was used, it showed that a community member would have to sell two goats per month in order to stay slightly above the two dollars per day limit.

Table 6.8 Goat production simulation

Months	Goats	Sold	Females	Males	Females sold	Females left	Amount
0	50	0	0	0	0	0	0
10	100	45	35	15	30	5	19500
20	110	49.5	38.5	16.5	33	5.5	21450
30	121	54.45	42.35	18.15	36.3	6.05	23595

Figure 6.20 showed that the output rose sharply after the first production cycle but then levelled off immediately after the first production cycle. This was understandable because 90 percent of the output was then sold. However, although the output rose during the third production cycle, it still did not rise as sharply as during the first production cycle. Again this was explained by the fact that 90 percent of the output was sold. The conclusion that was drawn from this was that it was not worth the additional management cost to keep goat herds that are larger than 50.

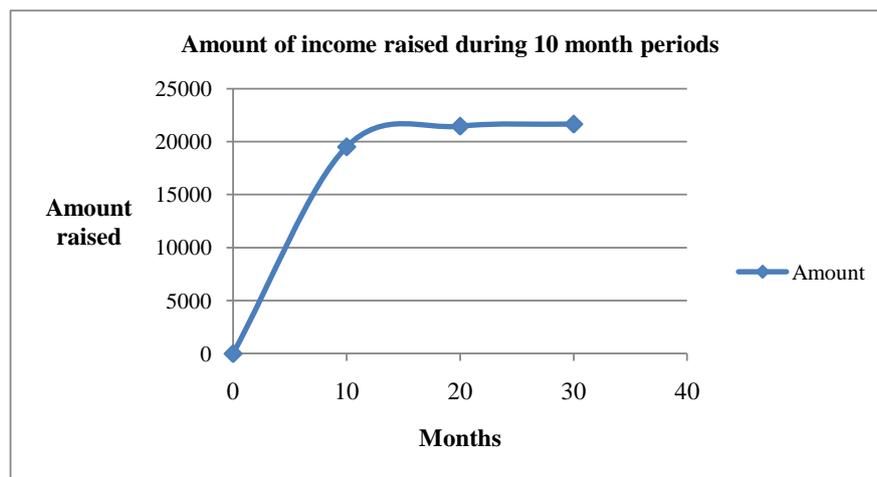


Figure 6.24 Amount of income raised during three 10 month periods

In modelling the goat production for a herd size of less than 50 goats a production cycle of six months rather than ten months was used. The assumption used in this case was that the goats were capable of kidding twice in one year. The bias towards this rather optimistic modelling scenario was mainly for convenience, because it made the yearly calculation easier. The calculations would be just as valid for a ten month cycle. The herd size was then plotted against the number of male and female goats sold each month, goats remaining and new totals for a complete year. This is presented in Figure 6.25.

The results shown in Figure 6.25 indicate that the herd sizes of 10 and 20 goats represented non-sustainable herd sizes if a farmer was to sell two goats per month. Therefore, the results reveal that the farmer should not sell any goats within the first year. The herd size of 30 goats indicated the minimum herd size at which the farmer could start selling two goats per month sustainably. The goats remaining after selling and the new totals indicate a sustainability component because the goat herd size

continued to increase despite the farmer selling two goats per month. The zero number of female goats sold at the herd size of 50, does not mean that there were no female goats at all to sell, it simply meant that the farmer did not need to sell the female goats at this production level since there would be sufficient numbers of males produced. This information could be used by the Livestock Improvement Management Integrated Development (LIMID) program. That is, to identify the farmers who were likely to have female goats that they could sell to other farmers during the implementation of the LIMID community development program.

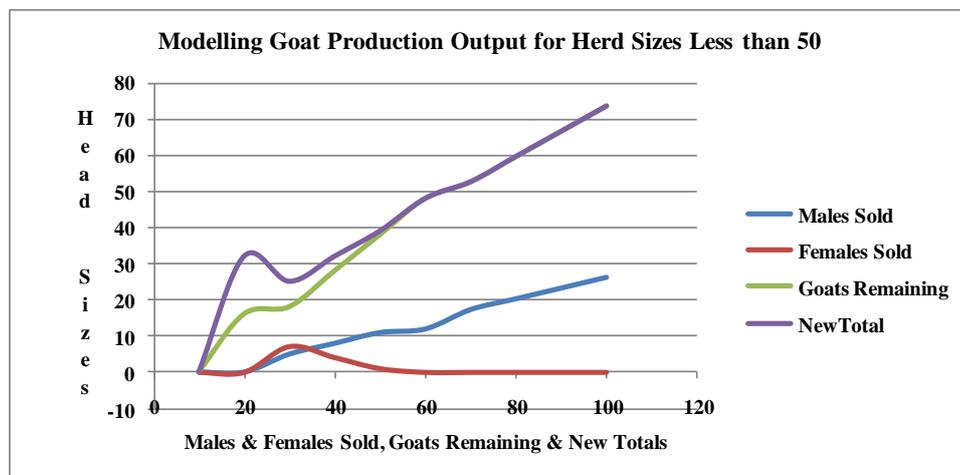


Figure 6.25 Modelling goat production output for herd size less than and beyond fifty

In conjunction with encouraging the community members to enhance their management and improve their livestock output in order to improve their living standard, there was also need to assess the potential impact of the goat population on the range. This required matching the total number of goats with the carrying capacity of the area. When it was assumed that the carrying capacity could be supplied by the animal production division of the Ministry of Agriculture, the PGIS demonstrated that it could supply the number of goats at any given time as outlined immediately below.

Although getting the goat numbers was still a sensitive and personal issue in Tshane village, in order to illustrate the process by which this information could be provided by the PGIS, grazing goat heads were observed and counted from colour aerial photographs as shown in Figure 6.26. The figure also includes a small table that indicates the counts made. One of the goat numbers was supplied by the goat owner. On the average, the goat herd sizes range from 8 to 60. It was clear from the estimates

of the counts that out of the seventeen estimates presented, only one was greater than the 50 goats used to simulate the goat production.



Figure 6.26 Using the aerial count procedure to estimate goat herd sizes

It was also possible to identify the goat kraals within the village from a visual interpretation of colour aerial photographs. A total of 28 kraals were identified. Using an average of 20 goats per kraal, the total number of goats in the village could be estimated to be 560. This was a surprisingly low figure even though the villagers often lamented the shortage of grazing. By recording the number of goats per kraal, assuming that the PGIS was subsequently allowed to keep such data, and supporting the sale of goats in the village, the PGIS was demonstrated to have the capability to keep a relatively up to date figure of the total number of goats. If the carrying capacity figure was provided, then all the PGIS needed to do was to keep the goat heads within the carrying capacity of the rangeland and sound the alarm when the figure was breached.

The vegetation dataset also had vegetation descriptions along road transects and vegetation sampling at certain points along the transects. This information was superimposed on the satellite imagery from which it was derived and, it was demonstrated that using data from a previous survey, vegetation information could be derived from the imagery without the need to carry out extensive and tedious vegetation survey again. However, it was noted that the imagery had to be from the same time period and the rangeland should be under the same climatic conditions, for the correct information to be extracted in this manner.

6.2.9 The Knowledge Content Repository

This section was concerned with integrating the rest of the compiled data into the PGIS prototype in order to create the complete knowledge content repository (KCR). The KCR was intended to be a knowledge access, knowledge building, knowledge sharing and knowledge communicating facility. Although the KCR stored knowledge content which was produced by the PGIS process, it also contained some of the literature that the research project used as well as the draft webpage. Specifically, the KCR contained knowledge content on business, knowledge structures, the village knowledge centre, data summaries on the social survey and the attitude scale, six public domain software, pictures, voice recordings and videos of the activities which were carried out. Part of this information is shown in Figure 6.27, the figure shows the shelter and goats map views, a video clip, knowledge structuring software and the list of folders containing the rest of the KCR content.

With regard to the actual activities which were envisaged, the KCR was formatted based on the observation that at the outset, the village community required enhanced access to basic information rather than a formal knowledge base system. Access to most of the archived information was based on simple search operations using the search facilities of the common software applications such as Microsoft Office suite of applications, Windows Explorer and the PDF reader software. The use of long file names was taken advantage of especially in documenting the literature. Such long file names contained year of publication, authors, titles of documents and thematic tags in order to facilitate word or phrase based searches. Knowledge content input and collaboration work was based on the note making facilities in calendars, Microsoft Excel and Word. Public domain software was used to create knowledge structures and conceptual data models. Community members were expected to retrieve the information and use their knowledge to construct new knowledge for specific applications. The requirement was that such interactions with the KCR were to be documented as part of the process of building the knowledge within the KCR.

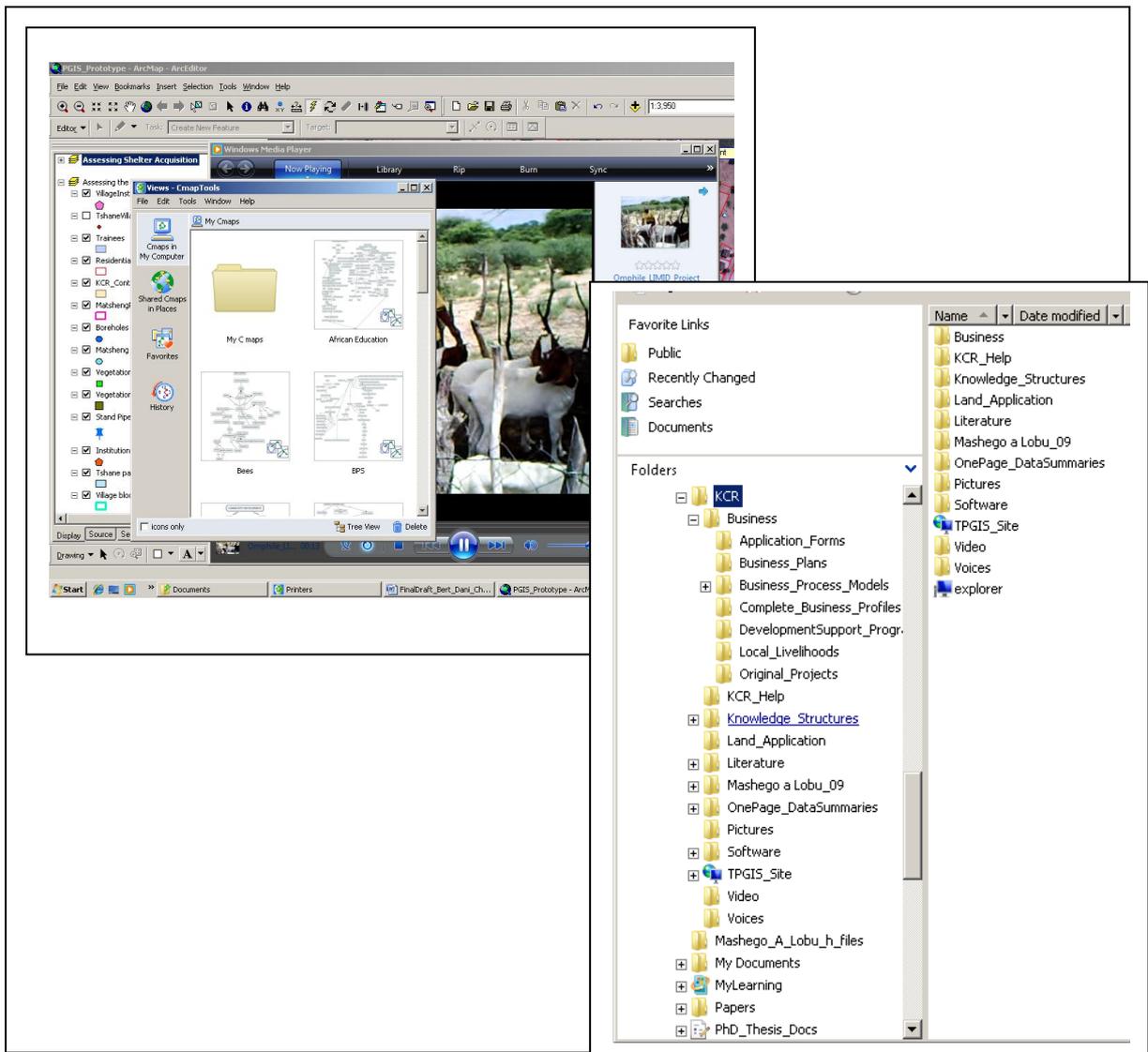


Figure 6.27 The knowledge content repository

6.3 The Final PGIS Framework

The goal of this research was to develop a geographic information system (GIS) based rural community development strategy with the active involvement of a rural community. The strategy was referred to as the participatory geographic information system (PGIS) framework. The rationale was that this strategy should anchor community learning, and assist the community to create and construct knowledge which should then be used to support individual or group action in order to improve living standards. This section presents the final version of the PGIS framework which was called the Rural Community Knowledge PGIS (RCK-PGIS), which is shown in

Figure 6.28. Although an attempt was made to present a more logical sequence, the actual flow of the work was mixed and did not lend itself to easy sequencing. The aim here is to explain the functions that the different roles supported rather than the exact process from the beginning to the end.

