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A METHODOLOGICAL FRAMEWORK FOR ICT ROADMAP DEVELOPMENT FOR RURAL AREAS

A thesis submitted in fulfillment of the requirements for the degree of

Doctor of Philosophy (PhD) in Computer Science

by

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Declaration

I, the undersigned, declare that the work contained in this thesis is my own original work. I acknowledge that all references are accurately recorded and that, unless otherwise stated, all work herein is my own.

Signature: 

Date: **18 December 2012**

Preface

I wish that in the near future all ICT services could be available to everyone in rural areas, with access to ICT services at various sites – and encourage competent, fair and trustworthy services at reasonable costs to meet the basic ICT needs of rural individuals.

Considering this statement, this thesis proposes an innovative methodological framework for an ICT infrastructure roadmap. This roadmap framework focuses on explaining the ICT infrastructure, technologies and services that should be in place for rural areas to be able to access public services within their respective communities using available ICT devices. The roadmap framework is built based on the current state of ICTs, trends in ICTs, future technological projections and the different roles currently being played by ICT stakeholders on the African continent. The current ICT developmental plans and roadmap were analysed, and this was important in the designing of the ICT roadmap framework discussed in this thesis.

The author is very grateful for the support given by different research groups involved in this research. These were considered as the major stakeholders with the different ICT experiences necessary for the development a methodological framework for the ICT roadmap.

This research is dedicated to all ICT stakeholders, including rural ICT users.

Acknowledgements

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To the thesis editors, Dr Siziba and Andy Grewar, data translation expert Mr Muruviwa, the statistician Tlou, guys who proof read and helped in designing the ICT roadmap framework (Dr. Taruvinga, Sylvester Honye, Brighton Chamunorwa) – your comments were fruitful and I thank you. Family, friends, relatives and colleagues who all supported me - Be Blessed. And to my fiancée, Millicent – thanks for the support and encouragements.

Finally, I would like to thank all those who supported me, including research colleagues from Walter Sisulu University with whom I shared various research ideas towards the end of this research. Thank you all.

Publications related to the work reported in this thesis

1. JERE, N.R., THINYANE, M., TERZOLI, A. (2011). Factors affecting the Future of Technological ICTs Projections in Marginalised Communities. World Wide Web Applications (ZA-WWW 2011), 14–26 September 2011, University of the Witwatersrand, Johannesburg, South Africa.

2. JERE, N.R., THINYANE, M., TERZOLI, A. (2011). Development of an ICT road map for eServices in rural areas. ITU Kaleidoscope 2011, 12–14 December 2011, Cape Town, South Africa.

3. JERE, N.R., THINYANE, M., TERZOLI, A. (2012). ICT eServices Requirements to Address Rural Users Expectations and Needs. Journal of Communication and Computer 9: 285–296.

4. DHIR, A., JERE, N.R., PUNEET KAUR, MIKKO HEISKALA, IBRAHIM A. ALBIDEWI, DANIYAL M. ALGHAZZAWI. (2012). Design Guidelines for Pervasive Computing: Implications of Technology Use in Africa. The second IEEE International workshop on social implications of pervasive computing, 2012, Lugano, Switzerland, pp. 925–930.

5. DHIR, A., MOUKADEM, I., JERE, N.R., KAUR, P., KUJALA, S., YLÄ-JÄÄSKI, A. (2012). Ethnographic Examination for Studying Information Sharing Practices in Rural South Africa. ACHI 2012: The Fifth International Conference on Advances in Computer-Human Interactions, Valencia, Spain.

6. GUMBO, S., JERE, N.R., TERZOLI, A. (2012). A Qualitative Analysis to Determine the Readiness of Rural Communities to Adopt ICTs: Siyakhula Living Lab Case Study. IST-Africa 2012 Conference and Exhibition, 09–12 May 2012, Dar es Salaam, Tanzania.

N.B. These publications have been included to show the research that the author carried out during the whole thesis preparation, but they do not represent the entire thesis content. The thesis is a complete stand-alone work, as is the tradition of South African Universities.

Author's contributions

Paper 1 – factors affecting future technological projections

The paper focuses on identifying the future ICT projections, looking at the current literature available on future ICT projections. Then, the different factors affecting the projections, both positive and negative, are discussed. These factors are based on what rural ICT users and also ICT experts shared on how various ICT factors could influence the deployment of future projections in rural areas. Socio-cultural factors were viewed by rural users as the main factors that discourage future technological projections implementation in rural areas. For ICT experts, poor infrastructure, shortage of ICT resources and high technological illiteracy were the main discouraging factors. The main difference we noticed in explaining the factors was that the community members felt socio-cultural factors were the key factor that negatively affects the developments of ICTs. However, the ICT experts, probably since they are mainly from developed countries, felt that poor infrastructure was the main factor. In the case of Dwesa, the community members felt their community is improving in terms of infrastructure as a result of the SLL, so they could hardly say poor infrastructure was the main factor. In conclusion, we noticed that there are different efforts to improve rural communities and all of these are encouraging the future technological projections to be achieved. However, there are many factors which differ from one community to the other, and major challenges in rural areas that make it difficult to develop ICTs there.

Paper 2 - An ICT roadmap for eServices

The paper considers the future technological projections, general problems in rural areas, different ICT developments and the current status of the eServices within the SLL to propose an ICT roadmap for African rural areas. The paper proposes a strategy that addresses the current ICT challenges experienced in rural areas. The paper also explains that rural users are the important stakeholders required for ICT roadmap development for rural communities. A user-centric methodological approach is discussed as being useful for the roadmap development. The paper highlights the proposed idea to improve the sustainability of rural ICTs by preparing for the future through an ICT roadmap and gives some key components of the proposed roadmap. ICT roadmap components discussed in this paper include: future projections, users expectations, ICT services and how users access services. These components address social, economic and technological factors affecting ICT developments and how to fulfill the rural users' expectations and how future projections could be applied in rural areas.

Paper 3 – ICT services requirements – Rural users vs ICT experts

ICT end users were interviewed; these were from the Dwesa rural community. For this paper we were interested in the views of 50 different users from this community. The paper also includes the views of ICT experts' views on ICT services expected in rural areas. The paper gives a summary of the views of ICT experts from developed nations versus those of the rural users. One of the key points to note in this paper was the differences between the views of rural users and ICT experts on each of the intended ICT services. We found that in some cases the rural users were not sharing the same opinions about some of the services that ICT experts thought are important for rural areas. The findings of the paper show that rural users expect ICT services that are available, affordable, accessible and that provide income generating opportunities. The issues of ICT training needs, proper business models for ICT service development were also raised in this paper. These services were useful in developing the ICT roadmap framework presented in this thesis. The paper highlights ideas which could be used to close the gap between the two study groups expectations by proposing a basic ICT architecture that positions the rural community users as the centre of the proposed roadmap plan.

Paper 4 – Design guidelines for pervasive computing

The author carried out studies in Alice and the Dwesa community to get an understanding of how rural people view and use ICTs. An ethnographic study was done to see how rural people share ideas using technologies. The mobile device was the main ICT device discussed. The author engaged with rural people and with other ICT experts from Finland, India and Saudi Arabia to write the papers.

This paper aimed to make recommendations on designing technologies that can help to improve rural peoples' lives. This could be helped by gaining an understanding of the users' requirements and expectations. One of the key findings in this paper was that there are many forms of ICTs in poor communities and most of the ICTs are not fully utilized. The idea of the paper was to understand the impacts of different technologies and the views of the rural ICT users on what they feel technology could do for them. In this paper, the feelings of the rural users on technological changes and the future were explored. Such findings were important for this thesis as they assisted in alerting on how and what ICT services and devices to provide for rural people. The paper also proved that the ICTs such as mobile phones are available in rural areas, but very few people use them to share information. Most people in rural areas still prefer oral communication and rely more on word of mouth. This was important for the thesis as one can tell the best ICT services and the plan of action that is required in rural areas for the services to benefit the community at large. The author was on the ground to collect information and arrange all meetings. The data reported in these papers were collected by the author of this thesis.

Paper 5 – Ethnographic study

This paper focused on understanding how rural people share information. The idea was to find out if they use ICTs to share and exchange information. The authors wanted to know what ICT devices are available in rural areas and the ownership of ICTs. An ethnographic field study was performed in order to understand the current state of mobile phone and ICT usage in rural areas. Two poor rural communities in South Africa were chosen. One of the contributions in this paper was to identify rural ICT needs of the users dwelling in a rural context and comparing these to those in the developed world. There is a big difference between rural users' expectations and those in developed nations.

Other, similar research has been conducted in India and China. However, in this paper, only results from two rural communities in South Africa are reported. The key objectives of this study were: first, to study how South African rural dwellers use mobile phones and other ICT devices to share information. The idea was to use the findings to help in developing a new mobile phone interface to cater for poor and low-resourced communities. The second idea was to compare the South African context to that of India and China. This made this study partially cross-cultural in nature. This paper helped in understanding the ICT device requirements for rural areas and the current ICT usage or challenges in rural areas.

Paper 6 – Rural community eReadiness

Having conducted various studies in rural areas, the author carried out an eReadiness study in Dwesa community. The focus of the paper was to identify the current state and readiness of the community to use the internet within the community. The internet was chosen after noticing the benefits that it could bring to the Dwesa community. The readiness of rural communities to use technologies and services such as Internet was surveyed. The author visited the Dwesa community to understand and check with the community members if their community was ready for ICT devices. Having conducted various studies in rural areas, the author carried out an eReadiness study in the Dwesa community. The focus of the paper was to identify the current state and readiness of the community to use the internet. The internet was chosen after realizing the benefits that it could bring to the Dwesa community. SLL researchers (including the author of the thesis) organized meetings with teachers and community members from each of the eleven schools to engage them in sharing the proposed internet service deployment to the community. An assessment of each of the schools was done and the ICT resources were recorded. The views of the community and their understanding of ICT services were noted and recorded, and presented in this paper. The final conclusion was that some of the schools still lack basic ICT infrastructure to support ICT services, but that the community is ready and willing to use ICTs to improve their lives. The community is already aware of some potential ICT benefits and ready to enjoy such benefits.

For all the publications coming out of this research, the author initiated all the interviews, community engagement and workshops to get the feedback from the stakeholders involved. The involvement in data collection was important to clearly understand the ICT trends, future ICT trends and for building the roadmap framework. The publications were all important in explaining the findings that were used to develop the framework. The papers were used to build up the ICT roadmap framework as the results reported in the papers are those on which the discussed framework is based.

Research abstract

The use of Information Communication Technologies (ICTs) can support sustainable development within societies. ICTs have been supported by governments, private companies, non-governmental organisations, academic institutions and individuals. However, technological changes have made most ICT initiatives haphazard due to poor planning. There is no systematic plan on how to deploy services, infrastructure and devices especially in rural areas. For instance, in some cases, computers have been donated to communities in rural areas yet they are not being used, and ICT services have been deployed without the supporting ICT infrastructure. One of the solutions to addressing these ICT challenges is through the use of roadmaps to guide ICT solution implementation. This thesis proposes an ICT roadmap methodological framework to improve ICT roadmap development for rural ICT solutions.

A composite methodological approach was employed in this research. This involves the use of qualitative research techniques such as participant observation, design exercises, workshops, focus groups and individual interviews supported by ethnographic studies. The Siyakhula Living Lab in the Eastern Cape Province of South Africa was used as the case study. Studies were conducted to identify the current state of ICTs in rural areas, the future of ICTs and overview of roadmap developments. Rural users in South Africa, ICT experts in Europe and Africa, government officials and academic institutions were engaged to understand the current ICT planning, developments and needs.

The author found that there are variations in individual ICT services required by rural users but, most ICT services in need fall mainly in the areas of health, education, entrepreneurship, agriculture and employment creation for rural people. These services require ICT devices and infrastructure which include computer peripherals, mobile phones, radios, televisions and wireless infrastructure, mobile infrastructure, satellites and broadcasting infrastructure respectively. It was found that the common future ICT projections expected in rural areas include: growth of mobile usage, social networking, increase internet services and localization of services.

The roadmap framework is built based on the current state of ICTs, trends in ICTs, future technological projections and the plans currently been initiated in African continent. The ICT roadmap methodological focuses on how roadmaps could accommodate infrastructure, services and ICT devices to reach rural people. This should help rural users to be able to access public services within their respective communities using available ICT devices. ICT stakeholders could use the designed framework to improve the ICT roadmap development process for rural ICT users in Africa.

Keywords: ICTs; roadmapping; technology roadmap; roadmap framework; future projections; ICT services; infrastructure; ICT devices

Table of Contents

List of Figures

List of Tables

Chapter 1:
ICT DEVELOPMENTS

There have been a number of very important technological changes that we have seen in the last decade. Today, using the results of the global report of the last 10 years, we can actually see that countries that have made some key decisions have succeeded in increasing access and improving competiveness and fundamentally we can identify indicators important for moving in the right direction. Now we too have also seen that technology has a very fundamental impact on development. So the impact of technology on transformation and productivity improvements is much documented. Today we are also starting to see the impact of technology on countries which are poorer and maybe the citizen population less educated.[1]

1.1 Introduction

This chapter explains how technologies have changed and affected ICT developments. The overall thesis highlights the current ICT trends and ICT roadmaps that are important to close the gap between rural and advanced communities. ICT developments have been facilitated by government support in many countries. Today, ICTs are important in all sectors and in enabling community improvements. ICT developments have encouraged ICT stakeholders to come up with sustainable ICT development plans, the main one being the roadmap plans which are common in many countries. At this point, in this chapter, only ICT developments are discussed in order to share with the readers an overview of the current state of ICTs.

1.2 ICT overview

According to Singh *et al*. (2008), the ever-presence of Information Communication Technologies (ICTs) have the power to sustain societal relations, encourage business, facilitate technical education and uplift individual developments. Madon (2000) adds that the proper ICT policies and ability to use ICTs enable the sharing of ideas through the use of the internet, leading to positive improvements in low-resource communities. In this view, African nations are coming up with ICT solutions to empower individuals and improve poor areas (Southern & Townsend, 2005) in developing and developed communities as supported by (Singh, *et al*., 2008). Without

[1] Global ICT Research experts panel – 2011

ICTs, some individuals are left behind and find it difficult to benefit from some ICT capabilities, such as seeking employment, thus resulting in many rural people failing to be on par with the rest of modern South Africa (Chigona *et al*., 2010). However, the success of ICT projects requires stakeholders' commitment and continuous working together to deploy and implement beneficial ICT solutions in rural areas.

1.3 Overview of technological changes

The last decade has witnessed drastic technological changes and such developments have affected communication as well as commercial transactions amongst individuals (McGowan, 2003). There is no doubt that technological changes are everywhere; they have, however, not been the same in all places. There are better ICT developments and implementations in developed nations while rural areas in Africa are still lagging behind. Of course, the technological changes have made the world increasingly advanced and one cannot predict what the future holds as changes continue in all parts of the world.

Technological development and diffusion is a key ingredient in ensuring economic convergence between developed and developing nations (EU-Africa, 2007). The integration of ICT has a profound effect on the rapid improvement of growth, competitiveness and jobs across all sectors of the economy (IPAD, 2006). The technological changes and low cost ICT services have fastened social, economic and technical developments in most parts of Africa (IPAD, 2006). The enormous developments in ICTs have been necessitated by continuous technological changes.

The future is becoming an interesting area for researchers. ICT researchers and technological futurists have anticipated the future of technology and one of the proposed ideas is for instance, the growth of cloud computing, which could enable advanced web application accessibility (Jere *et al*., 2011; Digital Giants, 2010). On the other hand, mobile applications are expected to grow and improve sharing of information and services. The expansion of wireless services is again projected by many technological futurists. The growth of online business transactions and the use of the web are also expected. This could encourage easy service access and social networking (Jere *et al*., 2011).

All these future expectations have an effect on ICT platforms and the fact is that there is a lot of work being done to improve service delivery through ICTs in developing countries. This research project analyzes current ICT developments and determines future changes required to

envision ICT projections. Based on all of this information, the research provides a roadmap for what is to come. Some of the various questions at this stage of this research include: Will the current ICT applications be able to suit the changes in technology? What will the next 5 to 10 years bring? Will the pace of technological advances continue to be high? What are the effects of these changes on ICT applications deployed for rural communities? Various ICT solutions are in place to provide answers to the questions raised above; one such strategy is the use of technology roadmaps.

1.4 Highlights of roadmaps

Most companies are now using the roadmap approach, mainly in developed nations. Of course, developing nations have also seen the need for roadmaps, thus making roadmaps popular in Asian countries such as India, Bangladesh, Pakistan and the Philippines. In Africa, roadmaps are now gaining popularity in many countries such as South Africa, Lesotho, Egypt and Nigeria. It is also worthwhile to note that most of the technological roadmaps in developing nations fall largely under the category of policy, government and community roadmaps. There is a slight difference in the need for roadmaps between developed nations and developing nations. For example, during the study of the existing roadmaps, the author noticed that most of those in developed nations are set to improve business growth, mainly in industry, while in the focus in developing nations is on empowering people with the required services, mainly in ICT.

Motorola came up with the technology roadmapping idea in the 1970s in order to improve its IT alignment and Motorola's business growth (Grinnell, Richie & McQueen, 2002). From that time, several other organizations, in different sectors around the world, have tried to come up with various technology roadmaps. The aim of having technology roadmaps is to ensure flexibility and enable organizations to have an IT strategic plan that is in line with business goals supporting new ideas, long term plans and sustainable policy formulation (Blackwell *et al*., 2008).

Currently, there are different types of road maps available and many organizations are using them to plan for the future. This is encouraged by the fact that the roadmapping process enables all interested parties to come together to discuss, share and implement viable solutions. Successful roadmap development can allow the sharing of ideas and be used as a guideline and

for roadmap planning. This allows decision making and planning, both at the national and local level.

As highlighted by Bruce & Fine (2005), roadmapping has become popular as indicated in different case studies and research studies that focus on technology roadmapping. Academia, industry, government and communities all have a role to play in roadmap development (Albright, 2003; Smith, 1995). Further details on roadmaps are offered in Chapter 3.

1.5 Research problem

Technology is changing on a daily basis. Applications have been developed and are continuously being developed. Considering ICT applications which are currently being developed, and the changes in technology, it is difficult to predict the future of all of these applications. Technology seems to be moving so fast that most of the current ICT applications will become obsolete in the near future. Considering the changes in technology and the shortage of resources in rural areas where most ICT applications are deployed, it is difficult to prepare for and anticipate the technology landscape of the future. Anticipation and projections have been made for the future. These projections are even harder to make since the ICT environment is very dynamic. In addition, it is difficult to accommodate the ICT needs of different people and work with all the key stakeholders to ensure that appropriate ICT developments take place. The challenge is for ICT stakeholders to plan and manage ICT developments in rural areas, resulting in many ICT initiatives failing to benefit the targeted users. This requires proper planning and commitment of ICT stakeholders.

Roadmapping is a technique that has been used in different areas as a way to enable future planning. The roadmap development process involves taking into account the current state of ICTs, future projections that are currently suggested and ICT services expected in rural areas. The challenge is to combine the changes: ICT developments, ICT challenges in rural areas and ICT policies involving all ICT stakeholders. Technological changes affect services, infrastructure and devices. It becomes difficult to integrate these three and ICT stakeholders therefore need to plan for the integration. Currently, the available technology roadmaps focus on one or two of the components e.g. infrastructure or services, or devices and infrastructure, or services and devices. While all three components are critical for roadmapping, rarely does one find all three components discussed in one roadmap.

The following are therefore the key factors within the research problem of this research:

- Dynamic ICT environment based on technological changes
- Difficulties in planning for the future ICT landscape
- Varied ICT needs and challenges in rural areas
- No standardised and systematic way to manage ICT project
- Different ICT challenges in respective areas
- Engagement with all the key ICT stakeholders and come up with an ICT roadmap framework that accommodates infrastructure, services and devices at the same time.

The author found that there are ICT initiatives currently underway in rural areas, but there is no proper planning for ICT infrastructure and services to address the rural needs and challenges. Therefore, this thesis proposes the development of an ICT roadmap framework. This framework is based on the ICT roadmaps currently available and can be used to improve ICT roadmap development. The problems explained in section 1.5 led to the main research questions discussed in this thesis. These research questions are listed in section 1.6 below.

1.6 Research questions

The research was divided into different components so as to enable the development of an ICT roadmap methodological framework to be discussed in Chapter 6. However, the main research question is:

Main Research Question:

How can ICT roadmapping be used to plan for future ICT services in rural areas?

In order to get solutions to the main research question, some sub-questions are provided. This enabled the division of the research into different components. These components were necessary for answering the main research question. For example, the following are the questions that were raised to assist in coming up with the ICT roadmap framework. The author has included sub-sub-questions as these helped in fully getting the details about ICT trends especially in rural areas.

Question 1: Current state of ICTs – What are the ICT trends, developments and challenges in rural areas? The following sub-questions were covered:

- Which ICT services are currently available in rural areas?
- Which ICT services are rural people in need of?
- What are the characteristics of the ICT services expected in rural areas?
- Which ICT devices are used in rural areas?
- What are the places of ICT access in rural areas?

Question 2: Future technological projections – Which future technological projections are applicable in rural areas? Some of the questions raised under this research question were:

- What are the relevant future ICT projections?
- How are the technological changes affecting ICTs in rural areas?

Question 3: ICT roadmaps – To what extent can ICT roadmaps help in ICT planning and development within rural areas? Other questions were:

- What are key examples of roadmaps?
- What ICT infrastructure, technologies, devices should be considered for a successful ICT roadmap?
- What considerations are missing in the current ICT roadmaps?
- Can ICT roadmaps address the key aspects necessary for community development?

Question 4: ICT stakeholders – What is the significance of engaging all ICT stakeholders when planning for ICT development in rural areas? Some questions include:

- Who are the key ICT stakeholders?
- Do the current ICT roadmaps involve all stakeholders?

The common question after considering all the above sections could be:

Question 5: What ICT services, devices, infrastructure mix is applicable in rural areas?

Technological changes bring complexity to ICT developments in rural areas and make the roadmap planning process using the current state of the art a complicated process. However, if proper planning is done, ICT sustainability can be achieved; therefore, this research explains an

ICT roadmap framework to provide answers to all these questions. The exact solutions are indicated later in Chapter 8.

1.7 Research objectives

Having considered the past, present and future, it is clear that there have been various changes in technology. There exists a need to ensure the sustainability of ICT applications by laying a strong foundation on which future applications could be based. This is achieved through detailed analysis and experiments on ICT trends, developments and roadmaps. The research objectives are derived from the research questions that the research aims to address.

The main research objective is:

Main Research Objective

Analyse the current ICT trends and technological changes whilst taking into consideration the future of ICTs and existing ICT roadmaps towards the development of an ICT roadmap methodological framework.

The research sub-objectives are as follows:

Objective 1: *Understand the current ICT environment - this helps to find out which ICT services, infrastructure, devices are required in rural areas*

Objective 2**:** *Identify critical enabling technologies that are needed in rural areas*

Objective 3: *Analyse future ICT projections and indicate whether these projections are applicable in rural areas*

Objective 4: *Provide a systematic reference or framework to assist in ICT roadmap development*

Objective 5: *Specify the ICT stakeholders required for ICT roadmap development*

Objective 6: *Assess the ICT roadmap framework to ensure ICT development.*

These research objectives provided guidance throughout the research process. The proposed framework was developed based on these research objectives and should enable ICT policy

makers and different ICT stakeholders to plan properly when implementing continental, national or regional ICT roadmaps.

1.8 Research contribution

Clearly, great changes can be anticipated in technology. ICT applications that are developed today should be useful for the next 5 to 10 years, thus the future should be considered. This research allows preparation for what is to come as technology changes. This could enable the sustainability of ICT services in rural communities. The idea proposed aims to ensure the sustainability of ICT applications by laying a foundation on which these applications could be based. The contribution of this research, as explained in the thesis, is to develop an ICT reference methodological framework which supports ICT roadmap initiatives. The roadmap framework clearly specifies the different ICT components such as services, infrastructure and devices that should be available for successful ICT roadmap implementation. The roadmap framework educates ICT stakeholders in understanding the common ICT services in demand, the possible infrastructure required to support the services and the devices that could be used to access the services.

The roadmap methodological framework is not specific to a particular locality and therefore does not give figures, percentages and specific impacts of ICTs. It does however assist in informing ICT stakeholders of the technical ICT requirements that should be in place for successful and sustainable ICT solutions. This roadmap methodological framework is developed from an academic perspective after meeting ICT stakeholders and through rural community engagement to gain a clear understanding on the current ICT trends in rural areas.

1.9 ICT roadmap research outline

It has been noticed that there are many examples of roadmaps currently available, as will be discussed in Chapter 3 of this study. The ICT roadmap was chosen as a solution towards ensuring ICT sustainability in rural areas. The ICT roadmap methodological framework includes the following:

ICT services expected – in this regard, ICT experts shared ideas on several ICT services which they felt were important for any rural community. It was also interesting to realise what rural

people expected in terms of services. The differences between the views of ICT experts and rural ICT users were noted and considered for the development of the roadmap.

ICTs should be used to transform public service delivery and ensure better services to rural people (Caspary & O'Connor, 2003). This encourages ICT information sharing. ICT services should be more user-centric and integrated across all communities (Gichoya, 2005). The thesis encourages better access to information for the community, business and public sector and open government services to allow sharing and access to government information whilst encouraging online access to government where possible. The thesis also provides a common approach to the provision of ICT resources. This should ensure the most efficient and effective provision of ICT components that are common to all parts of poor communities.

The thesis recommends ICT social services for poor communities. This could be achieved by developing technical education programmes for creating digital content for electronic games. This should be geared to assist creativity, designers, writers and ICT educators in rural areas. Again, the thesis highlights ICT entrepreneurship with an emphasis on the efforts of rural entrepreneurs to provide commercial services over the internet. This could be encouraged by ICT education in support of the development of ICT software for ICT services in rural areas. This could also allow business and software engineering to be combined so as to improve ICT sustainability.

To achieve the successful development of the ICT roadmap framework, different ICT stakeholders including the government, private sector and local communities need to work together to improve the ICT infrastructure and service delivery. The availability of ICT policies and government ICT plans is also necessary for the successful implementation of this roadmap.

Current state of ICTs – Rural people, mainly from Dwesa and other rural communities such as Keiskammahoek and Alice, were included in this study (all of these communities are in the Eastern Cape province of South Africa). Old people, the youth, farmers, teachers and rural entrepreneurs were targeted, as they represent the common categories of people found in these areas. Observations, community engagement and voice recordings were used to collect the data pertinent to this study. This provided knowledge on the views of rural people on ICTs. Details of the studies carried in this research are given in Chapter 4.

ICT challenges – ICT experts and people living in rural areas shared their views on the ICT challenges experienced in the respective areas. The key notable challenges include poor infrastructure and a shortage of devices.

Factors affecting ICTs – It was also important to discuss the factors that affect ICTs with various researchers. In this case, ICT experts and rural dwellers were considered. These factors include socio-cultural, economic, technological, political and government policies.

Identifying technological projections – To get future projections, ICT experts were targeted. Researchers from European countries such as Finland, the Netherlands, Italy, France and the UK were met. Other ICT experts in African countries such as South Africa, Tanzania, Kenya, Zimbabwe, Malawi, Lesotho and Nigeria were also involved in the discussions, as well as researchers from Asian counties such as China and India, who also shared their views. Research papers written during the course of this research were presented at ICT-related conferences such as ITU Kaleidscope 2011, SATNAC 2011, SACLA 2011, ZAWWW 2011 held in South Africa, and at the 2nd IEEE International workshop in Lugano, Switzerland, and ACHI 2012 in Valencia, Spain, and the feedback was used for the development of the framework. The sample of research papers is presented as Appendix B at the end of this thesis.

ICT roadmap methodological framework development plan – Workshops were conducted in Finland involving ICT stakeholders. Community engagement and the case study approach were used to gain insight into roadmap planning. Examples of the ICT stakeholders that were consulted are: government departments; local councils and municipalities; district and provincial officials.

Assessing the ICT roadmap methodological framework – The author used the existing literature review on current ICT roadmaps combined with ICT users' views in order to analyse and assess the methodological framework. An analysis of the findings regarding the current state of deployed ICTs was used during the framework assessment process. This included an analysis of existing ICT roadmaps. After gathering the required data on current trends in ICTs, the author suggested that the gap between developed and developing nations, in terms of ICT roadmaps, is narrowed through the development of a roadmap methodological framework. This was to support the previously stated research objectives and provide a sustainable solution to the ICT problems, as indicated in the research problems section.

The ICT roadmap methodological framework is useful in assisting ICT stakeholders to develop ICT roadmaps. The framework focuses on the technical ICT infrastructure that should be available in rural areas to cater for emerging technologies and ensure the provision of ICT services. Such infrastructure includes wireless networks, broadband connectivity and mobile infrastructure. Furthermore, the infrastructure plan should be open-ended in order to accommodate future advances in technology and to allow for the standardization of communication protocols and radio frequencies. This enables the deployment of ubiquitous ICTs and allows access to digital resources anytime and anywhere within rural communities.

This section has been included in this chapter to alert readers as to what they can expect to encounter later in this thesis. In addition, readers should be aware that in order for the thesis objectives to be met, a deeper understanding of technological roadmaps is required, as shown in the next chapter. This has enabled the development of the ICT roadmap methodological framework. The issues covered under this section are explained in further detail in the ensuing chapters. However, before engaging with the literature in the next chapter, it is necessary to mention the research area used as the test bed for this study.

1.10 Research background – case study

The ideas in this research were tested within the Siyakhula Living Lab[2] (SLL) in Dwesa. SLL has different stakeholders, including private, public and institutions. The project began in 2005, as a collaborative effort between the University of Fort Hare (UFH), Rhodes University (RU) and the rural community of Dwesa-Cwebe. The community is located in the Eastern Cape Province of South Africa. SLL aims to improve rural areas by deploying ICT solutions (Muyingi *et al*., 2006; Tarwireyi *et al*., 2008). SLL wishes to design the best ICT solutions aimed at closing the gap between rural and urban areas. This idea has been supported by the deployment of a wireless infrastructure which provides internet connectivity in the community (Gumbo *et al*., 2011).

Wireless connectivity has been facilitated by the availability of ICT devices such as computers and mobile phones. These devices are situated at the surrounding schools in the community, i.e. Mpume, Mtokwane, Ngwane, Nondobo Junior Secondary Schools (JSS) and Nqabara, Senior

[2]http://siyakhulall.org/

Secondary School (SSS). These schools are well linked and connected to support internet access within the community; this is enabled by the presence of fixed WiMAX/ VSAT/WiFi which were deployed in order to achieve this (Siebörger *et al*., 2010). The financial and technical support from one of the stakeholders, i.e. Saab Grintek, has led to the expansion of the SLL to cover other schools in the community. The expansion has added eleven other schools to the initial schools. Some of the schools in the new SLL network are: Ntubeni, Ngqeza, Lurwayizo J, Ngoma, Mevana, Hlabizulu, Nquba, Badi, Zwelidumile and Lurwayizo (Gumbo *et al*., 2011). SLL also promotes the sharing of ICT resources, which is noted by only two schools, i.e. Ngwane and Badi, through the hosting of a WiMAX base station and a VSAT; the rest of the schools have Customer Premises Equipment (CPE) which connects wirelessly to the respective base station (Dalvit *et al*., 2011).

As noted by Moshapo and Hanrahan (2004), ICTs are important in rural areas as they are critical in improving education, health and commercial transactions. This has been witnessed within the SLL through the development of e-service applications such as eCommerce, eGovernment, eHealth and eJudiciary (Muyingi *et al*., 2006). The current state of ICT services and infrastructure within the SLL is discussed later in this thesis. A description of the Dwesa rural community is as follows:

The Dwesa rural community is located on the southeastern coast of South Africa, Eastern Cape Province, which comprises an area spread over 235 square kilometres. The closest town to Dwesa is 50 km away. Dwesa suffers from a low human development index, i.e. 0.41 (McCann, 2006), far below the national average of 0.61 (UNDP, 2007). Dwesa also has a low literacy rate at 44.24% against the national rate of 68.5% (Statistics SA, 2004), an unemployment rate of approximately 78%, and increasing dependence on agriculture, state grants and remittances from urban areas (McCann, 2006). The working population of this region is primarily involved in farming related practices, while marginal numbers are dependent on arts and crafts for their subsistence. Due to the high percentage of youth migration to urban areas, Dwesa is left with a large elderly population and children below 20 years of age (Dalvit *et al*., 2008; Pade-Khene, Palmer & Khavai, 2010).

Various recreational and social activities are available in the Dwesa community, i.e. tourism enabled by the presence of an attractive beach, a nature reserve and art and craft activities

(Palmer, 2002; Kavhai, 2009). In Dwesa, access to ICTs is in the form of computers and people mainly utilise services such as emails, typing, printing and photocopying (Pade, Mallinson & Sewry, 2006; Pade, 2006). However, there is great potential for improving this community through ICTs as already indicated by the community members and observations noted from the SLL project's output. The current ICT infrastructure in the Dwesa community still needs to be improved for the community to have sustainable ICT solutions. The community still relies heavily on the schools as their main ICT access points and this affects service delivery and access to ICT resources.

1.11 Research strategy and outcomes

This section gives the exact sections where the research questions and objectives are addressed in the thesis. It also shows the actual sections where the research objectives and questions are addressed. Table 1:1 shows the link between the research questions and objectives of the study:

Table 1:1: Research objectives and questions summary

Research objective	Research question	Chapter or Section which addresses the research objective and question
Objective 1: *Understand the current ICT environment*	***How can ICT roadmapping be used to plan for future ICT services in rural areas?- main question***	Chapter 2, Section 2.9, supported by the Study 1 and 2. Table 5:1, 5:4 and Figure 5:2 give a summary of the ICT environment. Summary in Figure 5:9 also explains ICT trends
Objective 2: *Identify critical enabling technologies that are needed in rural areas*	***What are the ICT trends, developments and challenges in rural areas?***	Chapter 2 and Chapter 3 supported by Study 3 on future projections– Workshops with ICT experts, focus groups in rural areas gave an understanding of rural ICTs. Chapter 5, section 5:3, Figure 5:4 and 5:10 all address the research question and the objectives.
Objective 3: *Analyse future ICT projections and indicate whether these projections are applicable in rural areas.*	***Which future technological projections are applicable in rural areas?***	Chapter 2, supported by Study 3 provided details on future ICT trends. Section 5:3, figure 5:4 and 5:10 explain future technologies.
Objective 4: *Provide a systematic reference or framework to assist in ICT roadmap development.*	***To what extent can ICT roadmaps help in ICT planning and development within rural areas?***	Chapter 3 gives roadmaps overview, Figure 3:1, section 5:7, 5:8, 5:10 Figure 5:7 and Figure 6:1 summarise the proposed roadmap. Chapter 6, Section 6.6, supported by Study 5 and 6 – and through Desktop research, discussions at ICT conferences.
Objective 5: *Identify ICT stakeholders required for ICT development.*	***What is the significance of engaging all ICT stakeholders when planning for ICT development in rural areas?***	Figure 4:2 and 4:4 explain the various ICT stakeholders. Study 6 helps in sharing the ICT stakeholders. Supported by the stakeholders theory in Chapter 7. The need for workshops explained throughout the thesis as part of roadmaps development as Chapter 3 explains is an example of stakeholders' role.
Objective 6: *Assess the ICT roadmap methodological framework to ensure ICT development.*	***What ICT services, devices, infrastructure mix is applicable in rural areas?***	Chapter 2 on ICT services, Study 5 on ICT usage, Section 5:5, Study 6 all help to address the objective and research question. The sub sections 6.5.1 – 6.5.3 together with Figure 6:2 and 6:5 address the research question and objective.

1.12 Thesis overview

The thesis has seven other chapters besides Chapter One. The chapters build towards the development of the ICT roadmap framework. The summary of each chapter is as follows:

Chapter 2: *ICT current state of the art* – This chapter provides an ICT overview. It provides a summary of ICT trends, challenges, benefits and the future of ICTs. It covers the subject of ICT developments in both developing and developed nations. Examples of ICT developments particular to South African rural areas are also explained in this chapter.

Chapter 3: *Technology roadmap* – this chapter explains the types of roadmaps currently available in the private and public sector. The approaches, techniques and importance of roadmaps are given. The chapter is concluded by outlining the challenges of roadmaps and factors that affect technological roadmaps.

Chapter 4: *ICT roadmap methodological approach* – this chapter shows the research techniques used during the research. The research techniques are explained using the studies that were conducted in this thesis. Future forecasting techniques, such as scenarios and backcasting are also explained. The chapter finally explains the ICT roadmap methodological framework that is referred to throughout this thesis.

Chapter 5: *Analysis of the ICT roadmap developments* – This chapter discusses existing ICT roadmaps. The study findings are explained in this chapter and these findings were used to develop the ICT roadmap methodological framework. It provides the possible ICT infrastructure, devices and services that are required for roadmap success. The chapter also provides the projected services, devices and infrastructure for rural areas.

Chapter 6: *ICT roadmap methodological framework components* – This chapter explains the exact components that were used for the development of the ICT roadmap framework. The classification of ICT services, devices and infrastructure is explained. Diagrams that represent the ICT roadmap methodological framework are displayed in this chapter.

Chapter 7: *ICT roadmap methodological framework assessment and analysis* – The findings after the development of the framework are explained in this chapter. The findings are compared to the existing roadmaps and the assessment and analysis of the ICT roadmap methodological framework is provided herein. The ICT methodological framework explained in Chapter 4 is also

used in this chapter, in order to analyse and assess the framework. The chapter concludes by sharing information regarding the overview of the developed framework.

Chapter 8: *Research summary, recommendations and conclusion* – This is the final chapter of the thesis. This chapter offers and explanation of the research achievements together with recommendations made after the development of the ICT roadmap methodological framework. It also provides proposals for future research and an overall conclusion for the study. After this, the reference list with the details of the references used in this thesis is given. This is followed by the appendices, section which contain samples of the research questionnaires, workshops, publications and a summary of the meetings and discussions held during the research.

1.13 Conclusion

This chapter has introduced the thesis overview and what the reader can expect in the ensuing chapters. The chapter provides an overall introduction to the other chapters. It provides the research objectives and questions; it also identifies the sections where the objectives and research questions are covered in further detail later in the thesis. The next chapter further explains ICT trends that have been highlighted in this chapter; ICT initiatives, challenges and the future of ICTs are discussed in Chapter 2. An overview of technological roadmaps and rural ICT developments is also offered in the next chapter.

Chapter 2:
ICT – CURRENT STATE OF THE ART

Borrowing some important foreign ICT practices can improve ICT development in developing nations. Of course, it requires involvement of all stakeholders... In the near future vast positive changes can be witnessed.[3]

2.1 Introduction

The literature covered in this thesis mainly looks at ICT trends, focusing on current trends and finally what is expected to come. A look at the current ICTs and some problems of different ICT eServices is also covered. Several ICT factors which determine the accomplishment of ICTs and the future of ICTs are covered here. The history and changes which are occurring in technology and their effects on ICTs are explained. The focus of the literature reviewed was on ICT usage, findings from different ICT researchers and other findings and experiences of the author of this thesis. The findings are based on a variety of studies which were done and continue to be done world over. The author is actively involved in ICT projects within rural areas, and presents experience and details on a variety of findings critical for ICT analysis, which has also been covered in this chapter.

There are currently various publications on ICT initiatives, including those for rural areas. Several authors have also written on ICT trends, ICT services, challenges and the future of ICTs (Moshapo & Hanrahan, 2007; Chigona *et al.*, 2010). A variety of ways used to access ICTs are available and at the same time several ICT plans are in place to ensure sustainability. Thus, in this chapter ideas on ICTs which could help in developing a methodological framework are included. An understanding of the points raised in this chapter, i.e. challenges, developments, initiatives or plans, is necessary in developing an ICT roadmap methodological framework.

[3]Pakistan ICT development motto by Jaffri (2008).

The understanding of ICTs was enabled by considering some definitions such as:

Definition of ICT: The Commission on Information and Communications Technology from the Phillipine, (2004) defines ICT as: the use of technological devices to gather, keep, practice and deliver information to others. ICTs are made up of electronically enabled devices, systems and telecommunications networks that include both wired and wireless infrastructure (National Computer Center, 2012).

On the other hand, Warren (2002:2) explains ICTs as: "technologies and media that capture store and disseminate data and information, and they include tools such as video, teletext, voice information systems, radio, mobile telephony, fax and computer-mediated networks important for information and service delivery".

These definitions show that ICTs include various technologies, devices and services that are very dynamic. As a result, proper ICT planning is required for ICTs to benefit and sustain people in rural areas. Clearly, it can be noted that ICTs enable communication, exchange and sharing of information. The variations among ICTs require different ICT stakeholders to cooperate so that the benefits of ICTs can be extended to all poor communities.

2.2 Overview of ICTs

ICT stakeholders support the idea that everyone should use and access ICTs to get public services and share information at minimal charge. Many developing nations such as the Philippines government are focusing on improving service delivery to poor people in rural areas through ICTs (Ramon, 2006). According to the 2011 Millennium Development Goal (MDG) report, close to 2 billion people live on $ 1.25 a day and it is predicted that even by the end of 2015, there will be 900 million people living on $ 1.25 a day (MDG Report, 2011). The majority of these people dwell in the emerging markets within Africa and Asia. Developing nations suffer from poor infrastructure such as electricity, internet and transportation services. According to the latest estimate, current internet use is limited to about 2 billion people in this world (UNESCO Report, 2010). However, due to mobile phone penetration, with almost 90% having access to mobile phones, i.e. covering 5.3 billion people (UNESCO Institute for Statistics, 2010), internet users will continue to grow.

The report by ITU for 2011 indicates that the majority of new mobile users between 2007 and 2010 were in developing nations (ITU, Report, 2011). Therefore, service providers and business organizations should target developing countries as a possible market. The ITU report mentions that companies have to start considering the best ICT strategies to venture into this big market opportunity in developing nations (ITU, Report, 2011). Furthermore, this involves developing usable devices for ICTs and having business models which suit the requirements of the emerging markets. Of course, many people in developing countries are poor, but proper business models enable businesses to make profit in such areas (ITU, Report, 2011; Guislain *et al* 2006:8). Despite all this, African countries are all aware of the technological changes and the implications of such changes to their respective countries. Therefore, African countries are finding better ways of accessing and using this technological knowledge (Guislain *et al* 2006:8). Technology is required to assist in building up the African nations so that they access the global world and attain the same status as highly developed nations (World Bank, 2006a). The benefits of ICT in these countries can be slowed since internet usage in Africa is still very low at 5.7%, despite the fact that it is the second biggest continent in terms of population (Internet Users, Report, 2011).