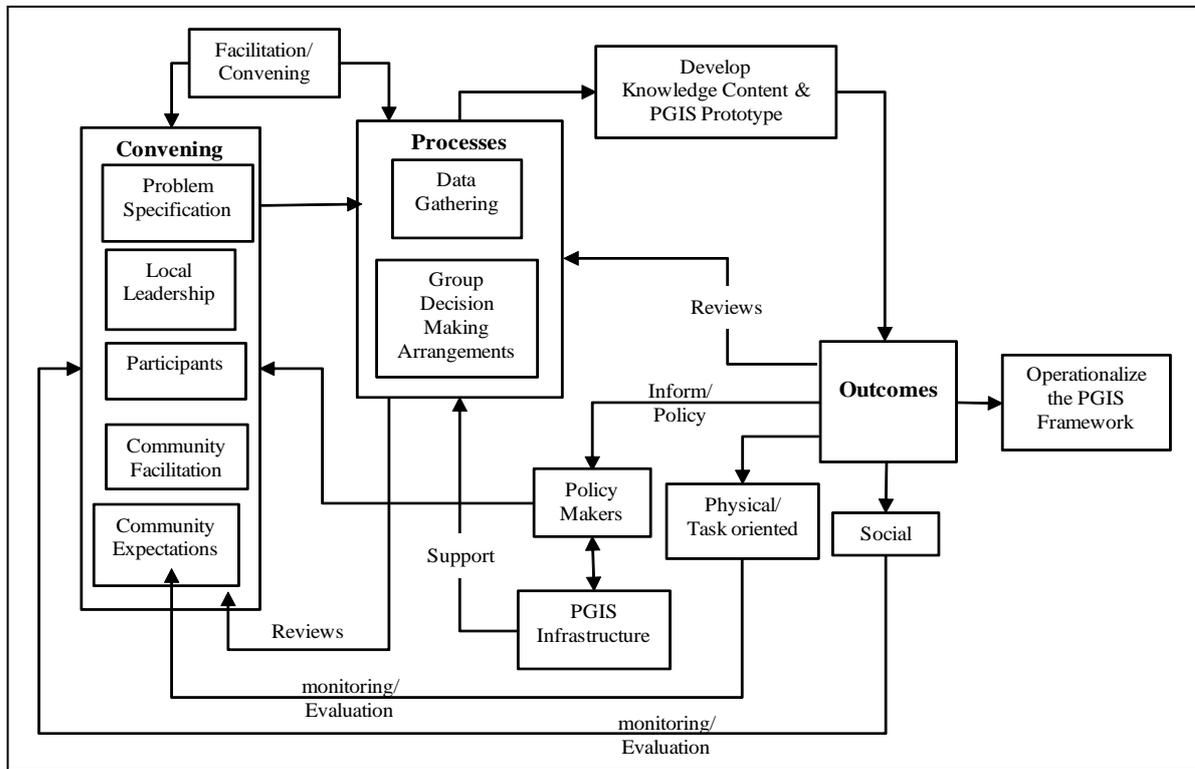


Figure 6.28 The Rural Community Knowledge PGIS framework

Overall the PGIS framework represented facilitated community collective learning. In this process the community leaders under the guidance of village based facilitators, restrengthened their leadership structure in order to prepare for and lead the community through a process of change in the acquisition and use of knowledge. This was done so that the community members could be empowered to secure dignified living standards themselves. Figure 6.28 shows that the PGIS framework had nine roles: the facilitation, the leadership, the community training and contribution, the structuring of the data, the creation of an exemplar PGIS prototype and knowledge content repository, the testing and evaluation of the PGIS framework, the input of the community development institutions, the operationalization of the PGIS infrastructure and the demonstration of created output.

The facilitation role served to initiate, energise and sustain the community activities and formed the strength behind an effective leadership structure, this PGIS framework component is discussed first. In the Tshane case study this represented the first field trip and the beginning of the setting up of a formal working relationship with the village community. The facilitation created within the leadership the need to step up to the leadership challenge that the community participation demanded and linked the leadership with the village wide community. The facilitation needed to assist the leadership to select local representation in the participation process and developed links with the development support institutions. Ultimately, the facilitation undertook to carry out all the preparatory work that needed to be done in order to ensure that all the necessary requisites and actors were in place. This was necessary in order to ensure that the activities proceeded as planned and were constantly monitored. In Tshane village this role was played by the village development committee and the researcher. The facilitation role was a leadership role and required knowledgeable actors.

Within a rural setting where the education levels tended to be low and the access to information and knowledge was limited, external and complimentary facilitation was not considered to be a weakness at the early part of the community learning. In addition, the researcher noted that even where such facilitation capability could be available locally, there was still need for dedicated rather than part-time or rotated facilitation. This was necessary because the immense additional background work that needed to be carried out demanded that this had to be so. The need to be constantly in tune with the activities made rotated facilitation an unwise option. The researcher noted that it was possible to use some of the local development institutions to assist with the facilitation role. For example, the social and community development (S&CD) officer in her presentation of the community development knowledge structures indicated and demonstrated that the community development work was part of her mandate. However, it was taken into consideration that some of the community development officers such as the S&CD officer were overstretched due to shortage of manpower at the district level. Ultimately, the facilitation work demonstrated clearly that this role was critical to the whole PGIS process, and in the case of Tshane village, provided the support and the strength that the leadership needed to play its role.

The leadership represented the wisdom and foresightedness of the community development work and constituted the second PGIS framework component. It had to have the capability to assess the community development situation, decide on what needed to be done, and avail the resources and the personnel to implement. The chief and his ward heads also had to lead, monitor and evaluate progress. This role too required adequate knowledge however, the knowledge required at this level was broad and strategy related and relied more on acquired experience and the wise use of the actual knowledge workers themselves. The main role of leadership was to create a shared vision of change and to lead the community through this process. In Tshane village, this role was played by the village chief and the ward heads with the assistance of the village councillor. To create and maintain a vision of change, the leadership had to set up communication, reporting, monitoring and evaluation sub-roles within its structure and delegated some of its functions to the VDC. Consequently the village leadership worked closely with the facilitation role. One ward member was assigned the role of attending the research project management meetings and another ward member attended the VDC regular meetings. These ward heads kept the rest of the leadership informed about the project activities. The Tshane village case demonstrated that even starting from a low knowledge base, wise leadership could learn and do so fast enough to lead the process of change successfully.

The first and second roles of the PGIS process were participation preparatory roles. They served to identify and place the leadership in position, secure a convening location, decide on convening times, select representatives of the village in the participation process and supplied the necessary requisites. The third role of the PGIS process was about gathering the data and building the geographic information system, this was the more common face of participation. In the Tshane case, this too was part of the first field trip. In order to achieve true community involvement where the community not only carried out tasks but also understood the whole process and its rationale, much training needed to be carried out. In interventions that involve information communication technology (ICT) such as in the implementation of a PGIS process, the training started from a very low base and involved many hours of hard work. In Tshane village for example, all the six VDC members had not used the computer before and six of the fifteen initial trainees had never touched a computer

before, while the rest had only rudimentary exposure. In such participatory work, the learning activity had to not only impart general learning, it also had to carry out the tasks. Therefore the training was planned around what needed to be achieved in the project and the practical component had to represent the project tasks.

In Tshane village the main need was productive employment and the improvement of living standards. Since many of the villagers could not find formal employment, self-employment through the establishment of small businesses formed part of the PGIS process solution. Thus the business process modelling work became part of the training. The base map layers too had to reflect support to local livelihoods. The learning strategy had to be experiential and constructivist as was the case in social learning processes. Therefore, in order to support ease and confidence in involvement, the teaching language had to be as local as the situation allowed. In order to enhance meaning and purpose and to successfully create a realistic and relevant context, the villagers had to work and communicate in their own language. The English language could be understood enough to enable the use of the language whenever it became necessary to do so, but to a large extent, the community members had to feel as comfortable working together in the classroom as they did in their everyday social learning community environment. This was particularly important where the individual capabilities were low and the participants needed to constantly learn from each other in order to augment their individual knowledge bases. The learning also had to involve individual presentations and demonstrations. This was necessary in order to allow the community members to demonstrate their understanding as part of the learning process. The community members also had to be given the opportunity to externalize and share their knowledge with others.

The fourth role of the PGIS process related to the structuring of the collected data and its preparation for further appropriation to more specific applications. For the spatial component of the data, this involved the finalisations of the spatial data. The datasets were created, topologies were built and appropriate spatial referencing was selected. For the non-spatial data, this involved data modelling, specific data tabulations and the identification and modelling of relationships. This component of the PGIS framework represented the more technical aspects of the PGIS process and the one in which the community did not have much input. Whereas this was often caused by the

external nature of the expert facilitation and the more technically demanding requirements of the process, it also related to the level of training that the participants held. In the case of Tshane, this tended to limit the successful appropriation of the skills even if the community members had been trained and made the sharing of knowledge more difficult and slow. In Botswana the lower levels of training such as in GIS did not necessarily relate to the rural areas only. Even at university level, the standard of training fell short of imparting adequate skills to the prospective GIS practitioners.

The development of the knowledge content and PGIS prototype was closely related to the data structuring and represented the fifth component of the PGIS framework. It involved creating exemplars of possible representations of the data that could be used to support particular livelihoods and which could be demonstrated at the community site. It also included the selection and archiving of the data and the setting up of procedures that facilitated access to and use of the stored information. Such a knowledge content repository was intended to assist the community to work together, and in the process to start the practice of contributing towards a continuous knowledge building culture. In this role too, the community had insufficient participation. Apart from specifying their needs in order to guide the development of the knowledge content and the PGIS prototype, the village community had limited input in the activity.

The testing and evaluation of the PGIS infrastructure was the sixth component of the PGIS framework. It was concerned with providing feedback on the work which was carried out in the first field trip and determined how effectively the PGIS infrastructure facilitated the community development work. In the Tshane case study, this was carried out during the second field trip where a number of workshops were held. The second field trip offered the opportunity for the village community members who participated in the project through the social survey and attitude scale to become more directly involved in the project by participating at village workshops. This activity involved checking the correctness of the compiled information. It also involved matching the support function of the PGIS artefact with the community needs and determining how adequate the support function was in supporting the procurement of the needs. More importantly, the evaluation assessed how well the

PGIS infrastructure contributed to the whole community development infrastructure. The PGIS infrastructure therefore, had to be checked on how well it functioned to assist the village community to effect the necessary linkages between the leadership, the facilitation, the general village community and the development institutions. These linkages related to how well the PGIS supported the process of securing the services of the community development infrastructure. In Tshane village, this activity was carried out by presenting the PGIS artefact to the VDC and the trainees so that they could assist with presenting the PGIS product first to the leadership, then to the community development institutions. The evaluation by the general village community would be carried out when the community members used the PGIS.

A very important part of the PGIS process ultimately was the actual use of the PGIS infrastructure, that is, the operationalization of the created intervention tool. This activity represented a higher level of participation and constituted the seventh component of the PGIS framework. Here the emphasis was on ‘participating’, which was beyond the initial ‘participation as learning’ to the actual involvement in implementing actual community projects. This activity also demonstrated the contribution of the community development institutions in that process. In the case of Tshane, this was intricately mixed with the evaluation activities of the PGIS framework. One of the activities involved confronting the leadership with the actual outcomes and soliciting feedback as a way forward.

The planned operationalization of the PGIS infrastructure was that the main system would be lodged at the VDC offices, with distributed systems at the Tribal office and the village wide wards. The setting up of the services at these venues had implications on the requirements of the sites to support the implementation. For example, the current ward meeting places were just open spaces with no office facilities. The requirement of a ward based system immediately raised a number issues with regard to the readiness of the ward sites to perform this role. These included: a) they were not officially registered with the Land Board, b) most of the ward sites were left over spaces with limited spatial dimensions, c) the community members had to decide on where they were going to get the financial resources to fence the site, d) the size of the office had to be decided upon and e) the community had to determine where they were going to get the resources to build the office facilities. In addition, the placement

of the proposed ward based systems within the village blocks which were used for the village mapping raised a heated debate on how the wards were going to be mapped to become the official ward boundaries.

As a way to raise awareness of the presence of the PGIS facility and an attempt to induce its usage, the development institutions were also confronted with the reality of the presence of the PGIS tool within their district. There was need to lobby the institutions both within and outside the village to participate in starting to use the PGIS intervention. In the case of Tshane, this meant visiting the institutions individually rather than calling them to a workshop which a number of them would find ways to avoid. The individual presentations were meant to confront the individual institution and present the PGIS information as it related to the particular institution. Five institutions were consulted. Apart from the feedback with regard to specific outputs as discussed in Section 6.2.4, the results with regard to the actual operation and use of the PGIS intervention were the same, there was no utilizable feedback. The conclusion that was drawn was that there was need for another series of training workshops in order to impart the basic skills to use the PGIS tool. A number of the institutions realized the potential application in their own fields, but until they had actual experiences of applications in their jobs, the PGIS tool was likely to remain just another non-utilized service with little prospect for sustainability.

In order to maintain the momentum, activities were initiated which were aimed at moving the community forward. The village ward heads tasked the trainees with determining the amount of space that was required for the ward based offices and decided to apply for the official allocation of the sites by the Land Board. Two trainees were tasked to review and correct the datasets. With regard to planning to establish the knowledge centre, the plan shifted from starting with setting up the centre first to setting up a ward site first. This happened because the ward head at that particular ward was active and was prepared to implement some of the new ideas.

The last part of the PGIS framework related to assessing the outcomes. Although according to the current counting, this would represent the eighth component of the PGIS framework, it actually represents the ninth, because the other component of the PGIS framework is the GIS artefact itself. The crafting of the GIS was closely infused with all the PGIS framework processes, but its presence was clearly evident from the

data gathering stage of the PGIS framework. The presence of outcomes which were produced by the PGIS process were important to show not just as proof of the effectiveness of the strategy but also to demonstrate actual usefulness to the community itself. Nonetheless, the presence of the outcomes was also used to evaluate the participation process. A number of outcomes were reported at the various stages of the PGIS process. The most important outcome was the establishment of a knowledge centre and the agreement to have a distributed structure as shown in Figure 6.29, where a wireless internet based network was proposed. For all the activities which were carried out in Tshane village, either the VDC or the trainees accompanied the researcher. Therefore, there are a number of activities which the community needs to follow through with. The more important being the setting up of the community computer training facility and further work on planning the building of the *Mashego a Lobu* knowledge centre. The community is aware of these expectations and this will ensure that the PGIS initiative will continue to evolve.

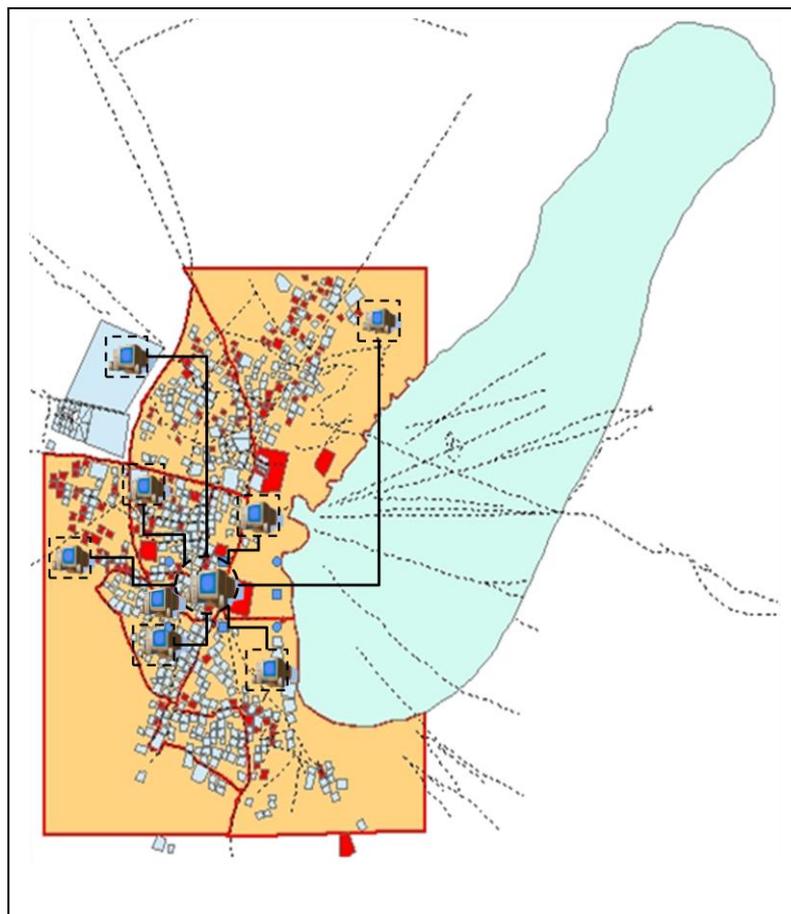


Figure 6.29 Layout of the Tshane PGIS Wireless Network

6.4 The Overall Evaluation of the PGIS Framework.

The evaluation was done in two ways. The first evaluation was carried out by the researcher as part of the presentation of the results, where each stage of the PGIS process was evaluated with regard to its sustainability and empowerment attributes. The second evaluation was carried out at the site by the village leaders, the VDC and the trainees, but it was also based on a form which was developed by the researcher. The evaluation was also discussed according to the PGIS framework components.

6.4.1 Evaluation of the PGIS Framework Components

The results of the first type of evaluation are shown in Figure 6.30. As discussed in Section 5.6, the evaluation was based on a three score rating which was devolved to a two score decision making format, where a score of '0' represented lack of capability and a score of '1' represented the presence of capability. The capabilities were also divided into individual or collective capabilities and the combinations of these were used to infer sustainability.

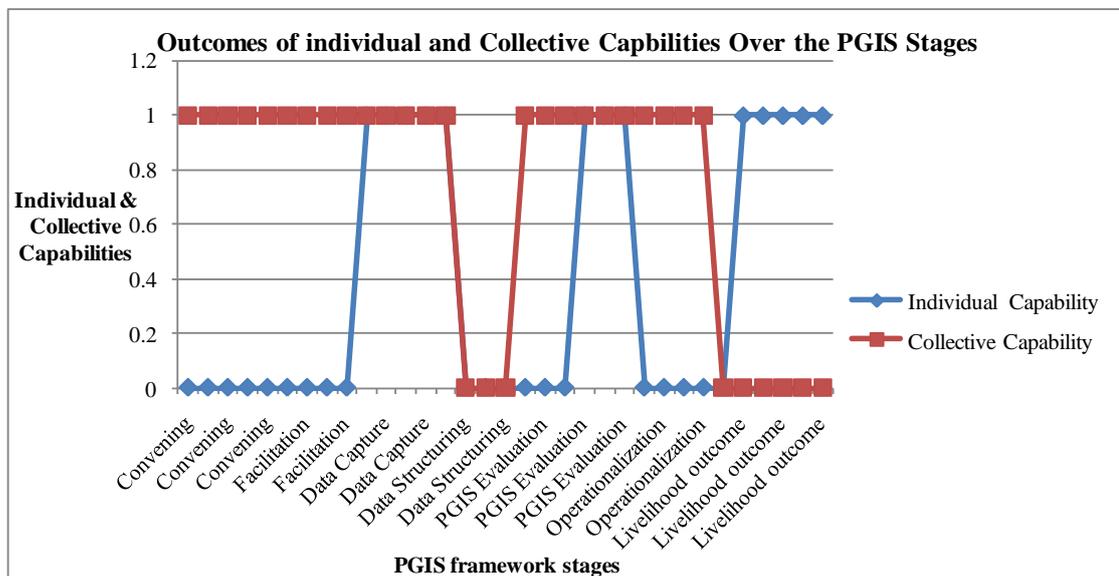


Figure 6.30 Outcomes of the individual and collective capabilities over the PGIS stages

In Figure 6.30, the convening and facilitation stages showed lack of individual capabilities but were noted to have collective capability. This result was interpreted as non sustainable individual capability but sustainable collective capability. Such a combination of individual and collective sustainabilities resulted with an overall positive sustainability rating because community development was considered to be collective work. Strong community capability was necessary in availing community wide social services which could then be used by individual community members, whereas individual capabilities could not achieve community wide social services. It was also concluded that the leadership and the village development committee were empowered to perform these roles adequately. The low rating of individual capabilities resulted from low educational and training backgrounds. This situation could be addressed by selecting VDC members who held higher education qualifications, thus increasing their capacity to understand government policies, development support programs and other social service related procedures. Whereas the placement of more highly educated village leaders was more difficult to achieve than the VDC membership, their capacities to provide more informed leadership could be enhanced by availing higher level advisory services. However, because the village leaders had become civil servants, their legitimacy as the village authority was also threatened by their allegiance and accountability to the District Council, rather than to the village community. This too needed to be reconsidered.

The data capture was noted to have both individual and collective capabilities and was interpreted as being sustainable at both individual and collective levels. This PGIS role was concerned more with direct task based activities compared with the more planning based input required at the leadership and facilitation roles. Nonetheless, at the data capture the training was aimed specifically at ensuring individual capability, while the tasks themselves and the group learning that the trainees often employed to assist each other, also effected collective capabilities. This PGIS stage too was considered to have empowered the trainees to carry out the business process modelling, GIS based mapping and the social survey.

The two roles of the data structuring, namely the more detailed data processing, and creating the geographic database and the development of the PGIS prototype and knowledge content repository, were noted to lack both individual and collective

capabilities since they were carried out mainly by the researcher. These roles of the PGIS framework were therefore noted to be not sustainable unless they were supported by external expertise. Consequently, these roles represented the weak components of the PGIS framework. Three issues were considered to contribute to the noted weakness. The first was the VDC and the trainees' low education base which would have limited the imparting of capability even if the training had been undertaken. The second was the divided context where these roles were performed away from the community context. The third issue was the time dimension as the PGIS framework required more time than the fifteen months which were spent with the community. The initial lack of capability at the noted components of the PGIS framework was therefore noted to be not necessarily negative. This research concluded that at the initial phases of the PGIS process, specialised expertise was required for these stages until such expertise was available within the village. It was therefore also concluded that it should be possible to build such local expertise. This was where the time dimension came in. These roles represented another training intensive phase of the PGIS process, the time which this research did not have.

The evaluation phase of the project represented the formal evaluation phase of the PGIS process and produced complementary results from the researcher's and community's view points. With regard to the researcher's evaluation of the PGIS stages, the results showed sustainable collective capabilities except for the data structuring components. The attained collective capabilities were considered to reflect empowerment at community level. The comparison of this result with the community evaluations is discussed under the community evaluation. The two separate evaluations were considered to be necessary. The researcher's evaluation would consider the research vigour and the community evaluation would provide feedback on the empowerment attributes of the PGIS intervention. In addition, three community development institutions were used to review three community outputs. Based on their inputs the research concluded that the evaluation reflected both individual and collective capability with regard to the institutions. Therefore, the input of the community development institutions at evaluating the community output was considered to provide sustainability to the future guidance and maintenance of the community projects.