The 2011 Global Information Technology Report shows that Africa has not yet met the other continents in terms of technological advancement (Global IT Report, 2010/11). The low usage of ICTs in Africa was also a finding by other researchers such as Mosia and Ngulube, (2005) and Kweku (2006). The main reasons for poor technological improvements are: poor infrastructure, no reliable markets, high illiteracy levels, poverty and poor regulation polices (Caspary & O'Connor, 2003; Munyua *et al*., 2003; Richardson, 2006, Chigona *et al*., 2010). Nicholson (2011) noted that because of the poverty in Africa, it appears that most Africans in rural areas will never have personal technological devices such as laptops, Kindles or mobile phones (Nicholson, 2011). This means that there is need for proper planning on ICT services and devices to be used if ICTs are to benefit the rural poor. It entails that ICT stakeholders come together and ensure that ICTs are available, affordable and reach all the people including rural areas.

2.3 Potential of ICTs

ICTs enable private and public companies to offer high quality services at low cost and ensure uniformity in all areas (UN, 2009). ICTs enable individuals to have the latest updates on current affairs, and the fact that all the news is readily available at the same time makes it easier for people to share and communicate (Ramon, 2006). ICTs, in other words, are critical in ensuring effective service delivery which could improve social and economic status in various areas. In the Philippines, for instance, ICTs facilitate investments and employment creation (Ramon, 2006). This section gives some of the capabilities of ICTs:

Improving access to information: The variations in African society require sharing of ideas and information. Each country has different ways, beliefs and standards of living, making it essential for ICTs to be accessible (Munyua, 2007). ICT research institutions have made efforts to localize ICT content and services so that information can reach many people (Munyua, 2007). Different ICT devices such as DVDs, CDs, TVs and radios have been used in different sectors, such as agriculture to improve information access to farmers (Munyua, 2007). Other means to enable information access include radio programmes, online chat sessions, audio cassettes and web sites (Stefano *et al*., 2005). The main challenges to enable providing access to information in poor areas include shortage of ICT skills, lack of understanding of the content and difficulties in sharing available information (Munyua, 2007).

In some countries like Uganda, project reports are delivered through newsletters, radios and billboards to share information and experiences with their target audiences (Munyua, 2007). This promotes local content development and understanding and satisfies the findings of Stefano *et al*. (2005), who recommend local content to enable ICTs to reach and address communities in need of services.

Community service delivery: The author noted through studies and literature review that the majority of rural people rely on subsistence farming. The literature shows that ICT developments for particular services such as agriculture benefit the communities around. These benefits come in the form of improved information access, awareness and sharing. This improves entrepreneurship and ICT education, which are critical for rural development. As a result, many people in developing nations are in need of ICT services to enable improvements in agriculture, for example. In countries such as Nigeria, Benin, Zimbabwe and Kenya, agricultural extension

officers make use of ICTs to disseminate agricultural information. The author agrees that such initiatives in agriculture can go a long way in promoting ICT usage in rural areas, to enable information sharing and other required services such as health awareness, education and community communication. The general consensus is that ICTs can speed up economic development and increase economic growth. In Malaysia, the ICT sector has been supported by government and ICT stakeholders to improve standards of living and this has been encouraged by the formulation of ICT policies (National IT Council, 2008).

The author observed that the challenges in many places affect some initiatives and leads to failure of some ICT projects. Again, it was also noted that in some cases not all ICT stakeholders are involved, leading to many ICT initiatives failing. The author realises that there are many other ICT initiatives in different countries which are meant to improve communication within the respective areas.

2.4 ICTs in rural areas

Rural communities are often communities where people do not have the right to use the desired community service facilities (Heeks, 2002). Health facilities are poor, medical staff are often unskilled and clinics distantly located. Many ICT authors note that in order to access government ICT services such as Home Affairs, one has to travel to the office in urban areas (Munyua, 2007). Schools are common sources of ICT access in rural areas but the majority of the schools have ICT illiterate teachers (Moshapo & Hanrahan, 2007; Chigona *et al.*, 2010). In low-resource communities, geographical distance and poor connectivity are some of the barriers to utilise utilising services, though this is not common in urban areas (Richardson, 2006). There are various ways to enable some services that are common in urban communities to reach poor rural communities. Some of these are online health information, public services and eLearning ICT applications (Moshapo & Hanrahan, 2007).

The literature has shown that for ICT services to reach all areas there is need for: improved telecommunications infrastructure and that ICT stakeholders should work together. The ICT stakeholders are important in enabling ICT services such as eGovernment, eLearning, eCommerce, eHealth, etc. to reach rural areas (Munyua, 2007; Moshapo & Hanrahan, 2007).

ICTs enable the exchange of information in different places regardless off the distance between them, allowing access to information anytime and anywhere (World Bank, 2006a). Proper ICT usage has also encouraged the exchange of ideas which could help in coming up with new ideas and techniques (United Nations Report, 2009). ICTs can also improve economic growth within societies through the creation of employment and skill development programmes. Such programmes can promote new ideas that can improve entrepreneurship in rural areas (United Nations Report, 2009). This idea is also supported by Caspary and O'Connor (2003) and Hudson (2004), who noted that research in developing nations has shown that ICTs are vital for socio-economic development in various communities. ICT developments in poor areas result in better living standards in such communities, enabling rural technological developments.

Joseph and Andrew (2006) and Benjamin (2004) argue that since the 1980s, the *general public access* mission started by the International Telecommunications Union (ITU) has provided alternatives to put ICT services within easy reach of all of mankind. The literature shows that the telecentre approach is currently the most used model for public service delivery and access in poor communities. Telecentres make access to ICTs more affordable because they give users easy access to ICTs (Munyua, 2007). But a large percentage of disadvantaged rural people on the African continent have no access to ICTs, meaning that there is need for new ideas on how ICTs could reach all the people.

New ICT ideas require proper planning. For example, Pakistan has a lot of ICT potential and more can be achieved if planning is done using a proper roadmap for development, as was done in the ICT4ALL Pakistan vision-2015 (Jaffri, 2008). Technologies have been applied in Africa to deliver education on health, agriculture and entrepreneurship, mainly through various ICT devices such as TV, radio, CDs and web applications (Pye *et al*., 2003).

2.5 Current state of rural ICTs

Most ICT services in rural areas are currently provided though fixed network operators that are authorized by respective governments (World Bank, 2006a). According to Moshapo and Hanrahan (2007), the following means are important in offering ICT services in rural areas:

- *Confidential access*: individuals having their own means of using and accessing ICTs
- *Collective access*: users access ICTs through public shared resources. This involves several other parties in ensuring ICT service delivery. This is common in most of the rural areas where resources are scarce, it the services are less expensive in this scenario, but not always available when required (Moshapo & Hanrahan, 2007).

Due to the difficulties in telephone connections in rural areas, mobile operators have tried to reach such areas with different wireless connection techniques. This has enabled internet access in rural areas. Telephony services therefore improve information dissemination and create community development in rural areas (Caspary & O'Connor, 2003), as it could improve ICT knowledge and permit rural dwellers to seek job opportunities.

The use of ICTs through the Web enables internet services, i.e, emails, social networking and business transactions and these are some ICT solutions that are currently available for rural communities (Caspary & O'Connor, 2003). This supports the projected growth of the internet which was suggested some years ago by Veltman (2003). Rural people now have the potential to access and effectively use the internet to share and exchange information (Best, 2002). Of course, there are many ICT initiatives taken by stakeholders to ensure connectivity in rural areas. Moshapo and Hanrahan (2007) found that about 25% of schools in South Africa were connected; however, most of these schools were in urban areas, leaving rural schools without much connectivity (Moshapo & Hanrahan, 2007). Since schools are a possible source of ICT access in rural areas, the government of South Africa, through the Department of Communications is coming up with an infrastructure plan aimed at providing ICT access at rural schools (DOC, 2010).

The South African government has established an e-Skills Council that is responsible for identifying the areas, services and skills that are required in rural areas for ICTs to benefit all the people in the country (DOC, 2010). This helps to identify the ICT challenges faced in rural areas and come up with relevant solutions that address the problems encountered. In addition, there

are various skills development programmes which focuses on youth development and empowerment (Moshapo & Hanrahan, 2007; DOC, 2010). This will encourage a strong skills development base that would bring tangible benefits for the communities.

2.6 ICT services for rural areas

ICT for development in Africa involves the provision of ICT services to improve the economy. These services can range from commercial, knowledge enrichment and legislative services (World Developments Report, 2009; Harris, 2004). ICT services require a secure and reliable infrastructural network to deliver public services that are accessible to everyone, and this requires the support of various ICT stakeholders (World Developments Report, 2009).

According to the United Nations, ICT services include different application services such as those that support business, education and health. The United Nations also mentions the need for a proper ICT infrastructure to support the ICT services (UN, 2009; World Developments Report, 2009). ICT services are improving rural livelihoods and changing how individuals communicate, do business transactions and benefit from ICT usage. ICT eServices include eGovernment, eCommerce, eHealth, eLearning, agriculture, postal and telephone services, basic access to information and interactive communication (Dymond & Oestmann, 2004). Other common services are internet services such as email, computer training, content services on education, career development, content development and entrepreneurship, banking and insurance services, social facilities such as, youth clubs, women's clubs, farmers' clubs and better telecommunications services (Harris, 2004; Qiang, Clarke & Halewood, 2006:66). According to Dymond and Oestmann (2003), ICT services could be based on the following:

- Proper supporting ICT infrastructure;
- Ways to access and use ICTs;
- Provision of services and applications on demand.

Most ICT services are accessed from local schools, multipurpose telecentres, clinics, community centres, local radios stations, TV, or satellites. ICT service delivery has been improved by improved networks and mobile wireless developments (Connect Africa, 2007). According to Connect Africa (2007), in a report entitled 'Proof of Concept Project Report Southern Africa Trust "Proof of Concept"', the following were some findings:

- The current ICT services in rural communities do not give any profit due to poverty in these areas. Most of the people cannot afford to own personal ICT devices
- Despite the growth of mobile phone ownership, rural people find airtime credit expensive and struggle to recharge their phone batteries due to power supply difficulties. In some areas, people have to pay to recharge their mobile batteries and that is expensive for many people
- There is need to provide and deliver public services for future ICT sustainability
- A common service in need in rural areas was the need to make photocopies required for government application forms for public services
- Most rural dwellers are in need of government services, e.g. applications for identity documents, birth certificates, passports, etc.

It is therefore important to consider all these aspects of the current state of ICT developments in rural areas when planning to offer ICT projects.

Besides these findings, some of the current challenges when dealing with Africa, a continent where around 1,000 different languages are spoken by 14% of the world population, are that ICT companies need to develop software packages such as accounting and word processing in at least some of the African languages (Joseph & Andrew, 2006). This should be supported by e-learning services at schools in rural places, as Chigona *et al*. (2010) also suggest. African ICT stakeholders should take the educational initiative to provide different institutions with access to general ICT, e-mail and internet. Policies should be in place to include ICT curricula at schools, limited internet access should be given for free and workplace training on computer skills should be provided (Joseph & Andrew, 2006).

ICT policies should encourage more African and female learners to study science and technology, i.e. poor women must be in a position to use new technologies to access ICT services (Joseph & Andrew, 2006). More ICT training centers should set up, because skilled labour is in short supply in this sector (Joseph & Andrew, 2006). Policies should be in place to reduce the cost of computers and internet connection in rural areas. ICT training should be offered in rural areas to educate and empower ICT users with the required skills.

2.7 ICT challenges in rural areas

Various researchers as well as the author of this thesis have identified several ICT challenges in developing nations. The author decided to classify these ICT challenges as follows: *affordability, appropriateness, accessibility and ICT utilization*.

Any technology, product or service that is aimed at rural communities of developing nations must be affordable and appropriate (Kalusopa, 2005). Both these parameters are essential for the low income and resource-constrained rural communities. Clark and Gomez (2011) emphasize that costs or economic considerations can restrict the public's access to technology such as computers and the internet.

Over 70% of people in developing nations live in rural areas. The poorest people who cannot afford basic services like food live in rural areas and most of them earn very low incomes (UNDP 2005:16). The number of poor people in rural areas is expected to grow to more than 300 million in the near future (Munyua, 2007). In an attempt to relieve food shortages and reduce poverty in rural areas, better science and technology techniques are proposed in the agriculture sector (ECA 2005).

The cost of most ICT services is too high for people in rural areas, who cannot afford to pay for such services. The ICT devices and infrastructure to support such services require a well-planned national budget (Kalusopa, 2005). The high cost of ICTs has been as a result of poor ICT infrastructure. This means that in order to access better quality ICT services, African countries will have to pay more (Kalusopa, 2005). Regarding the affordability of ICTs, Munyua (2007) noted that the current ICT infrastructure, i.e. satellite infrastructure, is too expensive for many African countries to maintain.

Appropriateness is related to the language of the content that is delivered to rural users in countries like India and South Africa, which have 18 and 11 different official languages respectively. ICTs should therefore accommodate all the people in these countries (Media Explosion, 2009). Online education and the need for localized ICT content are two keys for the success of any new technology, product or service (Zanifa *et al*., 2010). Most of the ICT services in Africa are expensive for the majority of the poor people who need such services, hence the need for ICT planning, and proper business models for ICT developments to accommodate the poor in all areas (Zanifa *et al*., 2010). Rural ICT users are willing to learn how to use ICT devices, but in most cases foreign languages discourage many users. As noted by Lallana and Uy (2003), most websites are designed in English and rural ICT users are not always familiar with the language. According to Lallana and Uy (2003), technical, language and social diversity are some of the ICT barriers, and that rural users rarely understand online material, as was also indicated by Kimura (2010).

African governments are making efforts to enable rural people to access these services, but the majority of rural areas are still unreachable. As an example, in Kenya the government assisted TKL to reach the rural areas, but the company did not generate enough revenue from these areas and because it was making losses, the project failed (Noah *et al*., 2005). Many other African governments have tried to offer ICT services in rural areas with little success. This means that proper planning for the actual user needs and business models should be in place if service providers intend to invest in the rural areas of Africa and for the services to be accessible. Since 1990, there has been an improvement in accessing ICTs, though Africa still experiences poor connectivity (UNDP, 2005). Some of the challenges identified in the Eastern and Central African regions include lack of ICT resources, technological illiteracy, unreliable connectivity and language barriers (Munyua *et al*., 2003; Kalusopa, 2005).

Other factors cited include, a culture of less effective communication and shortage of ICT devices (May *et al*., 2007). Maru (2004) identified poor infrastructure, shortage of ICT skills, lack of connectivity and inability to develop advanced ICT applications as major challenges in Africa. Richardson (2006) identified a number of constraints including, unreliable connectivity and lack of technical skills and of ICT devices. Guislain *et al*. (2006:8) found that ICT connectity is not at the same rate in all places. These findings are in line with Heeks (2002), who mentions

lack of technical skills and lack of supporting ICT infrastructure as key challenges in developing nations.

Oreglia and co-authors (2011) have emphasized that underutilization of the present ICTs is a growing concern for rural areas, hence, instead of developing new technologies, product owners should use the existing infrastructure, i.e. mobile phones, TV and radio. The argument is that ICTs are present in poor areas but not all of them are being used. The author observed that many homes and schools in rural areas have at least one ICT device, but, not all are used. For example, many rural schools in the Eastern Cape province have computers which are lying idle, and in some homes ICTs are just ignored.

A study by Joseph and Andrew (2006) identified different challenges which could be the reason for the underutilization of ICTs. The list them as follows: some rural areas resistant to technological changes; ICT illiteracy; no adequate ICT regulations; drastic ICT changes; expensive internet access and equipment; shortage of power to operate ICTs; lack of ICT maintenance; no ICT awareness programmes; and ignorance.

There are many other ICT challenges in different areas which have been identified by several other authors. These include:

Low bandwidth: In a study done by rural ICT users, poor internet bandwidth is one of the main ICT challenge (Munyua, 2007). Most African countries do not have recent ICT infrastructure that can improve connectivity. As a result this affects service delivery and some possible ICT benefits such as job opportunities and fast communications.

Poor ICT policy development and implementation: Munyua *et al.* (2003) found that ICT polices were one of the key factors missing in many developing nations. May, Karugia and Ndokweni (2007) also arrived at the same conclusion. There are various ICT policies in many countries, e.g. to promote agriculture, but not all of these ICT policies are fully put into practice (Guislain *et al*., 2006:14).

Leaving out women in ICT initiatives: There is no doubt that women are critical in ICT developments in rural areas. The findings from a study conducted in Kenya confirmed that women with the same level of education as men will produce more than one fifth output in

agriculture than the men (Munyua, 2007). Therefore, the provision of ICT skills to women can result in more output of better quality, particularly in agriculture (World Bank 2006b:13,15). This could be essential to uplift the standards of living in rural areas.

Lack of ICT skills: Studies by ASARECA-RAIN in 2006 have shown that academic institutions in Africa are not offering essential ICT skills. As a result, many university graduates lack the required ICT skills. Again, the technological changes make it difficult for many rural ICT users to have the necessary ICT skills (RAIN 2006).

Lack of sustainable ICT initiatives: A variety of authors in different studies have realized that many ICT projects fail to benefit rural areas because of poor planning and improper models (Benjamin, 1999; Holmes *et al*., 1999, Heeks, 2002; Mayanja, 2002; Munyua, 2003; Kalusopa, 2005; Asaba, 2006). In other research, challenges in rural areas that affect ICT developments as explained by Pitke (2007) and Wire (2008) are:

- Shortage of basic commodities such as water, public roads and power supply
- Physical obstruction such as mountains, poor terrain, steep areas affecting smooth telecommunications networks
- Unreliable weather conditions.

All these challenges are common in most rural areas and determine how ICT services should be deployed. According to Tiamiy, Bankole and Agbonlahor (2012), physical challenges make it difficult to connect rural areas, as supported by a research done by Informa Telecoms & Media (2010) on rural connectivity. Close to 75% of the population engaged mentioned that better access to ICTs and infrastructure is "very important" to their business. The other 25% also highlighted that it could be moderately important" (Africom Report, 2010). The same report also produced findings on the importance of power supply with reliable electricity for the success of ICTs. ICT challenges have encouraged ICT stakeholders to come up with various solutions and means to improve ICT service delivery. Of course, the author appreciates a lot of the efforts and ICT projects which are currently underway in many developing nations to improve ICT developments. There is a lot of work by different ICT stakeholders, including governments, NGOs, private companies and individuals to enable easy ICT penetration in rural areas. The most

popular one is improved network infrastructure which encourages connectivity and this has been encouraged by different ICT stakeholders' efforts as explained in the next section.

Telecommunication companies in Africa, for example in Kenya, have tried to find better ways of offering services so that people can afford them. Internet service providers are also coming up with better pricing strategies such as cyber cafes in Kenya to overcome other costs and making services affordable (Noah, *et al*., 2005). Competition from different service providers in the mobile industry has seen most services available at lower prices. As an example, most mobile providers like MTN South Africa use the call per second pricing strategy to enable services to be affordable. Different charging methods are being used in many African countries so that the poor in these areas can also afford to pay for ICT services.

The South African Government has an infrastructural plan to connect all the rural areas and improve access to ICTs in poor communities (DOC, 2010). This has been encouraged by the Department of Communications. This is to address the needs of the majority who are in rural areas. The planned infrastructural plan is necessary for South African rural areas to address the needs of over 18 million people who are living in these areas (DOC, 2010). This is the reason that an ICT framework is needed that can equip rural ICT users with necessary skills. Government support is necessary for ICTs to fully benefit rural communities. The planned solution is to improve food production and develop the economy in rural areas. The South African government seeks to have electronic transactions that are cost effective and to improve transport services. These services could encourage eCommerce transactions to improve marketing information. The idea of the government is to facilitate the broadcasting digital policy. This should create the digital change-over to support various ICT devices.This has encouraged the development of a plan to fully implement a broadband infrastructure. This covers both wireless and fixed infrastructure.

According to the Department of Communications (2010), the broadband is intended to offer the following:

- ICT skills for all rural people
- ICT awareness programmes to educate and share ICT information;
- ICT education and youth empowerment and also all other age groups
- Promote technopreneurship and ICTs for business use in rural areas
- Enable information sharing and distribution through public community centres
- Identify possible ICT devices necessary and usable in rural areas.

During the literature review, the author noticed that almost all governments in developing nations have strategic places for ICTs and intend to reach all the people through ICTs. Such government initiatives are considered for the roadmap development explained later in this thesis. Various ICT stakeholders are working together to come up with proper business models, ICT policies and applications that could allow poor areas to benefit from ICTs at low cost (Joseph & Andrew, 2006). It is vital to note the various technological changes and how they affect ICTs. The next section identifies some of the future ICT projections that are important to understand for all ICT stakeholders in implementing ICT initiatives.

2.8 ICT trends

ICT specialists are of the view that new ideas and technological applications will improve ICT service delivery in the near future (Munyua, 2007). Futurists predict that in the near future, new technologies could improve agriculture and ICT related services and that these will be witnessed in Africa (Veltman, 2003; Harris, 2004; ECA 2005). Juma and Yee-Cheong (2005:15) defined new technologies as "including new applications regardless of whether the technologies have been used in other parts of the world and include the use of latest applications such as nanotechnologies and new materials". The United Nations Conference on Trade and Development (UNCTAD) (2007) further emphasized this point and stated that innovative solutions in farming sector are important in providing ideas and equipping rural people with required knowledge. The changing environment has affected the ICT devices for accessing ICTsduring the past 20 years (McGowan, 2003). The most notable change has been the

development of increasingly lighter, more portable ICT devices with higher memory storage capacity. Rather than looking broadly at all technological advances, the research focuses on considering inventions that affect sharing of information through ICT applications (Change Management, 2007). Some common ICT devices include mobile phones, laptops, wireless devices, radio and advanced TVs.

There is a lot of literature on different ICT future projections throughout the world. Researchers and futurists have talked about and projected many of the expected services or ICTs in future. In this thesis the author has considered some of the ICTs currently in place and other future projections. The author has noticed that some ICTs or services are already available in some parts of the world, but have not reached others. For example, most of the ICTs in developed nations are not yet available in developing nations, and are still to reach rural areas. The ICT trends below are from the findings of the research which was done by the International Development Research Centre (IDRC) in (2007). The following ICTs are available in the rural areas of some of developing nations:

Mobile applications: Mobile applications have benefited plenty of users in rural areas. The main area where the mobile applications have dominated is in farming. Most farmers in rural areas now rely on mobile applications for most of the farming activities like marketing information, weather updates and tracking of animals. According to Guislain *et al*. (2006) the developments in mobile applications and mobile phone usage have reduced cost for service access including employment searching. Bertolini (2004) found that the mobile phone is one of the most used ICT devices in agriculture within Africa. The findings by Rao (2007) indicate that close to a billion people will be using the mobile internet in the near future. This is an increase from previous years and the number continues to increase.

Electronic-based applications: Harris (2004) believes that the ICT web-based systems being developed continue to increase and attract more users. The web will influence the growth of internet users. The use of electronic applications is affected by poor power supply, however. Of course, the challenges are being addressed in most countries with various ICT means and solutions. For instance, in Burkina Faso, internet and computer usage have been encouraged, especially for women. In Benin, agricultural extension officers use the internet to share information with farmers (Munyua, 2007). Searching for markets and sharing of information is

also a popular use of the internet in Cameroon. The same is also witnessed in Mali, where telecentres are used to provide access to the internet and where information is also shared through the radio. This has helped to equip poor communities with relevant information on health, education and agriculture (Munyua, 2007). All these services are meant to improve service delivery and rural living standards.

Frequency Modulated (FM) or public radio stations: The radio remains the most common ICT device for sharing information in rural areas (Girard 2003). According to Harris (2004) the radio has been useful and important for rural farmers to share information on available markets for many years. The Zambian Radio Farm Forum (RFF) is an example of how the radio is an important ICT device for communications in poorly resourced areas (Munyua, 2007). The programme was initiated in the 1960s to improve information dissemination to Zambian farmers.

Satellite radio: This is now a common form of radio transmission that makes it possible to disseminate information to poor communities even in the absence of the internet (Munyua, 2007). However, findings indicated that the charges required for satellite radio in countries like Kenya affect the deployment of these services. As a result, some NGOs such as Open Knowledge Network (OKN) are providing low-cost solutions to promote satellite radios.

GIS, decision support systems: Geographical Information System (GIS) is "an information technology that links activities in the field and the office, and allows for comparisons between different types of agricultural data" (GIS, 2007). This has been a popular technique used in dairy projects and livestock monitoring mainly in Kenya. Some organizations are planning to use GIS as a forecasting technique for future purposes. For instance, the Kenya Agricultural Commodity Exchange (KACE) plans to use GIS to estimate the output of the produce and geographical coverage (Munyua, 2007).

Handheld devices: Mobile phones are the most common handheld device popular in Africa (Munyau, 2007). The advantages of handheld devices are their portability and the fact that instant information is always available. The use of wireless infrastructure makes these devices appropriate for accessing information. Again, such devices can also be useful in utilizing applications such as GIS and decision support systems (GIS, 2007). Handheld devices allow ICT users to receive solutions quickly at any time and reduce travelling costs (Munyua, 2007). ICT service providers are improving the original, traditional web services and applications to fully

utilize handheld devices by developing applications that can be accessed on these handheld devices.

2.9 Future ICT projections

Changes in technology have encouraged researchers and futurists to think of the future. For the purpose of this thesis, the author used Gartner's (2010) projections, as they provide a good summary of projections for 2010 and beyond. They give an explanation of the general applicability of future developments and are important in analyzing the projections to be considered later in this thesis. The Gartner projections include:

Growth of cloud computing services: Gartner sees many companies focusing more on cloud computing services. The research by Gartner (2010) indicated that most companies are going to offer cloud-based solutions. This is encouraged by the growth of cloud computing.

The growth of Facebook as social networks grows: Gartner suggests that Facebook is going to continue as the leading social networking application. It is going to outnumber all the other social networks and could be used in all areas in both business and for communication purposes. Other social networks such as Twitter will be available and continue to grow, but Facebook will remain the most common social network (Gartner, 2010).

Increase of electronic transaction users: More people continue to use the internet in doing business. The increase is expected to grow even for the older population, with above 3 billion of the mature population in the world likely to use electronic business transactions (Gartner, 2010). This number is encouraged by the growth of mobile internet usage, mainly in the emerging markets of Africa and Asia. Furthermore, the increase of computer peripherals raises the opportunities for electronic transactions (Gartner, 2010). For example, it is projected that by 2015, the total of used smartphones and advanced electronic devices will grow above 1,5 billion units and this is going to be more than the installed base computers (Gartner, 2010).

The summary of Gartner Special Report's findings on the future of ICTs indicates that the following will be the main notable developments: cloud computing, social networking, sustainability, mobile computing and internet marketing. The author has considered these projections and appreciates that there are other projections such as the spread of intelligent systems, audio-based applications and the growth of the semantic web. Different technological

futurists have made projections on future technological changes. These changes will affect services, trends and devices to be used.

For example, a study by Rao (2011) predicted that handheld devices will continue to increase to above 80% of global mobile traffic by 2015. The author has observed that most of the developments are slowly reaching some areas in Africa, though there are different challenges and delaying factors. The projections discussed are the ones which were noted during the time of the research and the authors accepts that many other new changes could be witnessed in future, but for the time being this chapter has covered the common projections. These projections have been supported by existing information and statistics. The following section covers the current literature on different technological projections.

Mobile devices: This ICT device is vital in searching for employment. Research conducted by the African Technology Development (2005) shows that over 20% of the people use mobile phones to search for jobs. At the same time more than 80% of entrepreneurs in South Africa use mobile phones for business transactions. The use of mobile phones for accessing various personal services continues to grow in various parts of the world (Technology Development Forum, 2005).

Internet usage: The internet is currently available in various parts of the world and many people have access to it. There is no discrimination on internet access as no racial discrimination is found in using the internet (Anderson & Rainie, 2008). The internet is a database of information and interactive tools that allows users to access information any time, anywhere, and enables business services for both private and public sectors (Anderson & Rainie, 2008).

Cloud computing: **"**Cloud computing is the next natural step in the evolution of on-demand information technology services and products. The Cloud is a metaphor for the Internet, based on how it is depicted in computer network diagrams, and is an abstraction for the complex infrastructure it conceals" (Mirzaei, 2010). "Cloud computing is a paradigm that focuses on sharing data and computations over a scalable network of nodes. Examples of such nodes include end user computers, data centers, and Web Services. The term for such a network of nodes as a cloud" ((Mirzaei, 2010)) Cloud computing means "reduced information technology overhead for the end-user, great flexibility and reduced total cost of owning resource and storage" (Kanwar, Singh & Modi, 2013).

Social networking: Social networks enable communication with different people, and can be used to boost businesses transactions. Examples of social networks include social media sites such as Twitter, Facebook, and MySpace (Ellison & Boyd, 2008). For, all African countries it is clear that proper ICT infrastructure is required to enable ICT service access at different places. This could enable poor areas to benefit from the proposed future services (Adam, 2009). Proper ICT infrastructure could encourage services such as social networking to grow in all parts of the world, including the rural areas.

2.10 Future projections for developed nations

During the literature study on the technological projections, the author found that there are some projections which have been talked of more in Europe than in developing nations. For example, a study conducted in Finland produced the following key ICT future projections: social networks, cloud computing, openness, ubiquitous communication, cognitive systems, digitalisation, online services, data eplosion, green ICT, globalisation and smart spaces (Ruuska *et al*., 2010).

On the other hand, the developing nations are mainly talking of the following as the future of ICTs: well networked environments, human language technologies, portable devices, open-source applications and internet services. The author has also noticed that there are variations in the applicability of these projections in some areas. Some of the projections are already happening in various areas, while in other places they are yet to be deployed. Therefore, there is a gap and different factors and challenges which affect the deployment of these projections. The author feels that a lot of ICT development and planning needs to be done in many developing nations, especially in rural areas to be able to apply some of the projections.

In support of the various future projections, one of the ICT experts said:

> *In general, I think, cloud computing is such a thing that might change a lot, specifically if there would be a flexible cloud computing concept which is similar to the applications. In my opinion, mobile is such a platform which can be more widely used if cloud computing is used. This might even lead to situations where normal applications meant to be used by normal computers can more easily be imported to the mobile environment. Until now the problem with mobile devices has been*

the bandwidth and the other problem is the power consumption. The batteries are a big problem. Therefore cloud computing might help with these problems.[4]

Factors affecting the technological projections: From a summary of existing literature researched by the author there are different factors encouraging the implementation of different projections in some areas such as: improved infrastructure, growth of mobile usage, ICT education, access to global markets, and growth of social networks, cheaper mobile phones, and deregulation polices, internet availability, improved bandwidth. These have been encouraged by efforts by governments, non-Governmental organizations and individuals in attempting to improve ICTs.

However, it should be noted that there are still challenges and factors which make it difficult for most of the projections to be achieved. These are: poor infrastructure, no access to computers, high illiteracy, low income, low bandwidth, socio-cultural barriers, poor connectivity, government policies, and shortage of ICT educators, no power supply, and security challenges. Again, the literature review undertaken in this research showed that the above factors are key barriers to ICT developments in rural areas. These factors are common in almost all rural areas of Africa and determine the pace at which technology is accepted and reaches people in different areas.

For developing nations where resources are scarce, cloud computing offers some benefits such as: easy access of services, improve efficiency in processing transactions, low cost of accessing services (Mirzaei, 2010). However, to realize the full benefits of cloud computing, users must be educated on how the data is kept private and secured and also have trust in data that is available (Mirzaei, 2010). To fully utilize and benefit from future projected services, i.e. cloud computing, there is need to consider some factors which are present in rural African communities (Jere, *et al.* 2011).

[4]The views of Aalto University ICT expert Mikahli Euro (2011) on key technological projections.

For example;

- Most rural areas do not have internet connectivity.
- Most rural people cannot afford any ICT device, even the cheapest ones
- High technological illiteracy that could affect the use of cloud computing
- Bandwidth is still low in Africa.

The other factors that affect progress in some future projected services have also been noticed based on the current ICT status of some areas. Despite the fact that the number of web users is over 50 million in the world, it was found that only 5% of Africans have access to the internet (Smith, 2008). The cost of ICT services is beyond the reach of many, including the broadband cost, and this will affect service deployments in other areas. The high cost of operating systems and ICT applications make it difficult for many people to benefit from ICT services (Smith, 2008). The shortage of power supply and failure to have appropriate ICT services that address local needs affect ICT usage (Smith, 2008) and make it difficult to deploy the infrastructure that is necessary to support ICT services in various parts of Africa.

There are some positive statistics that can encourage the achievements of the ICT projections. For instance, the growth of monthly web browsers and internet users, with close to 50% active internet users in South Africa alone, is a good indication of how the internet will continue to be used (MacInnis, 2009). However, it was still noted that the internet has achieved less penetration in Africa than on any other inhabited continent. However, there are still some positive developments that encourage increased adoption of future ICTs. For instance, the continuous growth of mobile subscribers in emerging markets, where over 60% of the world population has mobile access (MacInnis, 2009) means that there are higher success chances of ICT developments in emerging countries. The low income earners are likely to be able to own personal mobile phones as the cost continues to drop for basic mobile phones as a result of more efficient network equipment and more affordable handsets (African Technology Development Forum Report, 2005).

The findings of an American survey (2010) show that level of education affects internet usage. As an example, those who have higher qualifications tend to use the internet more than those with lower qualifications. Individuals with university degrees are eight times likely to own personal computers than those without a degree (American Survey, 2010). The author noted that various ICT stakeholders should continue to work together to plan for the future of ICTs. In this thesis, the use of a technology roadmap is proposed as a sustainable ICT plan to be considered for ICT developments and more information on roadmaps is covered in the next chapter.

2.11 Chapter summary

The chapter has focused on explaining ICT developments through service delivery, ICT challenges and various ICT solutions. This chapter gives an overview of current ICT trends, which is important for developing an ICT roadmap framework. There are plenty of initiatives from ICT stakeholders to ensure that ICTs benefit the people. These initiatives are mainly driven by technological changes. It is worth mentioning that there are also common challenges faced in trying to improve ICTs in preparing for the future. In addition, there are also factors affecting individual areas and communities which create great variations in the progress of ICT all over the world. As a result, there are different ICT service expectations across the world based on the users' experiences within communities. Based on all these findings, the author agrees that proper ICT planning through a roadmap could be a useful initiative to prepare for the future. ICT solution such as technical business models could improve ICT developments in poor communities. The roadmap framework is proposed as a solution to prepare for the future of ICTs as a way to ensure ICT sustainability through roadmap planning. The literature review has provided a better understanding of ICT trends in different parts of the world. Most of the ideas raised in this chapter were important for the assessment of the ICT roadmap methodological framework in Chapter 7. The author appreciates that the dynamic environment affects ICT developments. The next chapter gives the overview of technology roadmaps necessary for preparing for an ICT solution through an ICT roadmap methodological framework.

Chapter 3:
TECHNOLOGY ROADMAP OVERVIEW

Different companies and research institutions develop roadmaps, plan for the future and improve long-term decisions. Roadmapping requires coming together of various stakeholders with plenty of ideas. The roadmap forecasts on what is required for the future. It is an innovative solution that explains what the future holds.[5]

3.1 Introduction

This chapter gives an overview of roadmaps. Technological roadmaps are also popular as a way to plan for ICTs. Of course, the majority of technological roadmaps are not appropriate for this thesis, the focus is on ICT roadmaps. The current literature at the time of this research shows that not much that has been written on ICT roadmaps in rural areas, though different countries have ICT development plans. The literature has shown that there are gaps between ICT initiatives meant for developed nations, cities and towns and those meant for rural areas.

The trends in ICTs and the variations within ICT developments, explained in the previous chapter, encourage ICT stakeholders to think about proper ICT planning to achieve ICT sustainability. The author accepts that there are several initiatives which are currently underway to improve ICTs. Some of those which are well noted include sustainable ICT models, frameworks, architectures and, at times, business models. The failure rates of ICT projects require something that brings all ICT stakeholders together, including the community members, coupled with inspired debate regarding current ICT trends and a look at the future, focusing on technological changes. This idea has led to the discussion of the roadmaps in this section. This chapter provides an overview of roadmaps by concentrating on technological roadmaps. An understanding of the roadmaps, components, requirements, successes, benefits and challenges allows for a broader understanding of the requirements of the roadmaps; this was used later in this thesis so as to develop the roadmap framework.

[5]Technology roadmap view by Prof. Marko Nieminen – Aalto University (Department of Engineering and Management).

3.2 Overview of roadmaps

More than 1,300 public-domain roadmap documents are currently available in the area of science and technology (Phaal, Farrukh & Probert, 2010). These roadmaps are available online, clustered into broad themes for different categories, and are used by different companies. The roadmaps are all in the form of documents that can be readily downloaded from the internet. The term 'roadmap' has been commonly used in the past few years, and many 'traditional' technology, science, research and product roadmaps, as well as samples of less conventional uses of the term have been collected for illustrative purposes (Phaal *et al*., 2010). Roadmapping is currently one of the vital techniques to predict technological changes and align with the strategic business objectives to enable decision making (Camarinha-Matos, 2004).

The advantage of roadmapping is that it provides necessary details that determine the technological requirements and new ways of research and development which allow new ways of investing (Camarinha-Matos, 2004; Vähäniitty, 2006). It should be noticed that, to date, there is no common definition of a roadmap as it varies from one organization to another. Hence, various means and ideas from roadmap developers are required in creating roadmaps (Vähäniitty, 2006). Various authors define a roadmap as an appropriate planning process required to determine future trends. Galvin (1998) defines a 'roadmap' as a collection of future trends from different sources and determining key technological forces that bring about change. Vähäniitty *et al*. (2006) define road mapping as a research process that considers the technological components which lead to new changes for a particular organization within a specified time frame. The roadmapping process defines, analyses and selects long-term tactical options that are communicated within an organization to improve the decision-making process.

According to Da Costa *et al*. (2003), technology roadmapping is defined as a "variety of techniques to determine the future using different ideas and expert views taking into account the technological changes and the business environment". The main points in these definitions include the importance of coming together of various experts, sharing of ideas, and understanding and the continual review of certain stages during the roadmap development process.

Roadmaps are responsible for sharing the directions and are able to identify key directions for government and business organizations (Da Costa *et al*., 2003). As an approach, the roadmap is the most frequently cited good *communication approach*. Roadmapping requires that different parties come together, share ideas and reach an agreement. A successful roadmap can be used as a point of reference and for planning purposes (Phaal & Probert, 2009). Bruce and Fine (2005) state that roadmaps give a proper platform for considering what is going to happen. Various futures researchers have classified roadmaps into different types, as indicated in the section below.

The public domain from the University of the Cambridge contains more than 2,000 types of roadmaps (Phaal, 2011). These different types are also available on the internet. Some of the common types of roadmaps include the following: roadmaps for chemistry, construction, defence, energy, healthcare, business and industry, manufacturing, nanotechnology, policy, government, community, science software and information communication technology (ICT). Another survey on the types of roadmaps has also shown that almost 1,000 roadmaps exist from a variety of industries such as energy, transport, electronics, aerospace, ICT, healthcare, defence, energy, engineering, electronics and pure science (Phaal & Probert, 2009).

In 2003, during a Dutch-sponsored study on roadmaps, it was reported that there are more than 78 roadmap initiatives available in European countries, America and Asia (De Laat, 2003). The key issues from the findings indicate the following: the most common types of roadmaps from the study were those used in industry. This includes their use in areas such as: chemicals, metals, electronics and semiconductors. The author accepts these definitions and has used the key words of each of the definitions in developing the framework discussed later in this thesis. These definitions suggest the coming together of different stakeholders in order to plan, look ahead and provide a reference tool for other people to use as reference. The same was done in this research, as the proposed roadmap framework can be used as a reference model by different ICT stakeholders when developing sustainable solutions or ICT roadmaps. It should also be noted that the presence of several types of roadmaps was considered and, for this thesis, only the technological roadmap is used as the basis for the ICT roadmap.

3.3 Technology roadmaps

Technology roadmaps are now used by companies, government and research institutes. They are used in various domains such as government policy formulation. There are different forms of roadmaps and these depend on the purpose of the roadmap as well as the targeted area (Bruce & Fine, 2005). Some authors have also noted that roadmapping has attracted academic institutions (Roadmap Report, 2003).

The researcher has observed that most companies, mainly in developed nations, are now using the roadmap approach. Of course, many developing nations have also seen the need for roadmaps; this has made roadmaps popular in countries such as India, Bangladesh, Pakistan and the Philippines. In Africa, roadmaps are now becoming popular, i.e. in South Africa, Lesotho, Egypt and Nigeria. It is also worthwhile to note that most of the technological roadmaps in developing nations are primarily under the category of policy, government and community. It seems as if roadmaps could be developed for different reasons, mainly when one has to do an analysis of roadmaps within developed and developing nations. For example, during the study of existing roadmaps, it was found that most roadmaps in developed nations are designed to improve business growth, largely in industry. Meanwhile, in developing nations, most roadmaps focus on empowering people with the required services, mainly in ICT.

After the development of technological roadmaps in the early 1970s by Motorola, various companies have adopted this planning idea (Blackwell *et al.*, 2008). Roadmaps improve the alignment of the technological changes and the overall future plans of the business. The roadmapping process is dynamic and considers changes that are likely to take place, and thus can be adjusted to satisfy any business environment (Blackwell *et al.*, 2008; Phaal & Probert, 2009). To date, there are many types of roadmaps which are available and many organizations are using roadmaps to plan for the future. The availability of a roadmap encourages the sharing of ideas and information, thus making it a source of reference. This allows for decision making and planning, both at a national and local level. As highlighted by Bruce and Fine (2005), a lot of work has been done on roadmapping and there are a number of case studies and research projects that are in line with technology roadmapping. Academia, industry, government and communities all have a different role to play in roadmap development (Smith, 1995).