On evaluating the preliminary investigations of the operationalization of the PGIS process, the research noted lack of individual capabilities but presence of collective capabilities for the leadership, the village development committee (VDC) and the trainees. No operationalization capability was noted for neither individual nor collective capabilities with regard to the development institutions. The research concluded that more training was needed specifically for the operationalization of the PGIS infrastructure as a whole and this included the community development institutions. This phase too, represented a weak component of the PGIS process if the expertise was discontinued before the PGIS infrastructure was noted to be functioning.

The output component of the PGIS process produced positive results. By the end of the second field trip, a number of village outcomes had been realized. Three trainee outcomes were produced. The first trainee used the capabilities obtained at the village training to secure employment, the second used her skills to start moulding and selling bricks in the village, the third used the business calculations from the business process modelling to obtain twenty more goats for her goat rearing project. The village chief decided to experiment with home based free range chicken but obtained an incubator in order to increase the hatching rate. One VDC member experimented with a fast growing species of chicken and was able to sell some of the chicks to the chief. Another VDC member experimented with setting up a digital document copying and reproduction facility. The capabilities obtained at these outcomes were noted to be mainly individual capabilities and the projects were considered to be sustainable at those levels.

6.4.2 The Community Evaluation of the PGIS Framework

Two evaluations were made, one related to the general participation in the activities and the other related to participation at the incidences of decision making. In both cases, the evaluations were carried out by the ward heads, the VDC, the trainees and the researcher. In assessing participation at these activities, fourteen activities were each assessed against eleven goals. Each activity was graded between one and three as regards its influence on the achievement of the goal. A score of 'one' meant that the activity was not likely to influence the achievement of the goal, a score of 'two' meant that the activity could be expected to influence the achievement of the goal and

a score of 'three' meant that the activity should influence the achievement of the goal. With regard to assessing the participation at the decision making, seven categories of actors were each graded against fifteen decision areas. A score of 'one' meant that the actor did not participate in the decision making, a score of 'two' meant that the actor was indirectly involved and score of 'three' meant that the actor was wholly involved. The results for the participation in the actions are presented in Figure 6.31 and those for the participation in decisions are presented in Figure 6.32.

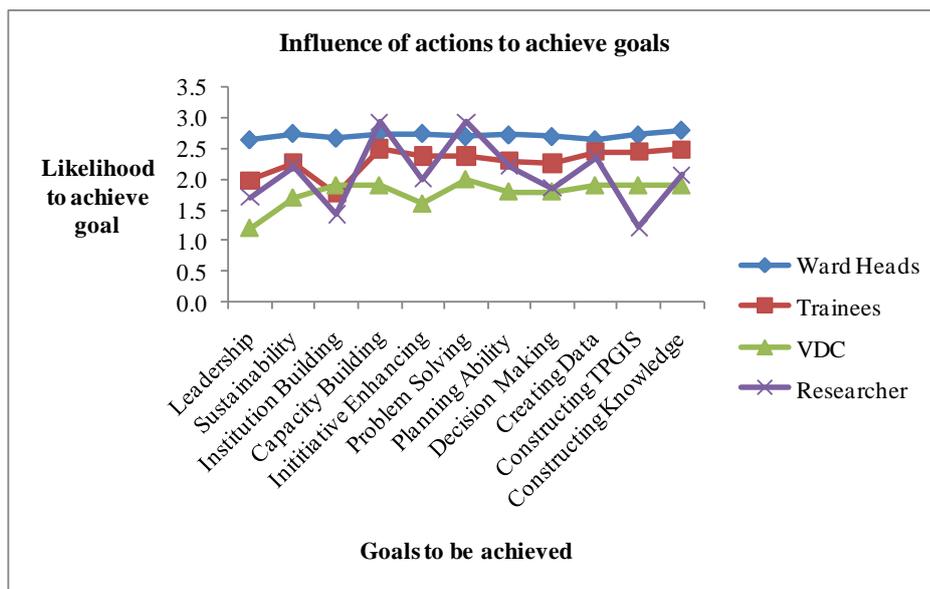


Figure 6.31 The Influence of Actions on the Achievement of Goals

The results in Figure 6.31 show that although the ward heads and the trainees indicated the highest confidence that the actions achieved the goals, the scores of the trainees are lower. The VDC had the lowest confidence that the actions achieved the goals and the researcher's assessment correspond more with the trainees' assessment. Although there are different levels of agreement among the four main categories of actors, there was generally the same trend in the agreement for both the positive and negative aspects except on the constructing of the PGIS. The researcher scored the constructing of the PGIS negatively while the others score it positively. This largely reflected that the community felt strongly that they were more realistically involved in the research project. The research project did contribute to raising the awareness of the need for recognized village leadership and more involvement by the village community.

Overall, there are more positive views of the achievement of goals, such as on knowledge construction, sustainability, capacity building, enhanced initiative, enhanced problem solving and decision making. Although the lower scoring happen to be on the more critical ones, such as leadership, institution building and decision making, the scoring reflected the situation for individual and non-facilitated capabilities rather than the more empowered collective capabilities. The research concluded though that these results indicated a much deeper level of involvement by the community as the next paragraph on participation in decision making revealed.

With regard to participation in decision making, Figure 6.32 shows that the ward heads and the VDC had the highest confidence that they were involved in the decision making. The trainees' scorings were lower for most activities because they were more involved in the execution of the tasks rather than the decision making. The researcher's scoring was also lower especially on the data gathering components where most of the training and the facilitated task executions were carried out. Overall, there was general agreement that there was mutual involvement in the decision making. It should be noted that the lowest grading on the selection of the convening location and the trainees by the researcher, did not represent a negative aspect, it was in fact a positive aspect because it indicated that in that case the village community made the decisions without the input of the researcher, this reflected strong collective capability and empowerment.

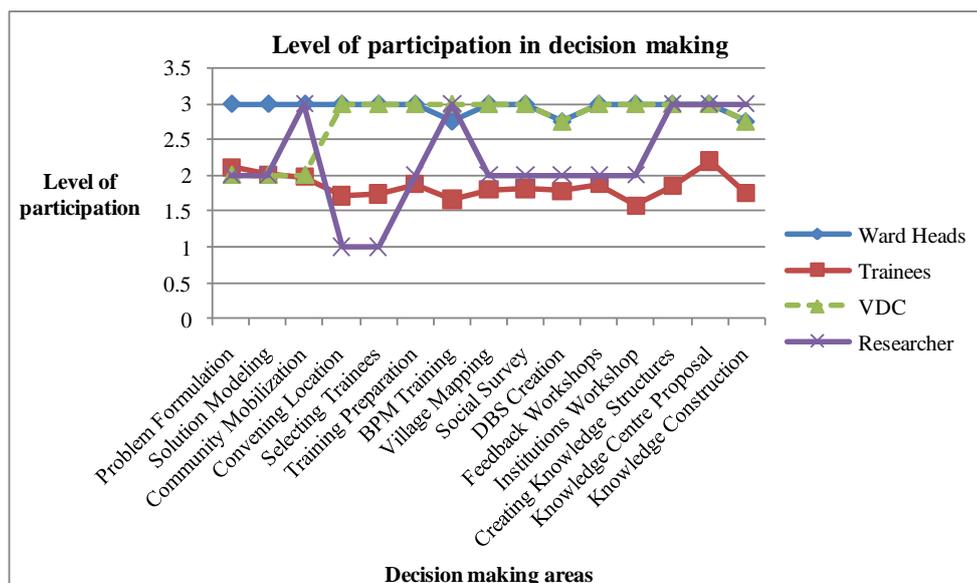


Figure 6.32 Perception of Level of Decision Making

6.4.3 The RCK-PGIS Framework Summary

This section presents the overview and impression of the complete PGIS framework as it was developed and implemented in this research, this overview is summarised in Table 6.9. The table provides a summary of the whole framework and outlines its components, its actors and its outcomes. The PGIS tool and community development institutions (CDIs) components could not be discussed in one area of the framework and were therefore recorded at the end of the table. The conclusions which were drawn with regard to the individual and collective capabilities and how these have been interpreted with regard to imparting either individual or collective empowerment were noted for each component of the framework. The empowerment was also divided into individual and collective components and these attributes were used to determine how each type of empowerment reflected on the sustainability of the PGIS infrastructure. Based on these conceptualizations, the overall reflection on the PGIS framework is presented.

The leadership was scored low on individual capabilities and therefore low on individual empowerment. At the individual level, this would have translated into little or no empowerment. However, based on their performance, their collective capabilities were scored at empowerment levels, because the outcomes they obtained were the expected leadership outcomes. Consequently their contribution to the sustainability of the PGIS initiative was rated as likely to support the sustainability of the PGIS infrastructure. However it was noted that the leadership relied on the backing of the facilitation role, nonetheless, in this case the leadership used the facilitation role wisely, picked its cues as the project activities unfolded and reacted appropriately.

The facilitation role was also assessed in a similar manner to that of the leadership. It was scored low on individual capabilities and empowerments but high on the collective capabilities and empowerment, and was thus scored positively for the sustainability of the PGIS initiative. The VDC in turn relied on the facilitation of the researcher and its own practical experience in the village development activities for its knowledge base and guidance.

Table 6.9 The overall summary of the evaluation of the PGIS framework

PGIS Component	PGIS stage	Actor	Outcome	Individual Capability	Collective Capability	Individual Empowerment	Collective Empowerment	Sustainability	PGIS tool Component	CDIs Component
1	Convening	Leadership	Recognized leadership	0	1	Low	High	Likely		
1	Convening	Leadership	Institution of knowledge Center	0	1	Low	High	Likely		
1	Convening	Leadership	Institution of village training	0	1	Low	High	Likely		
1	Convening	Leadership	Securing of village computers	0	1	Low	High	Likely		
1	Convening	Leadership	Request plan for knowledge center	0	1	Low	High	Likely		
1	Convening	CDIs	None	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed		
2	Facilitation	VDC	Institution of facilitation role	0	1	Low	High	Likely		
2	Facilitation	VDC	Leadership organizational structure	0	1	Low	High	Likely		
2	Facilitation	VDC	Plan way forward for knowledge center	0	1	Low	High	Likely		
2	Facilitation	VDC	Knowledge center organizational structure	0	1	Low	High	Likely		
3	Data Capture	Trainees & VDC	Business process models	1	1	High	High	Yes	9	
3	Data Capture	Trainees & VDC	Livelihood planning strategy	1	1	High	High	Yes	9	
3	Data Capture	Trainees & VDC	Village based mapping technique	1	1	High	High	Yes	9	
3	Data Capture	CDIs	Knowledge structures	1	1	High	High	Yes	9	10
4	Data Structuring	Trainees & VDC	Map based village sampling frame	1	1	High	High	Yes	9	
4	Data Structuring	Trainees & VDC	Geographic database	0	0	Low	Low	No, if no external expertise	9	
5	Data Structuring	Trainees & VDC	PGIS prototype	0	0	Low	Low	No, if no external expertise	9	
5	Data Structuring	Trainees & VDC	Knowledge content repository	0	0	Low	Low	No, if no external expertise	9	
6	PGIS Evaluation	Leadership	Formalized evaluation results	0	1	Low	High	Likely	9	
6	PGIS Evaluation	VDC	Formalized evaluation results	0	1	Low	High	Likely	9	
6	PGIS Evaluation	Trainees	Formalized evaluation results	0	1	Low	High	Likely	9	
6	PGIS Evaluation	CDI (Animal Production)	Adjusted goat production calculations	1	1	High	High	Yes	9	10
6	PGIS Evaluation	CDI (DWNP)	Legalizing village wildlife trophy craft	1	1	High	High	Yes	9	10
6	PGIS Evaluation	CDI (Land Board)	Passing spatial accuracy of village mapping	1	1	High	High	Yes	9	10
7	Operationalization	Leadership	Steering committee for knowledge center	0	1	Low	High	Likely	9	
7	Operationalization	Leadership	Plan for ward based offices	0	1	Low	High	Likely	9	
7	Operationalization	Leadership	Plan to map the wards	0	1	Low	High	Likely	9	
7	Operationalization	VDC	Office set up to ouse knowledge center	0	1	Low	High	Likely	9	
7	Operationalization	CDIs	None	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	9	10
8	Livelihood outcome	Trainee	Employment	1	0	High	Low	Yes	9	
8	Livelihood outcome	Trainee	Goat rearing	1	0	High	Low	Yes	9	
8	Livelihood outcome	Chief	Home based free range chicken project	1	0	High	Low	Yes	9	
8	Livelihood outcome	VDC	Home based free range chicken project	1	0	High	Low	Yes	9	
8	Livelihood outcome	Trainee	Brick moulding	1	0	High	Low	Yes	9	
8	Livelihood outcome	VDC	Document copying and reproduction	1	0	High	Low	Yes	9	

The data capture and structuring were scored at the extreme ends, the former was scored highly and the latter scored the lowest rating. The data capture component registered the highest scores because the data capture dealt mainly with the execution of tasks, where the processes contained routine procedures. These procedures were practised until the knowledge which needed to be gained was successfully internalized. This component was therefore scored highly on the individual and collective capabilities and empowerment, and on the future sustainability of the PGIS initiative. The data structuring registered the lowest scores. Apart from having been performed away from the community it demanded higher levels of expertise from the external facilitation and higher educational backgrounds from the village community.