3.4 Roadmap requirements

According to Phaal *et al*. (2010), proper planning, the commitment of stakeholders and senior management, clear understanding of the problem and follow-up are some of the key ingredients for a successful roadmap. Bruce and Fine (2005) noted that roadmaps require a social and collaborative process, a proper future planning method and a means of representing the key targets and goals of the roadmap. This could be done using visuals, graphics or statements. In 2002, "one of the European roadmap developments conducted about 10 workshops for the duration of almost a year, with over 150 future experts from 60 different affiliations such as industry, academia and government" (Kaplan, 2004: 12,13). Workshops enable the sharing of ideas and various changes that are taking place in different industries. This offers further explanation of and elaboration upon the key ideas necessary to improving the success of roadmaps (Kaplan, 2004). Well organized workshops gather different research experts from a variety of fields; this is critical in understanding how technological changes could affect different organizations. Further consultations with the wider community improve the quality of the workshop results (Phaal & Probert, 2009).

Bruce and Fine (2005) noted that roadmapping workshops give researchers time to discuss what is to come and to share different ideas on the subject domain on which the roadmap is focused. Furthermore, a successful roadmap process involves many people in the domain with different backgrounds and experiences. The following are some of the requirements and steps for a successful roadmap, as identified by Kaplan (2004):

- Clearly defined goals and focus
- Monitoring the impact of the roadmap
- Continuously revising, repeating, modifying and reviewing in order to accommodate changes
- Close check-up and assessment of the roadmapping process.

It should be noted that roadmaps are very popular in more developed nations. In each of these categories there are several examples of available roadmaps. Of course, during the literature review on the roadmap, the author noticed that some roadmaps are more popular than others. For example, there are not many roadmaps for ICT eServices. Of course, understanding roadmap requirements helped in the overall roadmap framework methodological process.

3.5 Approaches to roadmaps

The roadmap approach comes in different forms and there is no fixed approach for roadmap development. The roadmap can be represented in different forms, i.e. as text or diagrams. The other approach is through the development of a framework for the creation of roadmaps. The key questions to which the roadmap provides answers, as indicated by Phaal and Probert (2009), are:

- *Where are we now? Where do we want to go? How can we get there?*
- *Why do we need to act? What should we do? How should we do it? By when should it be done?*

Another source on key roadmap questions, as indicated by the RURAL WINS (2004), suggests that a strategic roadmap needs to answer the following in a simple, easily understood format:

- *We are 'here' – the current baseline situation*
- *We want to get 'there' – the vision and plans*
- *Timescale*: *by 2005, by 2010, etc.*

To answer the above, the process of the roadmap requires planning and understanding of the subject targeted for the roadmap, i.e. the study on the current stet of ICTs, future ICTs and development of the methodological framework, as explained in the thesis. Several methods are used to prepare for roadmap development. One of these methods is workshops; these allow for communication and networking with different experts in the area of study. Well planned workshops create a clear understanding of the actions required for the development of the roadmap. As supported by Smith (2005), a roadmap workshop is very important at the beginning of the process. Phaal *et al*. (2010) mentioned that workshops enable an understanding of the key issues of concern and areas of interest. This allows for the development of a roadmap that addresses the exact issues that are needed in a particular domain.

A roadmap approach also involves a needs assessment (Da Costa *et al*., 2003). Having a good idea of the needs allows the drafting of important questions which are crucial for the roadmap, such as: What would the need of the roadmap be? How would the roadmap be used? Who should use the roadmap and for what benefit? This is later explained in Chapter 7 of this thesis. According to Smith (2005), the emphasis of the roadmap should be on the need to clearly specify the boundaries and to involve the key stakeholders in the roadmap. These stakeholders include

industry, government, suppliers, customers and academia. The roadmap should clearly specify the different stakeholders involved and the role of each.

Da Costa *et al*. (2003) state that after development and implementation, proper validation and evaluation of the roadmap is required. This is an important process that should involve all stakeholders so that the benefits of the roadmap are explained and shared. Bruce and Fine (2005) are of the view that technology S-curves are usually used to represent the technology life cycle. The explanation is that, as changes occur, the development progress follows a constant period of time until it flattens out. The S-curve is a popular technique used in roadmapping. Smith (2005), of Technology Futures Inc., quoting Bob Galvin, said that the essence of the roadmap is to ensure that the current state of business has to be considered to determine the exact technology (Richey & Grinnell, 2004). Examples of key steps to take for roadmap planning, as noted by Smith (2005), include:

- Identifying the timeframe for the roadmap plan
- Selecting technology areas for roadmaps
- Clearly outlining the vision of the future
- Selecting of appropriate technologies.

3.6 Importance of roadmaps

From a survey that was conducted in the United Kingdom on about 2,000 manufacturing companies, it was found that close to 10% of companies have already implemented technology roadmaps. Eighty per cent of UK companies have used roadmaps and continue to use the roadmap process (Phaal, Farrukh & Probert, 2000). This was further supported in a study conducted at a later stage, by the same author with other co-authors, in 2009 (Phaal *et al*., 2010). There is a greater chance of business success if technology roadmapping is properly conducted and implemented (Phaal *et al*., 2009). According to Phaal *et al*. (2009), roadmapping can improve business plans, allocation of resources and communication processes within the organization and enhances strategic planning within an organization.

Grinnell *et al*. (2002), based on the Motorola case study, noted the following benefits of the roadmap. They posited that it:

- Assists in business planning
- Enables the user to see changes in the future

In addition to these benefits, Bruce and Fine (2005) explained that roadmaps are important as they establish a vision for the future and they accelerate innovation. They also explained that roadmaps provide a guide for scientific research and government funding. Roadmaps can improve ICT developments in rural areas, and Section 7.3 explains more details on the benefits of roadmaps in rural areas. The author found that developing nations such as Pakistan, the Philippines, Bangladesh, Malaysia, South Africa and Lesotho have used roadmaps as a planning technique to reach all people in their respective countries.

3.7 Characteristics of roadmaps

Using the ideas raised by Phaal *et al*. (2009), the key characteristics of roadmaps are outlined in this section: A successful roadmap should allow the following:

- Bringing in different parties with a vast range of experiences in different areas
- Encouraging effective communication among stakeholders
- Improving the alignment of technological changes to the overall business goals
- Providing knowledge to other stakeholders and acting as a reference tool
- Clearly define and give the time dimensions with specific technology trends
- Can be represented in various ways, i.e. graphical, document or text
- Highlighting the long term plan of an organisation.

These characteristics are important as they help roadmap developers recognise how to and what to come up with. Roadmaps allow companies to trace the current situation and what is expected in the near future and in the long run, hence, making the roadmap a proper reference tool within an organization so as to show where the organization is and where it is going.

3.8 Challenges and factors affecting roadmaps

Most organizations fail to effectively benefit from roadmapping because of the complexity of the roadmapping process. The inclusion of various ideas and different suggestions tends to create, in some instances, confusion within organizations (Phaal, Farrukh & Probert, 2004). Bruce & Fine (2005) found that roadmapping takes time and utilizes much equipment, in situations where various stakeholders are engaged. It was also noted that it is difficult to determine how to represent the roadmap in terms of applying a format that clearly explains how the roadmap was constructed; for example, whether to use graphs, diagrams, or statements to represent the output. Furthermore, rapid technological changes mean that roadmaps become outdated quickly. The author discovered that many roadmaps fail to address the required needs and, as a result, do not benefit the targeted people. In addition, not all key stakeholders are involved. For example, in the case of roadmaps for rural areas, rarely are rural people engaged; this reduces the success rate of roadmaps. There could be various factors that enable the success of roadmaps, as explained by the research survey outlined below:

Based on a survey of 2,000 companies, conducted in the UK, there are several factors that have to be considered for successful roadmap implementation. More than half of the firms mention the need for the following: straightforward goals and IT business direction, engagement of the proper team of stakeholders and constant management support (Phaal *et al*., 2009). In cases where these are considered, there is a greater chance of roadmap development success. Moreover, there are some factors that could negatively affect the development of a roadmap. These may include: lack of proper planning, insufficient knowledge on the field and lack of top management support (Phaal *et al*., 2009). The summary of the study by Phaal *et al*. (2009), in Figure 3:1 clearly specifies the requirements of a successful development of a roadmap.

Figure 3:1 shows findings from a study on the success and failure of technology roadmaps.

Success factors of roadmaps (from a study of 2000 UK companies)	
Success factor	% contribution
Understanding the users' needs	75%
Involving the right people (stakeholders)	65%
Commitment of senior officials	69%
Timing of initiatives	45%
Desire to effectively develop successful project	58%
Barriers to success of roadmaps (from a study of 2000 UK companies	
Lack of required data	65%
Lack of clear and effective process	32%
Lack of effective facilitation	33%

Figure 3:1 Factors affecting roadmaps. Extracted from Phaal *et al.* (2009)

The author has used these findings and considered the key factors required in the development of the roadmap framework. Figure 3:1 shows that there is a need to have an understanding on the users' needs, to have the input of all the key stakeholders and the commitment of senior officials in the roadmap development process. The targeted communities should be ready and motivated to cooperate in the road mapping process. These factors clearly affect roadmap developments. At this point, the researcher is merely listing the factors and later, in Chapter 6, where the roadmap framework requirements are explained, more details will be provided in this regard. The combination of all this can lead to successful roadmap development.

3.9 Roadmaps for developing nations

Whilst conducting the literature review, the author noticed differences between the common roadmaps which are currently available. As indicated earlier in this chapter, most of the roadmaps have been developed in more developed and advanced nations such as Europe and America. The author, however, also found some roadmaps in use within developing nations; this was observed mainly in Asia and Africa. The most common difference observed is that most of the current roadmaps in developing nations are created by the governments, and they focus primary on ICTs. In this research roadmaps for five developing nations were considered. The nations are South Africa, Pakistan, Bangladesh, the Philippines, Lesotho and Malaysia. An analysis of the existing ICT roadmaps in these developing nations is offered below.

The ICT roadmap for Bangladesh was developed by the government of Bangladesh to empower its people with ICT services. It focused on improving public services to the people and offering ICT education through technology (Bangladesh Roadmap Report, 2008). The Bangladesh ICT roadmap was citizen centered and was meant for all the people in the country.

In the Philippines' ICT roadmap plan draft document (2006), it was stated that the Philippines roadmap had the theme, "*The future has come*, let's prepare for it now". The Philippine government has noted the economic benefits of ICTs. The proper ICT roadmap plan was compiled by Ramon (2006), supporting the ideas which were raised in the Philippines' ICT roadmap plan draft document of the same year. Thus, the focus of the roadmap was to clearly plan and state the government's strategies and programmes which were meant to enable its citizens to access ICT solutions (Ramon, 2006). The Philippine roadmap was prepared by senior government officials from the commission for Information and Communication Technology. This was achieved through meetings with different stakeholders from national and local government units and focus groups (Ramon, 2006). In addition, two workshops were conducted and two formal presentations were provided so as to share ideas and acquire the views of other key stakeholders. People from both the private and public sectors were invited to analyse the roadmap. It was emphasized throughout the process that the focus of the roadmap was the provision of ICT services which are accessible, available, secure, and sustainable to the citizens (Ramon, 2006).

In Pakistan, the government realized that several Pakistanis living in developed countries were contributing effectively and making successes of themselves in these nations, because of the improved ICTs available in these countries. The Pakistan vision for 2015 was based on the premise that if some of the best international practices in ICT usage are applied in Pakistan under joint action by all stakeholders then, by 2015, Pakistan would be developed. Hence, the ICT roadmap for Pakistan focused on addressing the key services needed, which could be accessible with the use of ICTs (Jaffri, 2008). The idea was to provide these services to all citizens. Some of the services mentioned were the provision of access to education for all, as well as health, good governance, jobs, knowledge and economic opportunities for all (Jaffri, 2008). The main goal of the roadmap was to create awareness of the formation of the ICT commission of Pakistan. Planning meetings were held with the relevant stakeholders and the target was to accomplish this by 2015 (Jaffri, 2008).

The government of Malaysia identified the importance of ICTs to the national economy and planned to have an ICT roadmap of its own. A report to improve ICTs, which was prepared by the National Information Technology Council of Malaysia (2010), explains the government's strategy to improve ICTs. The focus of this strategy was to offer eServices to the people. Some of these services were: "eCommunity, eLearning, eSovereignty, eEconomy, ePublic services, eBusiness and eGovernment". The main priority in accessing these eServices was given to the public and the rural people of the country. The plan was to achieve this through the convergence of technology such as mobile telephony, internet and broadcasting (Dato, 2008). The future technological changes were considered and the current state of ICTs was also identified so as to prepare for the ICT roadmap. The focus of the Malaysian government in the ICT roadmap was to improve its efficiency within various sectors of the country (Dato, 2008).

The Government of South Africa, though the Department of Communications (DOC, 2010) accepts that ICTs are vital for offering and enabling rural development. The focus, in this regard, is to use ICTs in various areas such as: education, healthcare, small enterprises and agriculture (DOC, 2010). The Department of Communications initiated the development of ICTs after having discovered that almost half of the population of South African lives in rural areas. The Government planned to improve ICT access in these areas by drafting a roadmap strategy aimed

at connecting rural areas. The focus of the roadmap was to improve rural areas and reduce poverty in these communities, through ICTs. The plan is to achieve this by 2014.

The government of Lesotho – through the Ministry of Communications, Science and Technology – came up with an ICT Policy to guide the country in addressing the ICT challenges faced by the majority of the Basotho (Motsoahae, 2005). The policy was proposed to bring together the government, private sector and all the people. The idea was meant to gain understanding of ICT services and needs of the people so that the government can implement a solution that is people-centered (Motsoahae, 2005). The main idea of the policy was to identify the key areas that need to be developed so as to improve service delivery and empower the Basotho. The aim was to provide better ICT services to all the people, including those in the rural areas (Motsoahae, 2005). Their focus, in this regard, is primarily on offering ICT services to the people and ICT education. Some of the ICT services include: supporting infrastructure; access to education and fast delivery of ICT Services, i.e. eGovernment, eCommerce, eHealth; protecting the environment; ensuring gender equity; and youth empowerment (Motsoahae, 2005). The ICT roadmap's success will only be achieved through the commitment of the different stakeholders and government support.

3.10 Summary of roadmaps

The literature currently available on the roadmaps for developing nations indicates that governments in these nations play a significant role in ensuring enabling environments in their respective countries. The popular roadmaps are ICT roadmaps which focus on improving ICT services to citizens. The roadmaps attempt to address the key services required by the majority of people in developing nations. The author has, however, noticed that there are still a lot of ICT challenges in developing nations; these challenges hinder ICT services in many areas, especially rural areas. The researcher has learnt, from the relevant literature, that in order for the implementation and use of ICTs in Africa to be successful, there exists a need to work with government in focusing on agriculture, health, education and market information as well as engagement with rural communities in order to develop the relevant content. Rural schools should be used to arrange for ICT education and training. The public and private sectors, together with academia and other stakeholders, should come together to improve ICT deployment in low resource areas.

The presence of a vast range of types of roadmaps requires proper understanding of the actual needs to be addressed, so that the roadmap benefits the targeted domain. Da Costa *et al*. (2003) propose the idea that it is essential that the roadmap addresses the problems faced within a particular community. These challenges could be manifest in different forms, i.e. economic, social and political. It is integral that the designers gain an understanding of the people from the community which is targeted by the roadmap. Understanding the individuals from the targeted community helps to know which actual services are required and helps in designing a technological solution that solves the individual challenges. For instance, it was found that people do, at times, have access to innovative functions, but this does not mean that they will want and/or use the new ideas (Punie, 2003). This illustrates the need for an understanding on the people's social and economic circumstances and behavior so that the technological idea can benefit the community (Punie, 2003).

Most roadmaps are developed by companies, business organizations, and government departments. However, the roadmap discussed in this thesis is a unique one from the academia point of view. Nevertheless, the researcher interacted with companies, ICT stakeholders, government departments and other researchers in different institutions (Punie, 2003). The interesting question to have arisen from the literature review on roadmaps is: if there are thousands of roadmaps currently available, then why do we need another ICT roadmap?

3.11 Chapter summary

This chapter has explained current roadmaps which are done in different organisations. The understanding of literature on existing roadmaps gives more clarity on how roadmaps are developed, what has to be done, who is to be engaged and for what purpose the roadmap is developed. There is no doubt that ICTs are changing all over the world. The projections explained in the last two chapters are already a reality in many parts of the world. However, for these projections to reach all societies, there is a need for initiatives, planning and stakeholder engagement. There are numerous initiatives, from ICT stakeholders, which strive to ensure that ICTs benefit the people. These initiatives are largely driven by technological changes. It is worth mentioning that there are also common challenges faced in trying to improve ICTs in preparation for the future.

ICT developments in rural areas could be improved if proper planning is done. On the basis of future technological projections, general problems in rural areas, different ICT developments as well as the current status of eServices within the rural areas and technological changes, this thesis explains an ICT roadmap plan for African rural areas. The roadmap framework is proposed as a solution in preparing for the future of ICTs, as a way to ensure ICT sustainability. This literature has enabled the author to gain a better understanding of current roadmaps. It is in this chapter that the existence of other types of roadmaps was acknowledged. The understanding of current roadmaps gave the author clarity and better knowledge regarding the meaning, purpose and requirements of roadmaps. This has enabled the clear identification of gaps in the existing roadmaps that were crucial to the development of the ICT roadmap methodological framework. Chapter 4 explains the roadmap research methodology and a variety of studies which were done in preparation for the development of the roadmap methodological framework.

Chapter 4:
ICT ROADMAP METHODOLOGICAL APPROACH

The definition of the current situation and, of course, how to do the definition of the current state of the art and the current state of the practice: Who are the main researchers on this topic and what are the most important findings currently? How much do we know? … What are the future possibilities for eServices in rural areas? Then the first thing is to do a little literature review – what has been studied in that area so far… What are the communities that you have studied and how do people currently access those services in those areas?[6]

4.1 Introduction

This chapter explains the methodologies that were used in this research to understand the current state of ICTs and to plan for ICT developments. The author held workshops with several ICT experts in European countries, mainly in Finland, and with several ICT stakeholders with a strong rural background. Finland was chosen as the research country due to its success stories regarding ICT service delivery and government support to African countries on technological issues; this has motivated the author. Finland was number 3 in terms of technology developments at the time when this research began (Global IT report, 2010/11). Finnish ICT initiatives are found in many African and Asian counties such as South Africa, Namibia, Kenya, Tanzania, India and China (Global IT report, 2010/11). The analysis of future trends was necessary before the actual development of the roadmap could proceed and the author used workshops and interviews to gain different views and suggestions regarding the future. The researcher has quoted statements which were made during the workshops or interviews. The findings were grouped in different categories, for example, challenges in rural areas, factors affecting ICTs, ICT services expected and possible future projections.

[6] Technology roadmap view by Prof. Marko Nieminen – Aalto University (Department of Engineering and Management)

4.2 Research techniques

The nature of rural ICTs in Africa meant a set of methodologies was necessary to fully acquire knowledge from the key ICT stakeholders, i.e. ICT experts, rural people and government officials, as well as from the literature review. The methodology used to anticipate the future of ICTs is constructed from the current literature on ICT services. Most of the information used in this research includes the personal experiences of co-authors and interviews with selected ICT stakeholders. The methodologies are predominantly qualitative in nature; this encouraged a deeper understanding of the needs of community members (Bryman, 2004; Denzin & Lincoln, 2005). This helped to formulate a detailed ICT roadmap framework after a thorough review of numerous ICT roadmaps and an in-depth study of other related technological developments. ICT facilitated workshops were conducted with representatives from different ICT stakeholders in order to help in contributing to the development of the methodological framework.

The case studies, i.e. SLL, were useful in offering a clear understanding of the situation in the areas studied. Some of the research carried out in this study included a desktop survey, online communication over the internet and scrutiny of various sources from libraries. Several trips were made to selected institutions and rural areas. The set of research methodologies is explained in this section:

Interviews: These were aimed at rural ICT users and ICT experts, to explore the existing operation of ICTs and to clarify the needs associated with 'access to ICT services'. Furthermore, challenges associated with deployed ICTs, and suggestions for improvement were discussed during the interviews. ICT experts were also targeted for discussions on the future of ICTs. Several individuals in rural areas, such as school principals, government officials in ICT and other ICT stakeholders – such as individuals from the Nokia – were also involved in these interviews.

A focus group and narrative discussion: Focus group discussions are a means of obtaining information from people in a group; it is an interview with several people together on a specific topic or issue (Bryman, 2004:345). Focus groups usually involve a narrowly focused topic discussed by group members of equal status (Payne & Payne, 2004:103). Focus group discussions are normally used for the purpose of triangulation, or in conjunction with other data-gathering techniques (Barbour & Kitzinger, 1999:6; Cohen, Manion & Morrison 2007:376;

Denzin & Lincoln, 2005:704). Bloor, Robson & Frankland (2001:8, 12) pointed out that focus groups have a large part to play as a research method, alongside and complementing other methods. The focus group data may also be compared with other data, on the same topic, which has been gathered by other methods. The author successfully used this technique within the SLL where teachers, farmers, rural entrepreneurs, health practitioners, women, the old and young participated in the discussions so as to share their views on some of the services which they expected, the challenges affecting them and other ICT developments in the community.

The views of community members were gathered through a focus group discussion. This approach proved to be appropriate and effective as rural community members collaborated and agreed on the elaboration of their key needs. Most discussions were narrative descriptions of the existing needs associated with access to ICT services. The following research techniques were used to understand ICT trends within the rural community and how ICT experts analyse the ICTs:

- *Photography and audio recording*: Photographs were taken of the different people who met for the discussions, as well as of examples of ICT services and their operations. Audio recordings also supported the collection of discussions and narratives, to reflect the opinions of the local participants in the assessment. Data was stored on a voice recorder and later transcribed.