With regard to the external facilitation, the data structuring required the expertise of a systems analyst, database designer and application developer. In Botswana and possibly other developing countries, these experts are not common, particularly in GIS applications. Yet this component had to be sufficiently successful if the evaluation component which was based on its outputs was to be successful. For this reason, the researcher scored this component low with regard to imparting capabilities and empowerment and considered it the weakest component in sustaining the PGIS initiative. However, the researcher noted that the data structuring was not a regular input and that although its constructs had to be regularly monitored and updated, this input could be outsourced. This outsourcing could be used to develop the local expertise but it could also be used to maintain links with specialist institutions.

The evaluation component was another strong component of the PGIS framework. What was particularly positive was that some of the community development institutions (CDIs) were scored as highly as the data capturing component. This revealed the CDIs' potential role in supporting and sustaining the PGIS infrastructure. What was also particularly useful was that the evaluation moved the community and the PGIS process forward towards the operationalization aspects of the PGIS framework. This happened because the evaluation forced the community to revisit their preceding contributions, such as having institutionalized the village knowledge centre, having upgraded the VDC offices in order to house the knowledge centre and having instituted the village training program. In addition, the reference to the future operation of the PGIS infrastructure itself, such as the presentation of a village wide

PGIS network, challenged the ward heads to reflect on what their input would be and how they were expected to facilitate this activity.

Overall, the research concluded that the PGIS framework was a realistic rural community development intervention. Its real limitation lay largely in the availing of a technology supporting infrastructure, such as reliable electricity supply and internet services. Currently, two members of the community are undergoing training, the choices of which were based on the experience which was gained from taking part in the activities of this research project. One of the eleven trainees has enrolled in computer course which covers programming, databases, spreadsheets, book keeping and accounting. The course units relate to application development and business finances. One VDC member has enrolled in a basic computing course which is targeted at supporting the village training program. The trainee raised funds for part of his tuition by running a basic computer training program for the ward heads. Such developments and the ones which have been reported on previously, demonstrate that the community can respond positively to the community development challenge. What is required is that they should be provided with appropriate guidance and leadership and have access to a community participation enhancing tool, such as the PGIS framework.

6.9 Chapter Summary

This chapter covered the results and a discussion on their analysis, and the evaluation of the PGIS framework. These results were presented according to the outline of the PGIS framework. The presentation cycled around the outcomes, capabilities and their levels with regard to achieving empowerment, and the level of empowerment reached as it related to the sustainability. This was done for all of the components of the PGIS framework. Five outcomes were presented for the leadership and five for the facilitation components, these were interpreted to have strong collective capabilities which contained both empowerment and sustainability attributes. The data gathering also produced many outputs and was considered to have achieved both individual and collective capabilities. These indicated both sufficient empowerment and a strong case for sustainability. Most of the data structuring was done away from the community and scored low on imparting capabilities. This component therefore registered low empowerment and sustainability ratings. The evaluation of the PGIS

framework represented another strong component of the process, which if carried out effectively had strong capability and empowering attributes which should contribute positively towards sustaining the PGIS initiative. The results showed low involvement of the community development institutions at the convening stages but strong contribution at the data gathering and evaluation components of the PGIS framework.

The presentation of the final version of the PGIS framework shed light on how it was developed, especially the components that related to the interaction with the community. The presentation introduced and explained all the components of the PGIS framework. This was made more understandable since it was based on actual application experience. The formal evaluation of the PGIS framework reflected strong support for the way it was implemented because the community rated it highly for their participation in decision making and for the activities to achieve the intended goals

CHAPTER 7 CONCLUSIONS

This chapter concludes the process of developing a PGIS framework by reviewing the three main research objectives, and determining whether during the development of the PGIS framework, they were fulfilled. Ultimately, the fulfilment of the objectives reflected that the PGIS framework did provide a platform to facilitate the village community to create and construct knowledge although there were some limitations. A number of the outputs and outcomes which were achieved during and at the end of the PGIS process also confirmed that the knowledge which was created did stimulate some of the community members to experiment with livelihood activities with varying degrees of future sustainability. Overall, it was concluded that the village did obtain objectively verified levels of empowerment. However, the research project could not complete the empowerment process due to the lack of time. This had implications on the sustainability of the initiated PGIS infrastructure. The researcher noted that the completeness of the PGIS empowerment process rested on completing the village training which this research project had started. A critical component of the training included leading and mentoring the early operationalization processes of the PGIS infrastructure. This would ensure that the necessary capabilities were imparted in order to secure not only empowerment and sustainability, but also effective integration into the nationwide community development infrastructure.

7.1 Components Essential to Building Knowledge

The first objective related to exploring and identifying the components which were essential to building knowledge that supported the village livelihoods. The literature review provided the conceptual frameworks and the building blocks to create a generic PGIS framework, and the field trips provided the implementation and verification of the PGIS process. This objective was concerned mainly with the convening, facilitation and data gathering processes of the PGIS framework. Specifically, it was concerned with identifying: a) the required data and data gathering skills, b) the expected participants, their selection, their requirements and expected outputs, c) spatial data handling and analysis competencies and d) the community involvement in data capture, mapping and the PGIS structuring activities.

The data gathering served adequately to identify the required data and the data gathering skills. The selection of the trainees' livelihood projects and the business process modelling identified some of the required data. These identified agriculture related poultry and goat rearing projects, shelter related brick moulding and building construction, clothing related tailoring and information communication technology related wireless network, internet services and applications development. The GIS based in-house and field based mapping activities identified some of the spatial data gathering skills. The social survey served adequately to identify the required data through the design and testing of a questionnaire.

There were four main groups of participants who represented the village community. The first group of participants was the chief and his ward heads, who were the leaders of the community (a total of 9 people). The second group of participants were the village development committee (VDC) members because of the VDC's mandate to coordinate the village development activities. Out of a total of ten VDC members, six became part of the research project management team, three were involved indirectly and only one was not involved. The third component of the village participation was the village councillor, who was the political representative of the village and was also the link with the community development infrastructure. The fourth set of village participants were the trainees, who were selected by the village ward heads with the assistance of the VDC, they formed the main tasks execution team. Initially there were fifteen trainees but four dropped out after three months and the rest continued to the end of the project.

The data gathering also served adequately to provide the community requirements. Seventy percent of the community needs were identified by the trainees at the business process modelling activity. The remaining 30 percent of the community needs were identified by the social survey and the attitude scale. A comparison of the social survey and attitude scale responses before and after the feedback confirmed the persistence of the high priority given to the procurement of money and employment. These were considered to be the community's main expected outputs, since they were associated with improved livelihoods.

The geographic information system (GIS) based mapping served to identify the necessary spatial data handling capabilities. These included the georeferencing of

imagery from which the map data was derived and the subsequent creating of the map data from the imagery through on-screen digitizing. The specific use of the GIS mapping to develop a sampling frame served to introduce the trainees to some of the spatial analysis competencies. These included simple map and tabular data joins and the selection of spatial features using the joined tabular data attributes and labelling map features in order to support map analysis. The persistent reference to lack of knowledge was used to opt for a knowledge content repository to facilitate access to basic information and provide a platform for people to work together to generate and share knowledge.

The results showed collective empowering capabilities but low individual capabilities for the convening and facilitation roles and both individual and collective capabilities for the data gathering roles. These results were considered to have sustainable attributes. The results were confirmed by the participants' evaluation of the level of involvement in decision making and influence of actions to achieve the participation goals, which the participants scored at empowerment levels. The first objective was therefore adequately fulfilled and the participants were satisfied with the level of involvement in decision making and the attainment of the participation goals.

7.2 Structuring the PGIS Components to Build Knowledge

The second research objective was concerned with developing a PGIS framework design. This was envisaged as a geographic information system which displayed livelihood decision making options using integrated knowledge content, in order to support village development. This activity related to the data structuring components of the PGIS framework. It involved designing the geographic database, determining the process models and producing a logical data model for the acquisition of shelter and the goat rearing. With regard to the development of the geographic database, the village trainees contributed partly to the structuring of the map and non map data components. The trainees produced the village map layers, collected the basic plot attributes and matched them with their corresponding map plots. The trainees were also involved in collecting the non-map data by administering a questionnaire. However, the bulk of the work for this component of the PGIS framework was carried out by the researcher. For this reason, the researcher scored the data structuring component at none-sustainable capability and concluded that this component was not

sustainable without expert facilitation and an adequate input of training. Nonetheless, all actors, including the researcher have scored participation in decision making at empowering capability levels with regard to, creating knowledge, recognizing the need for a knowledge centre and constructing knowledge.

The research concluded that the community contributed to compiling part of the data that was used to develop the geographic database and the knowledge content repository but were not involved in the structuring of the final data and information archive. Therefore this component represented the weaker part of the PGIS framework, as noted in the discussion of the results. This was attributed to a number of factors which included low education bases, the divided context where the data structuring was conducted away from the village community and the lack of time to carry out the data structuring with the community. However, at the beginning of community collaboration work, this was expected and was noted to be not necessarily negative. This component served to highlight not just a village weakness but a national weakness, which was noted to be the low GIS expertise even at university level. Outsourcing was noted to be an acceptable option at the beginning of the PGIS process operation and was noted to be particularly useful to maintain the link with specialist institutions.

7.3 The Evaluation Component of the PGIS Framework

The evaluation of the PGIS framework referred to the formal testing and proving of the effective functioning of the PGIS process. This activity sought to determine three broad outcomes. The first and second outcomes were used to determine whether the PGIS tool was established and what purpose it served in the implementation of the PGIS framework. The third outcome was used to determine whether the PGIS did anchor the knowledge building and whether the community used the PGIS to secure knowledge to support their livelihood activities.

A simple user interface was produced by customizing the ArcMap GIS user interface to facilitate access to the data, information and the software which was used to create knowledge content. The prototype which was produced was not an expertly coded and compiled application but was an assemblage of two data frames and knowledge content. The knowledge content included business process modelling output, social

survey and attitude data summaries, multimedia files (pictures, voice recordings and video files), the village knowledge centre files, knowledge structures and varied themes of literature which related to the PGIS, learning and rural community development. In addition there were two A0 size posters. The first poster presented an introductory conceptualization of the PGIS intervention process. Its aim was to present the community development problem and its basic cause and rationalize the application of the PGIS intervention as a possible solution. The poster outlined the basic processes, the envisaged community role and the outputs the community was expected to produce during the implementation of the PGIS solution. This poster was presented at the Spatial Science Institute conference in 2008. The second poster follows up on the first one. It provides details on the implementation of the PGIS process in Tshane village in Botswana. It outlines some of the outputs which were created by the community members and also some of the GIS data. Overall, the poster concretizes the generation of knowledge by visualizing such a concept using graphic processes. These processes can easily be understood and the data objects and outputs are recognizable village livelihood assets and concerns.

The demonstration was first made to the VDC and the trainees and one VDC member then presented the PGIS concept and knowledge to the ward heads and village institutions. The main purpose was to demonstrate the application of the PGIS to support the community livelihoods and to also demonstrate the access to basic information such as development policies and support programs and varied types of forms and basic literature.

One of the basic functions that the evaluation performed adequately was to visualize and thus crystallize the PGIS tool. It clarified that the basic purpose as to avail access to information to the rest of the village community. The participants used the computer based demonstration and the posters to present their feedback. This confirmed that the PGIS was serving as an anchor to the knowledge building discussions. In addition, the fact that a VDC member used a poster to deliver eleven minutes of a non-assisted presentation proved that the PGIS concept was being internalized. The VDC member explained what the final PGIS process tool was about and how it supported the acquisition of shelter and the goat rearing. This proved that the PGIS had become a clearly understood initiative in the village. A number of

outstanding outcomes were realized as a result of the presentation of the PGIS infrastructure.

The outcomes were: a) the decision to map the village wards, b) the conclusions to upgrade the ward meeting places c) the decision to strengthen the planning of the building of the village knowledge centre and d) the potential role of the development institutions in the operationalization of the PGIS infrastructure. With regard to the development institutions particularly, the evaluation of the PGIS process included demonstrating it to the Land Board, the Animal Production unit, the Crop Production unit, the Department of Wildlife and National Parks (DWNP) and the Meteorology unit. The Land Board and the Animal Production unit indicated that they could be used to evaluate the output regarding the village mapping and the goat rearing, respectively. The Crop Production unit identified a potential solution which the PGIS provided and indicated the need for training in the use of the GIS. The DWNP and the Meteorology unit provided no utilizable feedback and confirmed the need for the training of the community development institutions. The demonstration of the PGIS tool to the institutions clearly identified a need for an operationalization component of the PGIS framework, which had not been identified before.

The discussions which followed the presentation of the PGIS initiative quickly delved into issues which related to the operationalization of the PGIS infrastructure. Central to most of these issues was the community initiative to establish a village knowledge centre. The researcher noted that this activity underpinned the successful institution of the village's PGIS initiative and that it was critical to its sustainability. The low rate of progress with regard to this issue was reported under the village development committee's facilitation role in Section 6.1.2. It became evident then, that the village experienced problems in attempting to establish the central node of the PGIS infrastructure first. Therefore, when one ward head noted that the block boundary for his ward identified his ward boundary sufficiently and that he had begun to use it as a formal boundary, this presented the opportunity to institute the operationalization of the PGIS infrastructure, one ward at a time. When this was discussed, the chief, the VDC and the trainees supported the idea.

Overall, the PGIS tool was established, and it served to raise the realization among the community members to review their perception about their ability to fend for

themselves. More importantly, it provided a livelihoods modelling tool that could be used to deliberate about livelihood solutions. Most important of all, the PGIS framework did work to bring the community to start working together. When it is implemented at the village ward level, it will continue to be one of the entities around which the village community will congregate to deliberate about their livelihoods and their village. It should truly anchor many of the activities of the village and provide an anchor too for a lasting link with development support institutions and the development infrastructure as a whole.

7.4 The Last Overall Reflection about the PGIS Process

The outputs which were created by the PGIS process were discussed from Sections 6.1.1 to 6.4.2, which covered the presentation of the results, the formal presentation of the final version of the PGIS framework and the evaluation of the PGIS framework. These outcomes were summarized in Table 6.9. What was noted with regard to evaluating the output as a means to evaluating the PGIS process was that the evaluation transformed seamlessly into a discussion of the operating components of the PGIS process outcomes. Thus the evaluation of the output identified the participating components of the PGIS framework. The evaluation component therefore, turned out to be a component of the PGIS framework which was critical to the institutionalization, operationalization and sustainability of the PGIS framework. This was particularly so because the evaluation produced strong sustainability results.

Ultimately, at the end of the PGIS process, there was need to look back and query the research project's basic goal. Was the PGIS framework developed? Did it anchor the learning which was needed to create and to construct knowledge? Did the knowledge support community development? The answers to all these questions were yes. The PGIS framework was developed and the initial steps to operationalize its constituent components into a PGIS infrastructure were begun. Except for the data structuring components, the evaluation indicated strong collective capabilities and thus strong collective empowerment. These attributes leaned favourably towards the sustainability of the PGIS infrastructure. However, the weak individual capabilities except for the data gathering components, which resulted from a weak education base and low access to information, threatened the sustainability of the PGIS process.

The overall results indicated clearly, that an educated community was required in order to interface collaborately and successfully with the modern community development infrastructure. Without the capability to balance the power relations in the community development interactions, the community development effort would continue to be undermined. Most fundamentally, without the knowledge, that the education opened access to, the probability to become self reliant would continue to be low. Even more important was the need to value not only formal but traditional knowledge too, which not only formed a base to fall back onto when the formal livelihood system failed, but also formed an important and critical base from which to understand other forms of knowledge. When this important store of knowledge was ignored by the community members, especially the younger generation, an important leverage to understand the modern political system, under which the rural community was governed, remained unutilized. The community therefore needed to address a number of issues especially relating to improving the individual capabilities.

The quality of the leadership needed to be strengthened with regard to educational backgrounds or access to higher quality advisory services and access to information and knowledge. The PGIS infrastructure, if it is implemented successfully should serve to facilitate access to information and knowledge. The quality of the facilitation services too, needed to be improved with regard to placing in office, community members who had sufficient education and knowledge background to understand the functioning of the modern development institutions and infrastructure. Here again the PGIS infrastructure could not only provide access to information and knowledge, it could also serve to concretize the infrastructure itself, by establishing live links within the development infrastructure, especially where access to email or internet services are provided. Both the leadership and the VDC needed to rope in the participation of the development institutions. They needed to guide these institutions to support community initiated livelihood projects. This was where the PGIS infrastructure came in also, which led to the need for an effective appropriation of the PGIS infrastructure by the village community as a whole.

The community needed to participate more meaningfully in the activity of the primary school in their village, because success at that stage of the education system determined access to the other upper stages of the education system. The PGIS tool

could be used to impart knowledge to the parents. Such access to other forms of knowledge could be used to indicate that the livelihood experiences of the elders represented critical knowledge, and that the knowledge should be used as a base to understand the modern lifestyles that their siblings were drawn to. In this way, the parents' access to the link between the old and the new ways of rationalizing about livelihoods, could re-establish their legitimacy as guardians to their own offspring. This is necessary because their offspring believe that they have little knowledge about modern livelihoods, and that they cannot advise them. The general community needed to enhance its community participation activities. The PGIS framework has proved that it could work very well to facilitate that process. The community participation was needed to promote the re-establishment of the community's social and human capital. The PGIS could serve well to support these activities by providing enhanced communication among the community members, and providing access to knowledge sources and distance learning too.

Finally, the leadership and the VDC needed to communicate and publicise the activities of the PGIS infrastructure more and to promote and present the successful community livelihood initiatives to the rest of the village community. This is required in order to demonstrate proof of achievements and to encourage the lively engagement of the community. It is through this process that the village community can work together cooperatively to generate and share knowledge and use it to avail the livelihoods supporting infrastructure. The livelihoods supporting infrastructure would then be appropriated to develop the individual community members and households, and thus the village as a whole.

7.5 Recommendations for Further Research

The work with the community was worthwhile and the community performed admirably, however there were a number of issues that were problematic. These will need to be investigated further in order to provide additional knowledge that the community can use to continue to build their capacity towards self reliance.

There is need to focus more on livelihood strategies rather than only on employment. This should serve to empower the rural communities who have had this varied livelihoods strategy in the past as part of their solution to adapt to failing livelihood

support options. In the past, community members have used varied livelihood options in response to poor or failed harvests, livestock losses due to drought, temporary lapses in the ability to fend for oneself due to health reasons, and so on. The focus on formal employment only as a source of livelihood has taken away their ability to rely on themselves to find livelihood solutions for their families.

In community development work, the power imbalance between the external experts and the community will be managed successfully by an adequately educated and knowledgeable village representation. Work needs to be done with regard to investigating how this can be done, given that in Botswana the village leadership and VDC posts tend to attract the less educated members of the community. The village development work needs to be taken seriously by the political institutions. The development work requires expertise, skills, an enabling social infrastructure, financial resources and proper recognition in the development institutional infrastructure. Development policies and broad based implementation strategies are not enough, there is need to develop fitting interventions.

Related to a need for an informed participating community is the requirement of a knowledgeable village based facilitation role. This is not only necessary for the participation process itself, it is necessary for the future collective organization of the community and the sustainability of the community development initiatives. The facilitation role requires a leading figure that has been accepted, is knowledgeable and is worth following. Due to less class differentiation among rural community members, a village community member is less likely to be accepted to serve the facilitation role. This means that this role needs to be developed and institutionalized to become one of the village institutions.

Work also needs to be done on how initiated development projects can be assisted to become established. Once a development initiative has become embedded in the community's social infrastructure, the community can then become responsible for its maintenance, especially where it provides value to the community. This point relates to taking the community development work seriously, because a major part of the failure of projects is the lack of financial and capital resources to sustain them. Sometimes the continuation of a project requires that physical buildings be constructed, operational procedures drawn up, salaries planned for, personnel hired

and equipment put in place. All these require financial resources and forward planning.

There is need to re-instate the valuing of traditional culture and to identify similarities with the modern culture. The similarities with modern culture should be used as base knowledge to understand how the modern world works. Technology does not really change what needs to be learnt or done, it changes the how and the speed of doing things. Crops still need to be grown and livestock raised, vegetables planted, chickens raised and homes built and so on. There is need to assist the rural communities to re-establish connections with their own knowledge systems and cultures.

There is also need to re-establish the spirit of community. In Botswana for example, the community used to have what was called *letsema (community contributed labour)*. This was a form of community assistance that was extended to an individual or household. The assistance helped community members to achieve livelihood objectives, such as ploughing, developing a new field for ploughing purposes, refurbishing the household in preparation for a wedding and so on. Within such a spirit of community, a community member could plough even if they did not have draft power. They could enhance their living surroundings even when they had limited skills. The community raised everyone up and contributed to the raising of all siblings in a given village. All adults were considered to be parents to all siblings in the community. In such a system there was community wide tutoring, guiding, mentoring, apprenticeship and disciplining of siblings. In the process the youth matured into skilled and contributing members of the community.

Information communication technology is often cited as one of the contributors to alleviating poverty. However, the training in information communication technology in developing countries needs to be brought up to empowering levels. Of relevance to this study is the training in geospatial science and technology. However the successful implementation of information technology in general is going to require the formalization of the technology in the local language. This is necessary in order to facilitate the development of local content and should reduce the exhausting amounts of interpretation work that needs to be carried out in order to effect communication with the local community.

The last issue relates to the need to investigate how the community based rural community development support structures can assist community members to develop and sustain their own projects. This includes investigating the revision of the roles of local government institutions, the non government organizations, community based organizations and the traditional extension services based community development institutions. It is now known that people are selective in how they appropriate and apply knowledge. The development assistance should not be delivered, it should be collaborated and negotiated. It should consider the knowledge already held by the community members and their priorities, because the priorities determine whether a piece of knowledge is relevant or not, regardless of its apparent value.