- *Workshops*: A few meetings were conducted with ICT experts and senior government officials. The workshops were used to gain more details, ideas and explanations regarding the roadmap strategy. In this respect, the visits to Finland during the research study were used to meet different ICT experts. In this regard, two separate workshops as well as interviews were held with several ICT experts, as well as individuals from the ICT industry – such as Nokia employees – government stakeholders and academics. The statistics of the people interviewed were provided earlier in this thesis.

- *Literature study, information gathering and expert-view analysis*: Literature on ICTs, roadmaps and ICT sustainable solutions was also considered for the successful development of the ICT roadmap framework. Current literature on both developed and developing nations and their rural areas was used to gain clarity on current ICT trends. Most of the findings from

the literature have been explained in the previous chapter and will continue in the later chapters of this thesis.

- *Case study approach*: In this case, the Siyakhula Living Lab and some rural areas such as Alice and Keiskammahoek, in the Eastern Cape Province of South Africa, were also considered. ICT users in these communities were interviewed and farmers, teachers, youth, old people, health practitioners and rural entrepreneurs shared their ICT experiences within their respective areas, through community engagement. This offered the researcher with better ideas on the views of rural people on the future of ICTs, the challenges which they face and some of the ICT services expected by different users. Most of these were explained in the previous chapter and were used for the roadmap development. Observations were also important in supporting the case study approach, as some of the data was recorded through observation.
- *Observation*: This is described as a powerful tool for gaining insight into situations (Cohen, Manion & Morrison, 2000: 315). Individuals are observed by noticing how they behave, act and react to a particular scenario and conclusions are made by the observer (Robson, 2002:309). Observation is considered important in research as it allows the researcher to assess what will be happening on a particular community without using reports or secondhand information (Patton 1990:203–205).

Ethical considerations: This refers to the researcher assuring the participants involved in the research that their, ideas, details and contributions are secured and there is no violation or abuse of data collected (Payne and Payne, 2004). This is supported by a proper research procedural plan that can be communicated to the people involved in the research. According to Busha and Harter (1981: 25), professional ethical standards should be noted during all phases of the research process. The following are examples of the ethical considerations integral to any research process: protecting the confidentiality of human subjects, following proper procedures to gain access and acceptance to instructions and organisations where research is to be conducted, reporting procedures and findings as accurately as possible, obtaining informed consent from the respondents, giving credit to research associates who provided direct evidence and placing a high value on intellectual honesty (Cohen, Manion & Morrison, 2000:50; Babbie & Mouton, 2001:120; Busha & Harter, 1981:25; Leedy & Ormrod, 2001:107). Consent letters to

carry out the research in Finland were provided by Fort Hare University through the Computer Science Department. For the purpose of the Dwesa community engagement, the SLL which operates in the same community provided the consent letter; moreover, meeting with the community members was easy to arrange as the researcher is one of the SLL researchers. The author did not refer to the community members using their actual names in order to protect their identity. However, it must be noted that all the conversation extracts and quotations from the engagement session which are used in this thesis were statements made by the different people met during the six studies explained in this thesis.

4.3 Description of the research methodology approach

Due the complexity of how ICT developments and understanding of ICTs in rural areas, a hybrid selection of methodologies was chosen. The variations of roadmaps especially for rural areas and variations in ICT services required in these communities require deeper understanding. The inclusion of ICT experts from different areas, government officials and institutions involved in roadmap development requires a composite of research methodologies. The nature of ICT developments in rural areas requires a mixture of different research methodologies. To clearly understand the ICT trends in rural area, a set of methodologies were useful to have a clear picture of the current situation. At one moment one needs to act within the community, behave or participate and at times act like an outsider without a clear picture of what is going on. As an example: the analysis of the current state of ICTs requires both the bottom-up approach and the topdown approach, for instance, for rural users indicating their needs and ICT services providers coming up with solutions. To understand how ICT services are used and the ICT devices in rural areas requires being part of the community, i.e. employing a participative research approach. In some cases, to clearly understand the rural users' needs and get exact feelings from the community, there is the need to act as an outsider. This allows the community to freely share their ideas and calls for the ethnographic research approach. Once there is an understanding on what is required, one has to carry out some experiments and demonstrations. This was mainly implemented during the focus groups discussions in rural areas. Again, this also encouraged participative and action research approach. To come up with the ICT solutions and the planning process mainly uses the top down approach. This allows ICT service providers to come up with ideas and answers to the identified problems. These developments and ICT solutions encourage

design techniques. For the studies within the Siyakhula Living Lab, the author was participative, experimenting and using some research design techniques. Thus, the author throughout the studies conducted in the research had to participate where necessary, do some action research, act as an ethnographist at times, especially for the studies that were undertaken in Keiskammahoek and Alice, where the author was not known. Interviews and further discussions were important in getting the views of ICT roadmap development experts.

4.4 ICT roadmap methodological approach

A composite of research methods was appropriate in accommodating the area studied. For example, workshops were useful in discussing future ICT trends. At the same time, in order to understand the current state of ICTs in rural areas, focus groups and the case study approach were chosen.

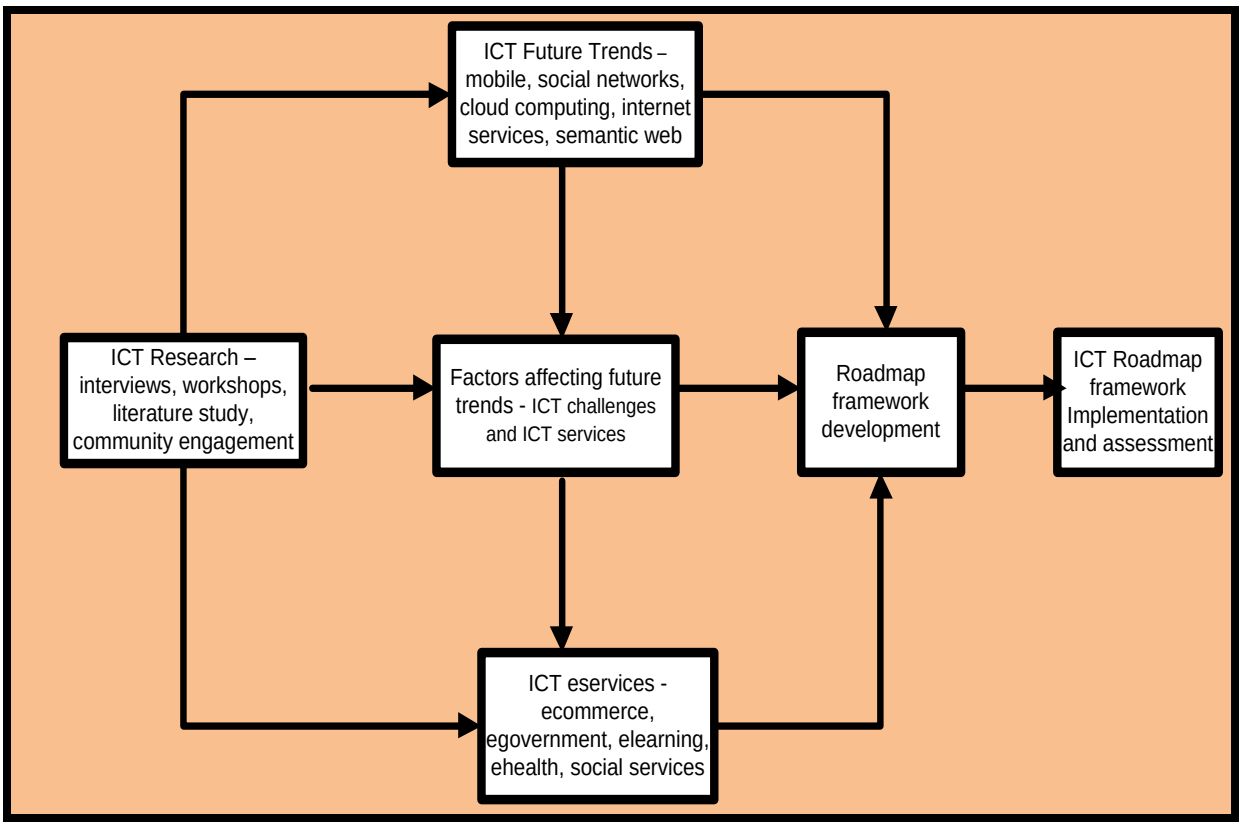

Figure 4:1 Roadmap methodological components

In order to determine the components of the ICT roadmap approach, as earlier indicated, different research groups and focus groups in rural areas were used. Figure 4:1 shows the different research components which were used to fully clarify the requirements of the roadmap

framework. As shown in Figure 4:1, a variety of research actions were used. All the components stated in the roadmap approach were necessary in the development of the final ICT roadmap framework. The author conducted studies through meetings, workshops, presentations, observations and arranged several meetings and site visits in preparation for the development of the ICT roadmap framework, as explained later in Chapter 6.

Figure 4:2 was used to further explain the exact user groups involved in each of the research components.

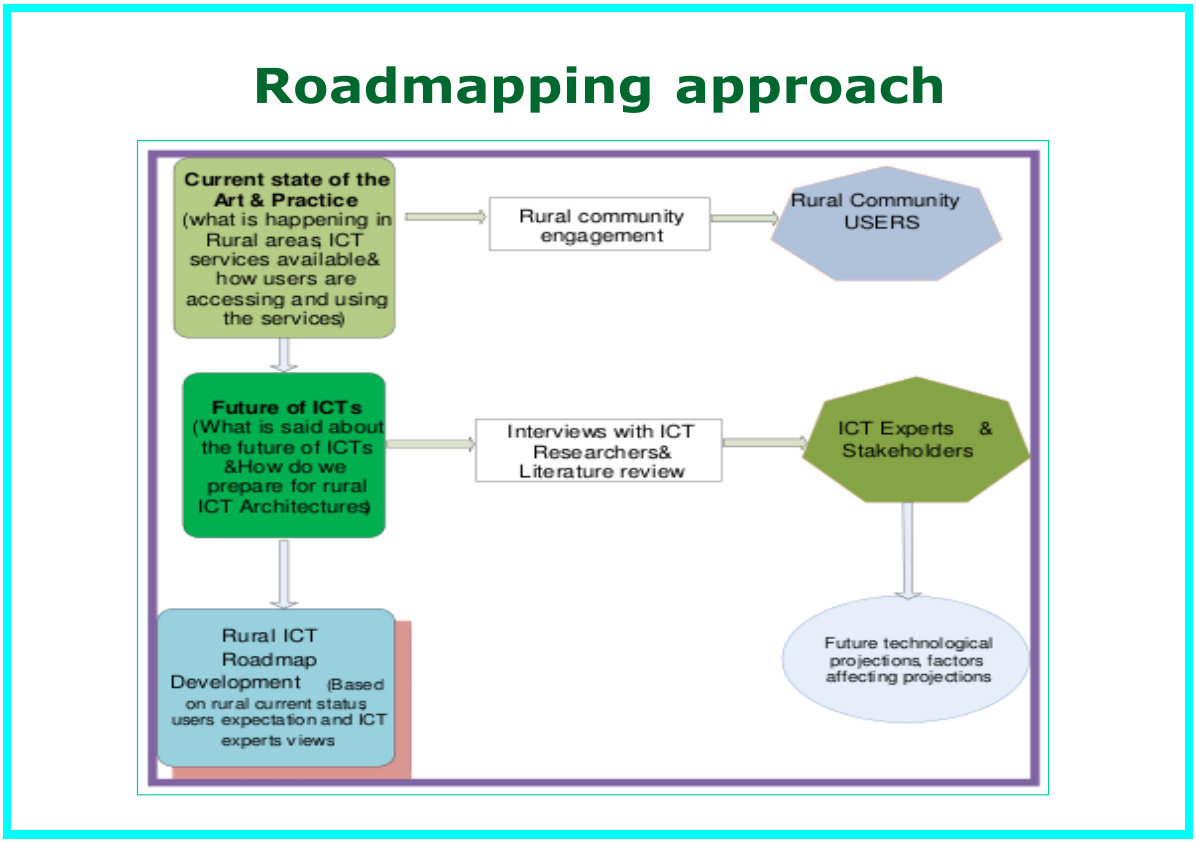

Figure 4:2 Methodological research plans

Figure 4:2 explains the areas that were considered for building the framework and the particular study groups that were targeted in getting the required feedback. Community engagement with rural people was necessary for understanding ICTs in rural areas. The discussions on the future of ICTs, to a large extent, involved ICT experts and other stakeholders such as government officials. The development of the roadmap framework was itself a combination of the different ideas from all the stakeholders involved in the research.

4.5 Moving towards roadmap preparation

As explained in Chapter 1, the author carried out different studies after classifying the different components which were necessary in providing the information required to build up an ICT roadmap framework. The majority of the findings from these studies are discussed in this section. The author is aware that these findings could easily be considered results and possibly explained in the results section, but since these were used in helping to develop an ICT roadmap framework it was decided to explain them in this chapter as part of the methodological approach. The findings were used to explain the different views of current ICT users; this has helped the author to clearly understand and plan for the requirements of the roadmap framework. All the steps and processes that were executed during the studies were all validated to improve the quality of the feedback. The studies include an understanding of the ICT services expected in rural areas, the challenges and factors affecting ICT usage, the future of ICTs, ethnographic studies and community e-readiness for ICTs. During the study, a variety of research techniques were implemented and all the data was recorded using an audio voice recorder.

Before developing the ICT roadmap framework and using the findings from the studies undertaken in this research as earlier explained Section 4.5, there is need to recall some of the research findings which were important for this roadmap build up. These are the research findings, summaries after the workshops, interviews, community focus groups and current existing literature review done in preparation for the roadmap. The assumption in determining the key drivers were that different stakeholders work together to achieve this infrastructural development plan. This has resulted in a summary of the roadmap drivers as shown in Figure 5:7:

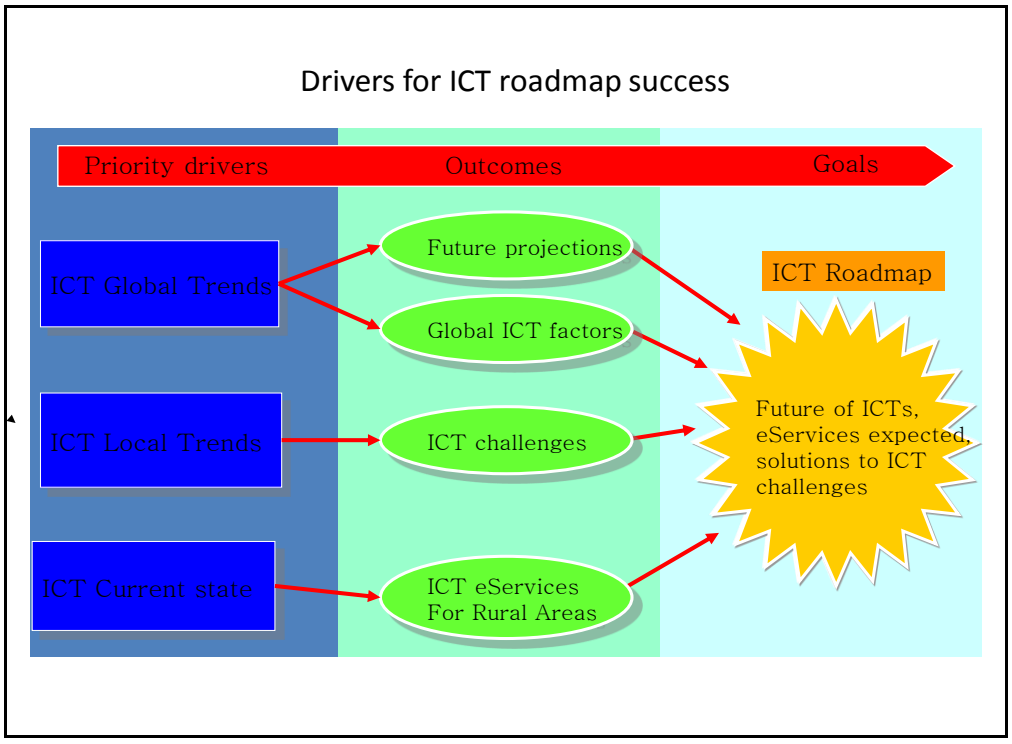

Figure 4:3 ICT key roadmap drivers

The identification of the key future trends; ICT services expected; the service characteristics; and an ICT challenges was based on: ICT expert opinions, interviews with ICT stakeholders, examining global trends, scanning current ICT plans and comparison with other rural areas, urban areas and ICT initiatives as indicated in the different studies explained in Chapter 4. The involvement of different ICT stakeholders has already been mentioned and to support the main trends explained above, the stakeholders considered are shown in Figure 4:4.

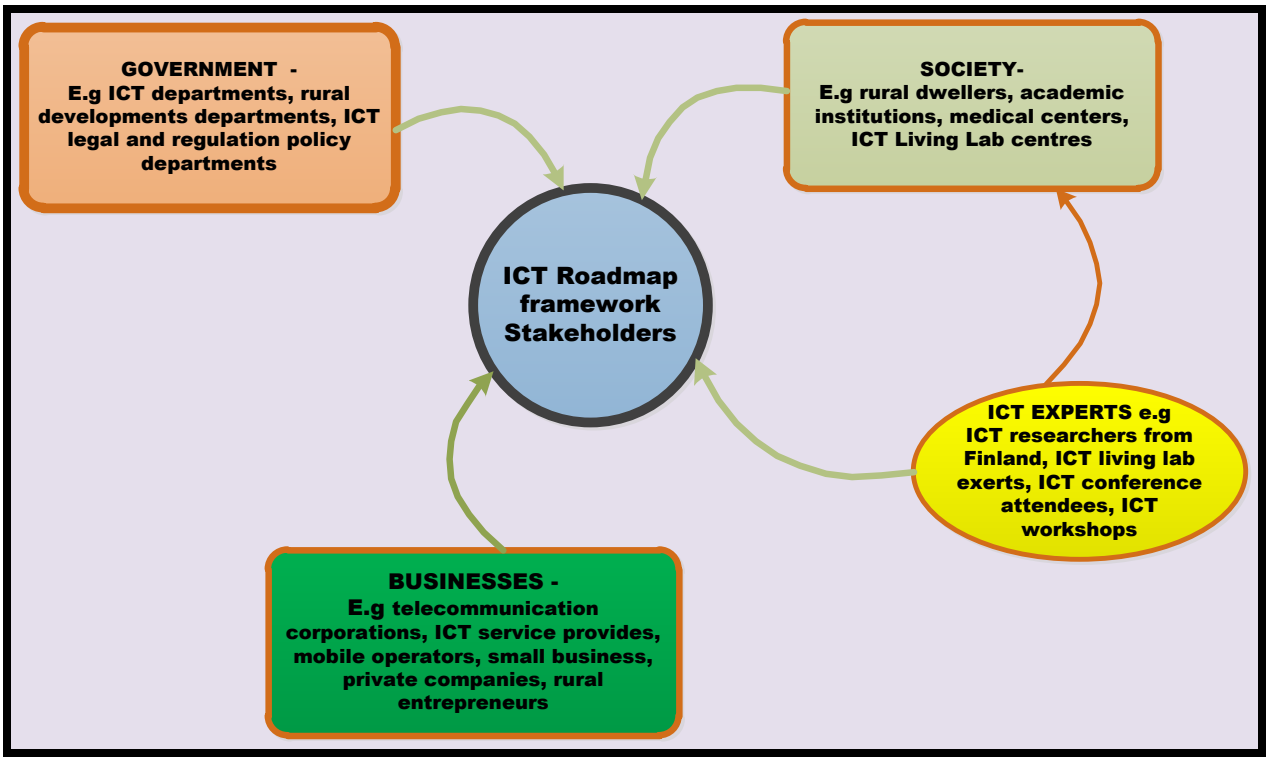

Figure 4:4 ICT stakeholders for roadmap planning

Four key stakeholders are involved in this thesis for the success of ICT developments especially for this infrastructural roadmap plan. These are the ICT stakeholders who are important in ensuring the success of the ICT roadmap. There is a strong belief among the respondents engaged with during the research studies that if all these key entities work together and use the drafted ICT infrastructural plan, then ICT success in rural areas is a possible outcome in the near future. This also supported the need for different ICT stakeholders for successful roadmap development as already mentioned in Chapter 2.

4.6 Roadmap methodological framework

To summarise all the studies which were carried out as explained in this chapter, Figure 4:5 was developed. This suggests that for any ICT stakeholder to offer a sustainable ICT solution, in rural areas, the components shown in Figure 4:5 have to be understood. The author has used this methodological plan to construct the roadmap framework. If all the factors shown in Figure 4:5 are considered, this could improve ICT sustainability in rural areas. The author discovered that rural development could be in any of the four aspects indicated in Figure 4:5. At this point, the figure serves the purpose of showing the readers how the author interprets the ICT developments, highlighting some key aspects which ICTs in any community can address. The

author discovered that there is a direct relationship between the aspects shown in Figure 4:5; the argument here being that any ICT development in one way or another has an impact on at least two or more of the aspects explained. Figure 4:5 goes a long way in this thesis, as it was also used in the assessment of the ICT roadmap framework explained later in Chapter 6.