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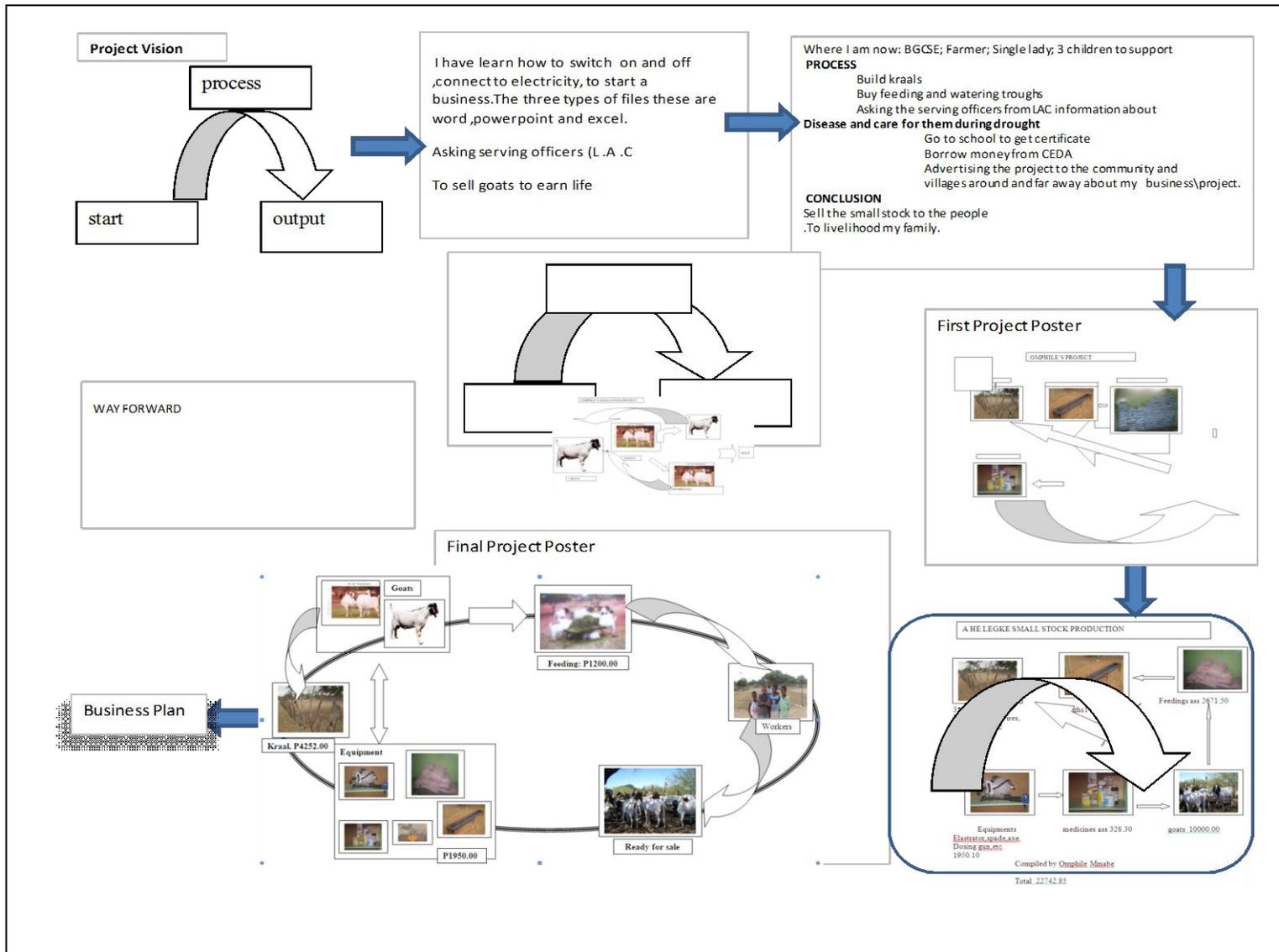
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APPENDICES

Appendix A Overview of the Goats Rearing Business Process Modelling

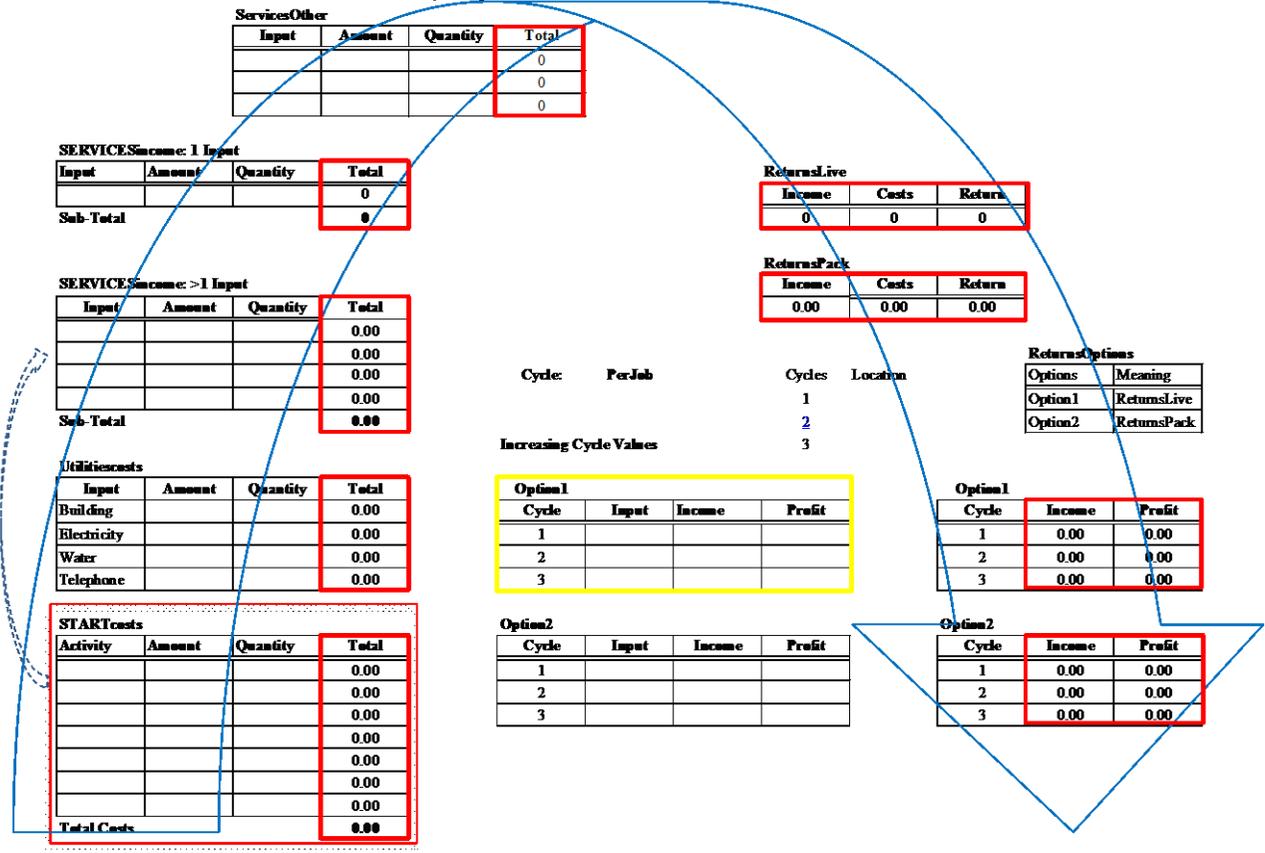


Appendix B Template for Simulating Business Calculations

The CASA Template
Cyclic Arc of Self-Actualization

THESE CELLS SHOULD NOT BE MODIFIED, DO NOT ENTER VALUES IN THESE CELLS, THEY HOLD FORMULAE AND CELL REFERENCES THAT CALCULATE THE RESULTS OF SPECIFIC VALUES ENTERED FOR COSTS AND SERVICES

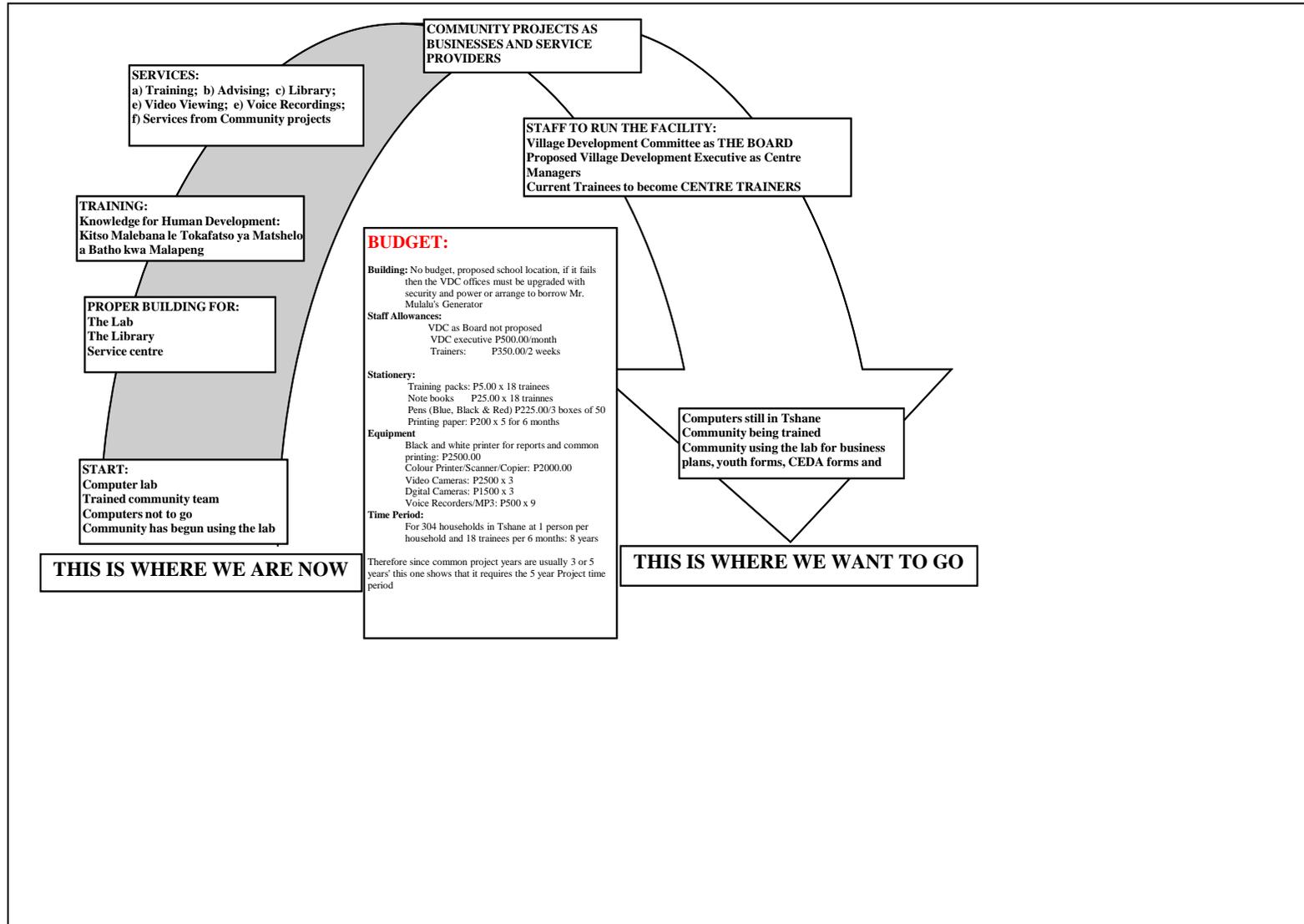
If you feel you have to modify these cells, kindly create another copy of this worksheet and use that copy for your experiments