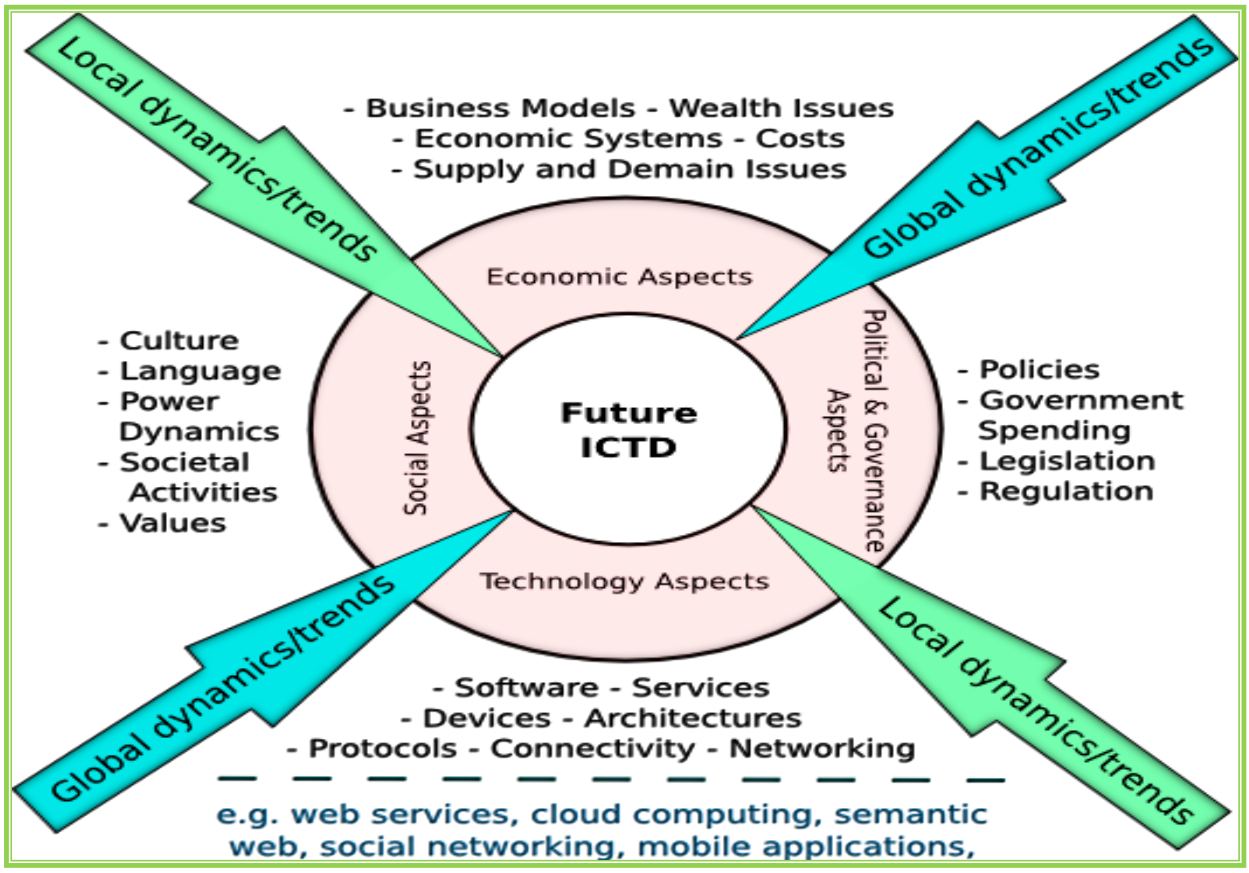

Figure 4:5 ICT roadmap methodological framework

The key characteristics and benefits have a strong impact on the economic, social, political and technical aspects in different areas (Singh *et al*., 2008). Such impacts can improve the standard of living and are always linked to one another. Madon (2000) suggests that ICTs require correct policies and clearly defined means of access so as to ensure effective communication. ICTs require a combination of various aspects. Obviously majority of the nations are using ICTs to improve and benefit from ICT developments (Singh *et al*., 2008) in both urban and rural areas.

Identifying ICT policies and government involvement in ICT initiatives can improve ICT service delivery and uplift the societal standards of particular people (Singh *et al*., 2008). This could be

enabled by ICT education so the community is aware of the possible ICT devices, services and infrastructure required. Having ICT knowledge is important for ICT users as it shapes and improves other aspects of their lives such as their economic, social and technical skills (Singh *et al*., 2008). In terms of the technological aspects, Tom (2010) noticed that the past two decades have witnessed dramatic ICT changes that have revolutionised the way businesses and governments operate, this was also noted in Singh *et al*. (2008) Advanced ICT facilities such as mobile phones, pagers, Personal Digital PDAs, wireless internet access devices, have removed the physical boundaries between ICT users in rural and urban areas. These ICTs have enabled an environment where work can occur anywhere and at any time. It is difficult to separate the role of ICTs from the common aspect, as indicated in Figure 4:5.

To support the proposed methodological framework in Figure 4:5, the following theories were used:

Substantive theory: This theory suggests that "technology could have both a positive or negative impact" on the people and society (Singh *et al*., 2008). There is a need to conduct a deeper assessment of these impacts. Where necessary, such impacts could be communicated and the community is educated on these. For example, in rural areas, education on the impact of technology in various aspects of the people's lives could be recommended. The impact could be noticed economically, socially, politically and technically.

Critical Theory of Technology: This suggests that "technology is a site of struggle and use of technology is shaped by underlying power relations" (Singh *et al*., 2008). Technology through the use of the internet creates a new set of relationships and places (Warschauer, 2004).

Social Informatics: This places 'social shaping' of technology as its central tenet (Singh *et al*., 2008). "In Social Informatics the focus is on looking at what people do with technology rather than what they have" (Taylor, 2004).

Community Informatics: This suggests that "ICTs enable community processes and the achievement of community objectives"; this includes overcoming "digital divides" both within and amongst communities (Gurstein, 2002; Singh *et al*., 2008). The ideas of these theories are critical in using the methodological framework.

The methodological framework components could be supported by existing literature from different nations when planning for ICT developments. A couple of countries were selected to support and justify the validity of the methodological framework. For instance:

The Philippines: According to the ICT roadmap draft document of 2006 for the Philippines, countries with better governance, with more transparent and efficient bureaucracies, stand a chance to offer better ICT services. The document goes on to mention that "with a better legal and regulatory framework there is a higher opportunity for more job opportunity" (Philippines Document, 2006). The Philippines recommends capilatilising on scarce resources, and producing high quality goods and services by using fewer inputs, to gain a competitive market place. The same is true for each and every individual. The Philippine document points out that ICT services should always be available, accessible and secure. These should be able to sustain the targeted population.

Lesotho: This country is of the view that it is important to have ICT solutions that ensure sustainability both socially and economically. This is vital to enable members of the public to exchange and communicate effectively. With sufficient ICT knowledge, the country is able to deliver and develop its citizens. This is supported by having proper ICT policies which promote ICT awareness and information dissemination. The Lesotho government has indicated that ICTs have the power to improve information distribution and boost the economy as well as improving overall sustainable development (Motsoahae, 2005).

Rwanda: The Rwandan government focuses on empowering citizens with technical ICT skills. This has also enabled the Rwandan vision 2020 to focus on a few key pillars. The main pillars of Rwanda's vision 2020, according to the Republic of Rwanda Ministry of Finance and Economic Planning (2000), are:

- ICT good governance
- Human development and knowledge based economy
- Infrastructure development
- Regional and international economic integration.

This should be done across all levels in society by addressing gender equity, protecting the environment and using science and technology to ensure the sustainability of ICT developments. The key areas to be addressed by the Rwandan vision 2020 can be satisfied if the community is

aware of the various aspects indicated in the methodological framework. The Rwandan pillars are almost similar to those indicated in the methodological framework in Figure 4:5. There is no proper integration on the technical skills and socio-economic aspects in Rwanda. This means that all the key aspects should be considered and well combined to ensure sustainable ICT developments in order for ICT developments to benefit Rwandan citizens.

South Africa – The view of the Department of Communication: The South African ICT plan emphasizes the construction of a well-planned ICT infrastructure throughout South Africa, including rural areas. This has been thought of after noticing the various ICT benefits. The South African perspective could be achieved if the South African ICT stakeholders:

- Come up with ICT solutions to benefit rural entrepreneurs;
- Equip the citizens with technical skills;
- Promote ICTs that encourage cultural and societal aspects;
- Promote local culture through localised ICT service.

The views of the above countries were referred to in order to support the methodological framework. Understanding the different aspects mentioned in the methodological frameworks and the views of other countries have improved the validity and sustainability of the methodological framework. The views raised by the above countries form a critical base for what should be done and what is required in developing nations, for the purpose of ensuring ICT developments. These ideas were incorporated in the roadmap framework discussed in Chapter 6.

The author acknowledges an almost similar approach in determining the driving forces of change, as mentioned by Kelly *et al*. (2004). According to Kelly *et al*. (2004, as cited in Erdogan *et al*., 2009), "the driving forces can be tracked by constant checkups through 'horizon' or 'environmental' scanning, in-depth interviews with acknowledged experts; targeted questionnaire surveys; and brainstorming workshops at the start of the prospective process".

Erdogan *et al*. (2009) summarised these techniques as *DEGEST, PESTE* or *STEEP*, which are explained below:

- *DEGEST: Demographic, Economic, Governance, Environmental, Societal and Technological*
- *PESTE: Political, Economic, Social, Technological and Ecological*
- *STEEP: Societal, Technology, Economic, Environmental and Political* (Erdogan *et. al.*, 2009).

In this research, the driving forces into the futureare determined using a number of methods. The idea of using the driving forces is linked to Figure 4:5 and the author used different studies to clarify how each aspect should be accommodated so that ICTs could reach all the people. The aspects explained in Figure 4:5 are important to successful roadmap development, and have been considered in this research. Now that the different methods have been explained and the findings from the rural users and other ICT stakeholders have been outlined, the actual development of the sustainable ICT roadmap begins in the next chapter.

The aspects described in Figure 4:5, together with forces of change by Kelly *et al*., (2004), can improve the sustainability of ICTs. The roadmap methodological framework explained in this thesis focuses on addressing the technological aspect. This includes the technical, social and learning status of a technology. The technical aspects explain technological features such as ease of use, compatibility with other technology and the ICT infrastructure required. The technical aspects also cover the overall reliability and functionality of the proposed solution. This also includes technical education to provide the required skills that could allow users to understand the implemented solutions.

4.7 Future determination techniques

The literature review was once again used in an attempt to plan for the future. Having analysed the future trends and gained an understanding of future expectations as well as current ICT trends, the author decided to use the backcasting technique for the development of the roadmap. *Backcasting* is one of the common forecasting methods (Robinson 1990). In backcasting, future changes are identified and the plan of action to rectify these changes is outlined. Robison says that backcasting works “backwards from a particular preferred end point to the current in order to determine the feasibility of future needs to be in place to get to the wished part” (Robinson,

1990:823). The following steps, as stated by Quist and Vergragt (2006), can be important when using the backcasting technique:

- 1st step: determine the problem
- 2nd step: consider other outside forces
- 3rd step: come up with the future plan
- 4th step: design the plan from the back
- 5th step: specify the plan of action required to support the backcasting.

Mudler and Biesiot (1998) are of the view that backcasting can enable a sustainable solution and clearly define the required time to achieve a targeted goal. This can also be supported by the five backcasting steps, as outlined above, which can be followed. Robinson (1990) mentioned that backcasting shows the degree to which unwelcoming futures can be avoided, thus making it a better future planning technique.

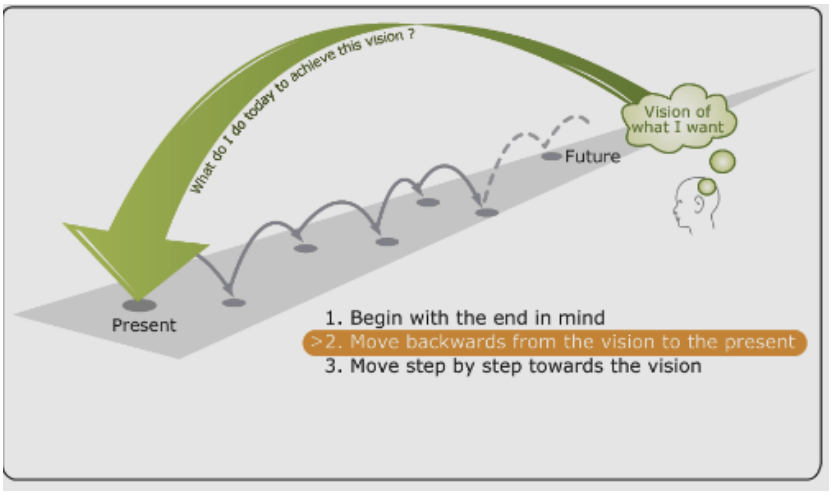

Figure 4:6 Backcasting techniques: Adopted from Quist & Vergragt (2006)

Another way to represent the backcasting technique is as follows:

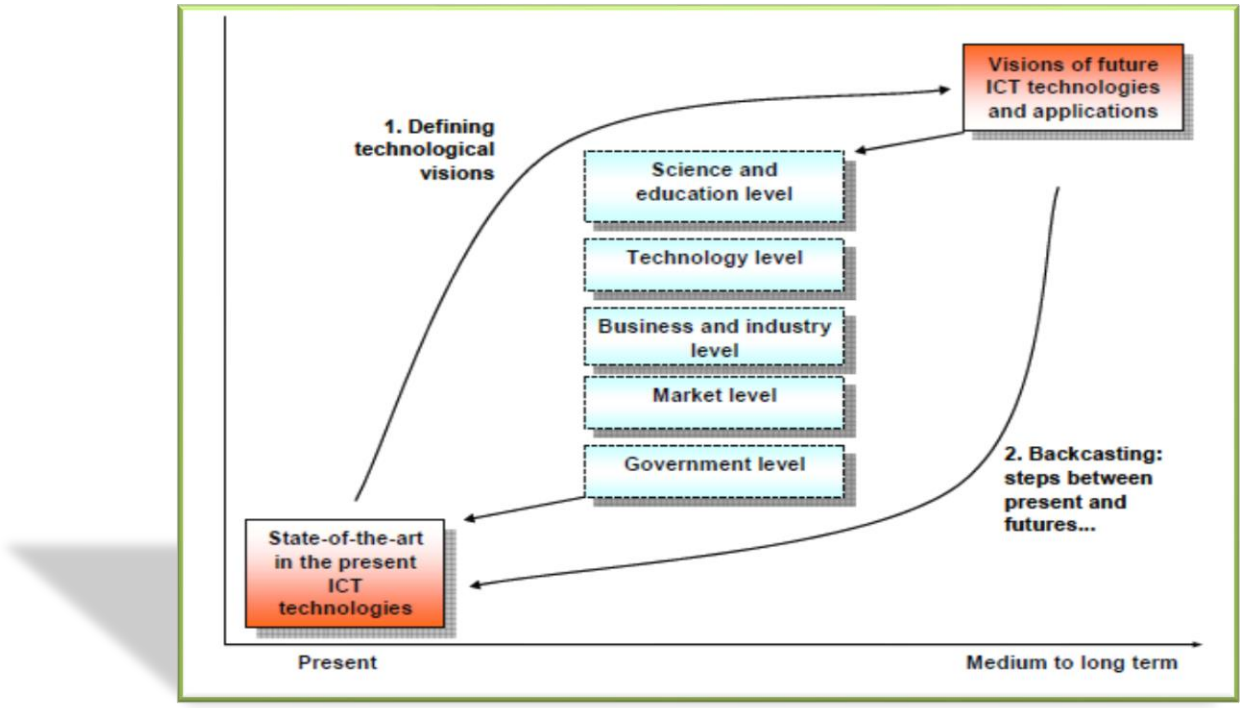

Figure 4:7 Backcasting process: Adopted from Miola (2008)

Backcasting provides answers to questions such as: "what can be done now in order to achieve a particular goal?" Backacasting considers all the possibilities and changes that could take place and it accommodates the worst situations. This makes it a more reliable technique than other existing forecasting techniques. This is the technique that has been used in this research to aid the design of the ICT roadmap methodological framework.

A literature review was used to gain an understanding of different future projection techniques used by futurists. Gartner projections were the main ones considered and some of the projections were mentioned earlier in Chapter 2, Section 2.2. The purpose of this endeavour was to acquire knowledge on how to predict the future. This was worth doing as it allows for proper planning for the ICT roadmap.

Authors such as, Chatterjee and Gordon (2006) and Miola (2008) have discussed possible ways or techniques that are used to predict the future. Some of these include: forecasting methods, i.e. backcasting, scenario techniques and Delphi techniques (Erdogan *et al*., 2009). According to Chatterjee and Gordon (2006), the technique to be used is determined by the understanding of the area studied, i.e. in cases where the research is easy and can be predicted, forecasting techniques are more appropriate. Scenario planning is more common in cases where there is

complexity and in unpredictable cases. As indicated by Miola, (2008) and supported by Banister and Stead (2004) future studies could be explained as follows:

- *Predictive nature*: This includes forecasting techniques where one is aware of what is going to happen. The future can easily be determined.
- *Scenario nature*: This is where there is a possibility of what will happen. Borjeson (2006) explains this as an instance in which the description of the possible future can be stated.
- *Desirable futures*: This focuses on what it is preferred would happen. Some of the techniques used in this case include backcasting and normative forecasting.

There is no single way to explain suitable future study approaches, though the scenario approach is the most popular technique that has frequently been used.

4.8 General findings on current ICT trends

The majority of the people involved in the studies that are explained in Chapter 5 were quick to point out that they want to learn about ICTs but, there are not enough resources. Coupled with this problem of the lack of resources, is the fact that accessibility of the few available resources is limited. Some community members also pointed out that the computer laboratories are always full and gaining access is difficult. In some cases, even when they are on the computers, the majority of people still get stuck, as they lack the requisite ICT skills. At one of the schools in a rural area, the teachers could not connect to a projector and no one was able to assist, thus resulting in the projector not being used. Since no one was available to assist on one occasion, the majority would just avoid the ICT available to them, thus leading to continued ignorance. The author has classified the different statements into different categories. Some of the statements which were made during the study, and reproduced in this thesis verbatim, are:

Socio-cultural factors: One old lady said:

> *"I do not understand most of the words which you said in English and I cannot read English. I want to learn, but it is difficult using this language"* ("this language" refers to English).

In contrast to this:

> *"Technology was brought by the foreigners. It is a foreign idea, so we like it in English and we learn it like that,"* one community member said.

These two statements show that the understanding of rural people is different and their expectations are not the same. This makes it difficult to plan and provide the required services to these communities.

Economic factors: In reference to the lack of resources and financial challenges which have already been mentioned in Table 4:4, one community lady said:

> *"I wish to own a computer, but the money I get from the government social grant is not even enough for food, so do you think I will buy a computer? I will have to rely on the school to open the computer lab."*

Other factors:

> *"I live somewhere up there,"* pointed one old man. *"I have come here for the computers. I want to learn. If the school teachers do not open the computer lab, there is nothing I can do, I will go back."*
>
> *"We have been here for the last two hours. It is nice that you have arrived"* (referring to the SLL researchers). *"We can get access to the lab, and the teachers were taking their time to open,"* the community youth said.

In showing his support for the teachers in the community to become computer literate, the principal at one school said:

> *"If teachers want some leave days to go for advanced computer training anywhere, I will give them the leave days, because the Department of Education wants all teachers and learners to be computer literate by 2013."*

However, there are some who felt that the government still has a lot to do in terms of ICT training; the majority of senior students and teachers at the schools feel this way, and they therefore hold mixed feelings on the role of government in their community:

> *"Introduction to computers is not part of the curriculum. We have not been allowed to include it on our timetable, so the students and the teachers can only use the computers after hours",* said one project champion.

In supporting the need for ICT education for the youth in the community, one old man from the Dwesa community said:

> *"These young children catch up very fast. We old people we take a lot of time to understand. I wish I had been educated while I was young".*

The author observed that there are some people within the community who are very eager to use ICTs and would not like to discourage ICT service providers by revealing all the challenges they face. However, the main challenges within the SLL community were recognized during this study and the author felt that the challenges raised were common to those currently available in the literature review. The statements and the key challenges raised together with the ICT services expected, as previously mentioned, were considered as the author built up to the development of the ICT roadmap methodological framework. Of course, it was not enough to properly plan for ICTs before looking at the technological changes. The statements quoted above highlight the current views of rural users, which are further discussed in Chapter 5.

4.9 Study findings and the ICT roadmap framework

The findings from the six studies explained in Chapter 5 were analysed using Excel spreadsheets and in some cases a statistical package, i.e, SPSS, or by observing the common trend of the results. However, it should be noted that the studies were conducted to have an understanding on ICTs, how current ICT users view ICTs and the future plans for ICTs through discussions with ICT stakeholders. The analysis of these findings did not follow any systematic process, but was mainly at the author's discretion to help in developing the framework. The author at times analysed the results by observing and recording the common trends, i.e. in rural areas where in most cases the same answers were provided for a similar question. For the data that was recorded and transcribed, this was analysed by selecting the statements as they were made by the audiences and reproducing them in the thesis to support or justify the study results.