Appendix D Mashego a Lobu Knowledge Centre Mission, Vision & Objectives

<p>Mashego a Lobu Knowledge Centre should become a reality</p> <p>Its basic objective: Kitso malebana le tokafatso botshelo ja motho ko lapeng Knowledge regarding the improvement of the life of the individual at the household</p> <p>Perceived components as brainstormed from workshop 6</p> <ol style="list-style-type: none"> 1 Building 2 Computers in a computer laboratory 3 Bodiredi/Botsamaisi (Management) 4 Motlakase (Electricity) 5 Bothokomedi (Security) 6 Prisoners' Rehabilitation Facility 7 Water 8 Transport and drivers 9 Account (Bank) 10 Postal address 11 Library 12 Constitution 13 Conference facility 14 Working stalls to provide basic services <p>Mission: Go tokafatsa matsshelo a malwapa otlhe mo Tshane To improve the living standards of all households in Tshane village</p> <p>Vision: Malwapa otlhe mo tshane a agilwe, mo go naleng seriti, a nale masika a a tshwaraganeng, a a tlotlwang, ebile a goketswe metsi le motlakase All households built to a dignified standard, occupied by united and respected families and supplied with water and electricity</p> <p>Objectives:</p> <table border="1"> <tr> <td>1</td> <td>Go busetsa setso sa go tlotla kgosi, dikgosana, kgotla, batsadi, bagodi botlhe le baeteledi ba ba farologanyeng ba motse, le go tlotla mananeo otlhe a Setswana To re-instate the culture of respect for the chief, ward-heads, the kgotla, parents, all the differentiated elders and leaders of the village and to respect all traditional institutions.</td> </tr> <tr> <td>2</td> <td>Go tlotlomatsa tlwaelo ya go aga dikago tse di naleng seriti ebile di na le boitekanelo To promote the building of dignified and healthy shelter</td> </tr> <tr> <td>3</td> <td>Go rotoetsa batho botlhe go nna le ditiro tse di busetsang To encourage the attainment of productive employment by all households</td> </tr> <tr> <td>4</td> <td>Go thusa batho botlhe go kgonafatsa gore ba nne ba itekanetse To facilitate good health for all members of the Tshane community</td> </tr> <tr> <td>5</td> <td>Go busetsa ngwao ya tshwaragano le popagano ya morafe ka go thatafatsa sesha mananeo a ngwao ya Setswana To re-instate the culture of community and togetherness through the re-strengthening of our local institutions</td> </tr> <tr> <td>6</td> <td>Go busetsa seriti sa motho ka go thusa batho go nna le bokgoni bongwe le go tsenelela dikgaisano, le go tshwaraganela ditiro le batho ba bangwe ba nale kitso To restore individual dignity through the development of skill, competence and participation</td> </tr> </table>		1	Go busetsa setso sa go tlotla kgosi, dikgosana, kgotla, batsadi, bagodi botlhe le baeteledi ba ba farologanyeng ba motse, le go tlotla mananeo otlhe a Setswana To re-instate the culture of respect for the chief, ward-heads, the kgotla, parents, all the differentiated elders and leaders of the village and to respect all traditional institutions.	2	Go tlotlomatsa tlwaelo ya go aga dikago tse di naleng seriti ebile di na le boitekanelo To promote the building of dignified and healthy shelter	3	Go rotoetsa batho botlhe go nna le ditiro tse di busetsang To encourage the attainment of productive employment by all households	4	Go thusa batho botlhe go kgonafatsa gore ba nne ba itekanetse To facilitate good health for all members of the Tshane community	5	Go busetsa ngwao ya tshwaragano le popagano ya morafe ka go thatafatsa sesha mananeo a ngwao ya Setswana To re-instate the culture of community and togetherness through the re-strengthening of our local institutions	6	Go busetsa seriti sa motho ka go thusa batho go nna le bokgoni bongwe le go tsenelela dikgaisano, le go tshwaraganela ditiro le batho ba bangwe ba nale kitso To restore individual dignity through the development of skill, competence and participation
1	Go busetsa setso sa go tlotla kgosi, dikgosana, kgotla, batsadi, bagodi botlhe le baeteledi ba ba farologanyeng ba motse, le go tlotla mananeo otlhe a Setswana To re-instate the culture of respect for the chief, ward-heads, the kgotla, parents, all the differentiated elders and leaders of the village and to respect all traditional institutions.												
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Appendix E Mashego A Lobu Knowledge Centre Way Forward Plan



Appendix F Output Indices for Trainees Activities

Project Activities	1	2	3	4	5	6	7	8	9	10	11
1 Expectations	1	1	0	0	0	1	0	1	0	0	1
2 Brief Computer Class	1	1	0.5	0.5	0.5	1	0.5	1	0.5	1	1
3 Participant Refelctions	1	1	0.5	0.5	0.5	1	0.5	1	0.5	1	1
4 Initial project drafts	0.5	1	0.5	0.5	1	1	0.5	1	1	0.75	1
5 Overview of initial project darfts	1	1	0.5	0.5	1	1	0.5	1	1	1	1
6 Second project drafts	1	1	0.5	0.5	1	1	0.5	1	1	1	1
7 Computer Program Development Logic as a Livelihood Planning Strategy	1	1	0	0.5	1	0.75	0	1	1	1	1
8 Project vision	1	1	0	0.5	0.5	0.5	0	1	0.5	1	1
9 First project poster (no graphics)	1	1	0	0.5	0.5	0.5	0	1	0.5	1	1
10 Second project poster (graphics)	1	0.9	0.5	0.75	0.75	0.5	0	0.9	0.75	0.9	0.5
11 Field day (Colecting graphics)	1	1	1	0.75	0.75	0.3	1	1	1	1	1
12 Third project poster (more appropriate graphics)	1	1	1	1	1	0.75	1	1	1	0.9	0.5
13 Business calculations	1	1	1	1	0.75	1	1	1	1	1	1
14 Final project poster with business calculations	0.5	0.5	0	0	0	0.5	0	0.75	0	0	0
15 Business planning	1	1	1	1	1	1	1	1	1	1	1
16 Completed business plans	1	1	1	1	1	1	1	1	1	1	1
17 Personal folder entries	0.9	0.7	0.8	0.7	0.7	0.7	0.7	0.8	0.7	0.5	0
18 Attendance	1	1	1	1	1	1	1	1	1	1	1
19 Way Forward	1	1	0.5	0.5	0.5	1	0.5	1	0.5	0.5	1
	0.9421	0.9526	0.5421	0.6158	0.7079	0.8158	0.5105	0.9711	0.7342	0.8184	0.8421

Appendix G Sample Calculation of Strided Plot Measurement Accuracy

Plots	side1	side2	side3	side4	stride	Dist1	Dist2	Dist3	Dist4	ADist1	ADist2	ADist3	ADist4	Acc1	Acc2	Acc3	Acc 4
1	42	57	35	57	70	29.4	29.9	24.5	24.5	30	25	25	30	0.6	-4.9	0.5	5.5
2	42	42	42	42	70	29.4	29.4	29.4	29.4	30	30	30	30	0.6	0.6	0.6	0.6
3	42	64	35	50	70	29.4	24.8	24.5	24.5	30	30	25	25	0.6	5.2	0.5	0.5
4	35	28	28	42	70	24.5	19.6	19.6	19.6	25	25	25	25	0.5	5.4	5.4	5.4
5	35	42	28	42	70	24.5	29.4	19.6	19.6	25	30	25	25	0.5	0.6	5.4	5.4
6	28	35	28	42	70	19.6	24.5	19.6	19.6	20	25	20	25	0.4	0.5	0.4	5.4
7	28	50	35	42	70	19.6	35	24.5	24.5	20	30	25	25	0.4	-5	0.5	0.5
8	35	28	28	28	70	24.5	19.6	19.6	19.6	25	20	20	25	0.5	0.4	0.4	5.4
9	28	35	28	35	70	19.6	24.5	19.6	19.6	20	25	20	20	0.4	0.5	0.4	0.4
10	35	28	35	28	70	24.5	19.6	24.5	24.5	25	20	25	20	0.5	0.4	0.5	-4.5
11	42	28	35	28	70	29.4	19.6	24.5	24.5	30	25	30	25	0.6	5.4	5.5	0.5
12	46	42	42	46	70	32.2	29.4	29.4	29.4	30	30	30	30	-2.2	0.6	0.6	0.6
13	42	48	54	47	70	29.4	33.6	37.8	37.8	30	30	40	40	0.6	-3.6	2.2	2.2
14	53	46	50	42	70	37.1	32.2	35	35	40	30	40	40	2.9	-2.2	5	5
15	28	39	25	28	70	19.6	27.3	17.5	17.5	20	25	20	20	0.4	-2.3	2.5	2.5

Key

Plots	Number of plot being measured
side1	Number of walking paces for one side of the plot
Stride	Length of the individual's stride (cm)
Dist1	Calculated length of side in meters (side x stride/100)
ADist1	Assumed actual distance based on Dist1
Acc1	Accuracy as difference between ADist1 and Dist1
Average	Average of the accuracies
RMS	Root mean square calculation

Plots	Acc 1	Acc 2	Acc3	Acc 4	Avarege	RMS
1	0.6	4.9	0.5	5.5	2.8750	2.6961
2	0.6	0.6	0.6	0.6	0.6000	0.0000
3	0.6	5.2	0.5	0.5	1.7000	2.3338
4	0.5	5.4	5.4	5.4	4.1750	2.4500
5	0.5	0.6	5.4	5.4	2.9750	2.8004
6	0.4	0.5	0.4	5.4	1.6750	2.4838
7	0.4	5	0.5	0.5	1.6000	2.2672
8	0.5	0.4	0.4	5.4	1.6750	2.4838
9	0.4	0.5	0.4	0.4	0.4250	0.0500
10	0.5	0.4	0.5	4.5	1.4750	2.0172
11	0.6	5.4	5.5	0.5	3.0000	2.8296
12	2.2	0.6	0.6	0.6	1.0000	0.8000
13	0.6	3.6	2.2	2.2	2.1500	1.2261
14	2.9	2.2	5	5	3.7750	1.4431
15	0.4	2.3	2.5	2.5	1.9250	1.0210

Appendix H The Community Requirements

Summarized into 10 categories	Verification & Justification of Requirement	Requirement
Shelter	39.22% did not own plots; 79.05% lived in one room structures; for number of people per household: 69% had 1-5, 17% had 6-8 & 14% had 9-16	The means or solution to afford better shelter
Education	18.64% had no education; 52.54 had primary education; 23.735 had junior certificate; 5.08% had senior secondary education; 64.91% could not help their kids with school work	Solution to poor education performance Education and training that increases the probability of finding employment
Knowledge	Lack of knowledge noted under business: why Batswana do not start businesses (36.66%) and why Batswana businesses failed (15%)	Basic knowledge about being more productive
Employment	Only 2% in formal employment; 7% in both formal and agricultural pursuits; in 67.21% of households, no one worked; 31.15% were not satisfied with life because they had no jobs	How to attain and increase productive employment and thus reduce high unemployment
Energy	Most households still using firewood; collected by women (63.94%), men (16.39%); this need was also captured at the Knowledge Centre proposal work shop and the objective that was derived there is used here as the requirement for both energy and water	All households built to a dignified standard, occupied by united and respected families and supplied with water and electricity
Business	5% owned some business; 83% did not own business; with regard to failure by Batswana to start businesses, 36.76% cited as lack of knowledge and 11.97 cited lack of capital and why Batswana businesses failed, 15% noted lack of knowledge and 16.67% noted poor management; 71.43% noted that if there was a public market, they would sell something	What training and knowledge is required in order to start, manage and run businesses successfully
Local Livelihoods	49.18% cited livestock and ploughing as their main livelihood; 57.4% owned livestock and 22.7% of these owned goats; 5% considered their savings to be on goats while 11.67% placed their savings on cattle	How to use local livelihoods in order to help to improve living standards
Training	88.53% had no training and 9.84% had only rudimentary industrial training	To be better trained so that they can find employment
Water	Most of the sampled households used the public water supply points for their daily supply of water, water was collected by women (45.90%), men (13.12%) and all including children (9.84%) The Knowledge Centre objective covering water is used as the requirement here as well.	All households built to a dignified standard, occupied by united and respected families and supplied with water and electricity
Health	74.0% noted that without money health cripples and 74.47% noted that with little money it is difficult to afford serious medication	All households should be facilitated to have access to medical aid schemes