The studies explained in the next chapter helped to identify the main ICT components which are important for ICT developments. These components were identified by the author and were classified as ICT services, infrastructure or devices. In this thesis, is no there is no order in which these components should follow, but what is important is to understand the dependencies that are found among them. The components depend on each other and the contribution made in this

thesis is to clearly identify the ICT services and the infrastructure that depend on those services including the ICT devices.

The findings of the studies highlighted the current state of ICTs, future projections, the communities' readiness to use ICTs and how the rural communities use ICTs. In summary, some of the findings in this chapter are meant to prepare for the roadmap methodological framework design explained in the next chapter. These findings explain the views of rural ICT users. Using these findings and selected case studies helped to understand the current state of ICT roadmaps in different countries. Using these findings it was possible to identify the ICT areas that have to be addressed. The ICT roadmap framework is based on the main categories of ICT services required, common ICT devices and possible ICT infrastructure in rural areas.

4.10 Conclusion

The chapter has explained the research methodological techniques that were used in the research. The impacts of ICTs in all aspects of human lives are discussed. An explanation of the choice of research techniques is also given in this chapter. These factors affect the implementation of some ICT policies as well as stakeholder involvement. It is clear that for a sustainable ICT solution, all the factors have to be considered. The explanation of the methodological techniques gives an understanding of how the ICT roadmap framework was designed. The chapter shows the various research techniques which were used throughout the research explained in thesis. Again, it should be emphasized that the dynamics of ICTs in rural areas, differences in ICT developments, ICT needs and how governments are involved in rural developments could affect the choice of the research techniques. In this thesis, various research techniques were implemented to get a clear and proper understanding on ICT trends and developments in rural areas.

This chapter was used to give a few highlights of the rural users comments on current ICTs in rural areas. These comments were important for the roadmap methodological framework development. The author uses these comments to show that the proposed ICT roadmap framework discussed in this thesis is a user-driven output.

Chapter 5:
ANALYSIS OF ICT ROADMAP FRAMEWORK

Technology roadmapping involves determining the key services that have to be addressed and finding technological alternatives that are readily available to ICT sustainability.[7]

5.1 Introduction

The findings of the current state of ICTs in rural areas, the ICT services expected in rural areas and the readiness of the communities involved are discussed in this chapter, as these were regarded as different methods necessary in planning for the roadmap development. The research methodologies explained in Chapter 4 were used to build up the roadmap framework. In this chapter, the author highlights ICT services, technologies and infrastructure which are applicable in rural areas. These have been determined from the analysis of the conducted research studies. The motivation for this was to fully prepare for an ICT roadmap framework development. The focus of the roadmap methodological framework is on the technical requirements for sustainable ICT solutions for eServices in rural areas. The author agrees that economic, social, government and political factors all play a major role in improving ICTs and used the recommendation in Chapter 8 to accommodate all of these. In this section, however, the findings from the six studies conducted are explained, and ICT technical infrastructure, services, devices and technologies are further elaborated as they constitute a greater part of the proposed ICT roadmap framework. This chapter therefore discusses the technologies, devices and services which make up the ICT roadmap framework.

5.2 Overview of ICT services and challenges in rural areas

There were six studies which were carried as part of the build up to the main research. These studies were all undertaken by the author and the research papers explained in this thesis came from these studies. The importance of these studies was to assist and design the proposed roadmap framework.

[7] *Prof. Matti - Aalto University (Sober IT)*

Study 1 – ICT services expected: The author conducted this study to understand the views of ICT users on ICT eServices which different people from rural communities think should be offered in their areas. Four separate visits were paid to Dwesa and two to Keiskammahoek. Two research trips were undertaken to Finland, with the author spending two months in the country during each research trip. The respondents were categorized into two groups: these were the ICT experts and rural users. For the rural users, the main focus was the technologically illiterate group and those who had received ICT training on the eServices deployed within the SLL. The feedback from the two groups, that is, all the responses obtained from the ICT experts and the rural users, was combined. The total number of respondents was 100. This means that the views of 50 ICT experts and 50 rural users were received. The ICT experts were met with during a workshop on ICTs for rural areas, conducted in Finland (organized by the author). The rural users were interviewed through focus group facilitation. Seventeen ICT experts in Africa were interviewed separately, as they were not part of the workshop, but were included in the total number of experts interviewed. This means that during the workshop in Finland, there were 33 ICT experts.

The rural users represented different categories of the rural population; they constituted a mixture of people, who were teachers, farmers, rural entrepreneurs, the youth and the elderly. A list of ICT services from the literature review, observations and some interviews was generated and provided to the respondents. Each of the members of the group being studied was supposed to indicate whether a particular service was important in rural areas or not. For each service, the respondents were supposed to indicate whether they regarded it as important or not. Only the numbers of those who thought the service was required were captured.

A summary of the findings on what the ICT experts stated, in comparison to what the rural users stated, is provided in Table 5:1.

Table 5:1 ICT services expected: Rural users vs. ICT experts views

Type of eService	ICT experts	Rural users
eCommerce	39	28
eHealth	42	21
eGovernment	46	33
eLearning	37	36
eJudiciary	36	27
Social services	28	42
Mobile applications	44	42
Basic ICT information centres	37	49
Agricultural information	41	32

Table 5:1 shows the exact numbers of the people and their views on the importance of different eServices. They specified the characteristics of what they expect as best ICT services.

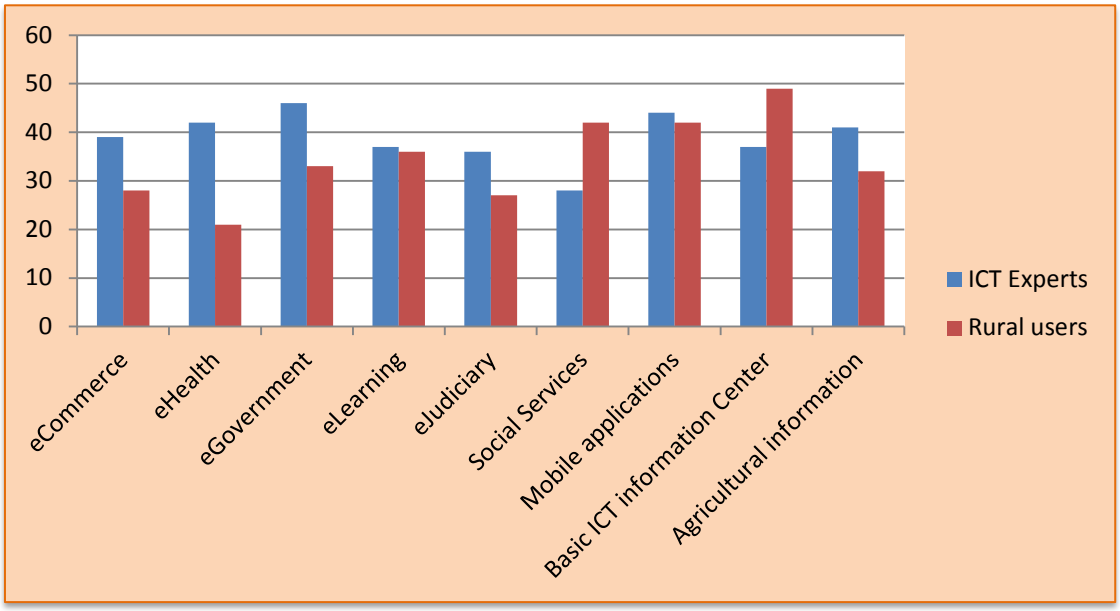

Figure 5:1 ICT services in need

In supporting the low number of respondents for eHealth by rural users, one old member of the Dwesa community had this to say:

> "*I am now 58 years old and I am strong. I was born in that hut and have never been to a clinic. If I have a problem I consult a traditional healer, so I do not visit clinics".*

One would certainly think that health is a key service requirement in rural areas, but the users have different views. Any service which did not fit into any of the above categories was put

under the basic ICT information center. Almost all the rural users said that they needed such a centre. They described it as a place, or environment, in which they could get information about whatever they wish. This was described as an environment where the community could access any information on education, markets, government politics, sports and weather, so that they are kept updated.

The rural users suggested services which would support the specific skills they have and services which suit their interests: For example, one of the youths in Dwesa said:

> *"If I am into music and like singing, bring me a guitar so that I can play to practice."*

And one old man was of this opinion:

> *"We are not all farmers. I do not like farming, so why do you want me to attend eAgric ICT training?"*

The author discovered that, at times, the rural users' views contradicted that of the ICT experts, as the experts proposed services that encourage community development and entrepreneurship. For example, in an attempt to make sure that there is an understanding and that ICT services benefit rural people one of the ICT experts in Finland said:

> *"One of the issues is the agribusiness on the farms that would provide jobs. This can generate revenue and enable the rural dwellers to pay for their electricity services. This is one project we have initiated to address these problems, i.e. with the Zambian government. But, what we need is more understanding of the village economics. Understanding the number of people in that position of lacking an income and the many people who cannot afford $1 per day should determine the type of services, devices and technologies to be used."*[8]

Alternatively, rural users were more interested in specific individual services to satisfy their personal needs. For example, they proposed services which they could access via personal mobile phones. It should be noted that within the SLL the schools are the places with computers, so community members rely on the schools being open, and once schools are closed they have no access. The respondents felt that if services were accessible via mobile phones, they would not rely heavily on accessing computers at the schools. In addition to the services, the author elaborated upon the research for rural users so as to explain some of the characteristics of the

[8] Antti Korhonen – a former employee of Nokia, now President of DigiEcoCity in Helsinki.

ICT services they expected. The same number of respondents was maintained within the same focus groups which were used for the ICT services.

Table 5:2 Characteristics of ICT services expected

Characteristic of eService	Rural Users Only
Availability	39
Accessibility	50
Cost effectiveness	39
Ease of learning	50
Addictiveness	3
Profitability	45

The rural users, as indicated in the findings inTable 5:2, would expect services that are accessible all the time and easy to learn. One of the women in Dwesa in support of the low number for having dynamic services said that:

> *"Some of the ICT services are too complicated. I fail to understand. They seem to change each time I go to the computer. Maybe if I am trained enough, I will understand."*

The woman was referring to the eCommerce, eGovernment and eHealth applications which are already available within the SLL.

The overall conclusion was that what the ICT experts (who represent ICT service providers) claim are the services needed in rural areas are not necessarily the services that people from these communities expect. The author appreciates the fact that there were no major differences between the two categories and, where available, the gap can be closed. After understanding the different ICT services expected, a different study was conducted on the ICT challenges. This study was done in Dwesa, Alice and Keiskammahoek, with only farmers being targeted in Keiskammahoek. This was because the majority of the people in this community are farmers. The variations in services required were noted and accommodated in the roadmap methodological framework.

Study 2 – ICT challenges: The author used the SLL community since there is already ongoing ICT training within the community. The purpose of the study was to note the ICT challenges experienced in this community. During the study, the respondents were observed, grouped into different focus groups to share some of the challenges they experienced when using ICTs. In this case, the main ICT device was the computer.

The total of the population used for this study was 85. The idea was to have all the major categories of rural people represented in the study population. Again, based on the current literature on ICT challenges, observations by the author and prior interviews involving some ICT experts, a list of common ICT challenges was drawn up. From the list, each of the respondents was asked to comment on whether a certain statement was a challenge or not. ICT users in rural areas were asked to comment on the effect of each of the challenges during the study.

Table 5:3 ICT users interviewed in rural areas

Rural ICT end users sample population	
Category	**No. of respondents**
Teachers	23
Youth	16
Art & crafters	9
Farmers	13
Health practitioners	3
Women & old people	14
Shop owners	7
Total no. of respondents	85

Each of the users involved in the research was supposed to indicate if any of the given challenges actually affected ICT training in the community. The respondents were supposed to indicate the extent to which they felt the challenge affected the community. All their views were recorded. Thus, all the respondents had to say something about each of the challenges and, fortunately, they all did so. In this case, focus groups within the areas of study were used and interviews were all recorded and later transcribed. Educators highlighted that they did not know that ICTs could be used as a teaching tool.

To indicate how the community might not be aware of the ICTs, one educator from Dwesa said:

> *"At first, I was in darkness. I had no idea. I thought computers are meant for office clerks ... I didn't know that I could get a programme or application that was meant for the learners".*

Therefore, ICT illiteracy is a major challenge in rural areas. Table 5:4 presents a summary of the popular challenges highlighted by the respondents.

Table 5:4 ICT challenges affecting ICT services

ICT Challenge	No. of people in support	% representation
Lack of resources	79	92.94
Poor infrastructure	80	94.12
Ignorance	25	29.41
Lack of time	32	37.65
Technological illiteracy	74	87.06
Shortage of educators	46	54.12
No access	70	82.35
Social & cultural	69	81.18
Religious belief	3	3.53
Economic challenges	72	84.71
No government support	20	23.53
Political challenges	17	20.00
Fear of the unknown	11	12.94

The author discovered that rural users note poor infrastructure, lack of resources, technological illiteracy and economic challenges as the main ICT challenges faced in the respective areas. The proposed roadmap framework should indicate how the methodological roadmap framework could address the challenges at hand. Figure 5:2 summarises some of the ICT challenges identified during the study.

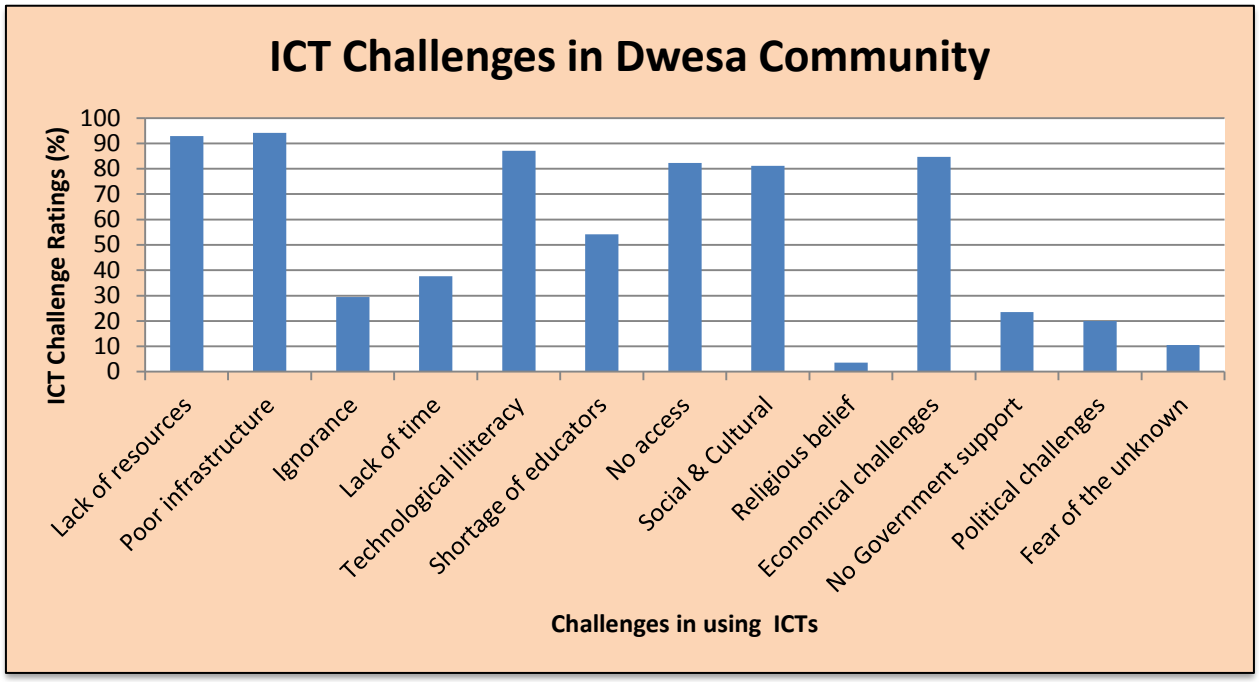

Figure 5:2 ICT challenges

The complications and differences of ICT services and challenges in rural areas were summarized by one ICT expert in the following statement:

> "*There is so much that we can do because primarily as the Centre of Excellence in ICTD we are a research institution funded by government and industry partners. What we can do is provide connectivity to computer hardware and training community on ICTs. Some challenges are beyond our capacity and ability but we have found ourselves dealing with and grasping them. Therefore we can't solve all the problems; we can only do what we can based on our capacity. The power problems are not for us to tackle."*[9]

The current ICT developments within the SLL are represented here. The ICT developments within SLL have been aimed at addressing some ICT challenges facing rural areas.

[9]Prof. Thinyane – Head of Telkom Centre of Excellence in ICTD (UFH), South Africa, also representing the Siyakhula Living Lab.

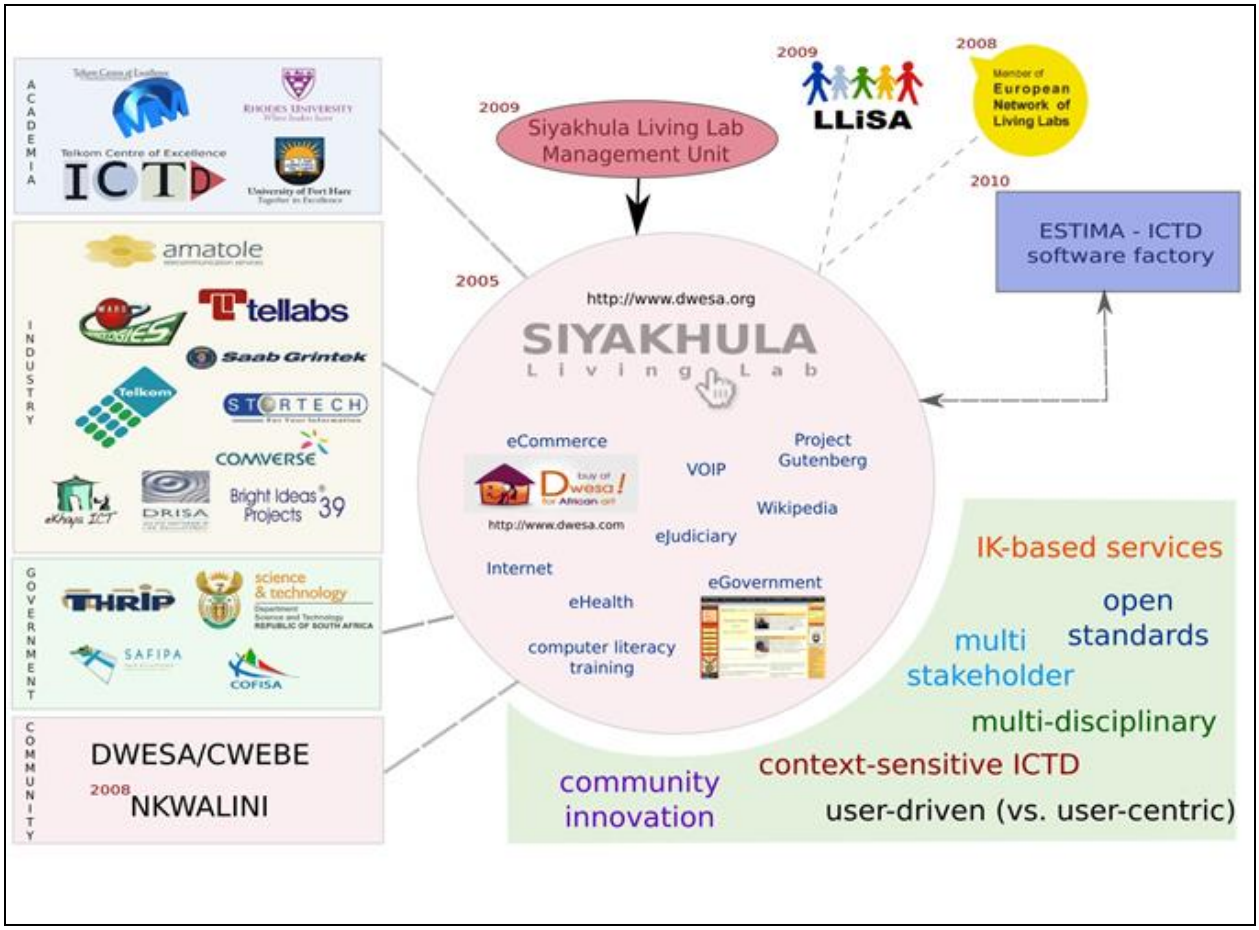

Figure 5:3 SLL Current state of ICT services and partners

The current ICT services available within the SLL include eCommerce, eHealth, eJudiciary, eGovernment, VOIP and internet access. The SLL has different partners and the Dwesa community is one of its key partners. Some of the partners include Telkom South Africa, Tellabs, Amatole, Saab Grintek, government through THRIP, academic institutions – UFH and RU as well as international organizations such as SAFIPA and COFISA. This has enabled the creation of an ICT factory company (ESTIMA – Reeds House System). The company focuses on perfecting different ICT services which have already been developed to be accessible on Teleweaver by rural ICT users. A separate study to identify the future of ICTs was done is this research and is explained in the next section.

5.3 Future ICT projections

A study involving ICT experts was carried out to get the views of experts on the future of ICT developments. Based on the technological changes, several ICT experts were engaged so that they could share their views on what they think are some of the ICT trends expected in the future. Most of the experts were quick to point out that it is difficult to project into the future, but tried to use their experiences as supported by technological changes. This contributed greatly to the success of the study.

Study 3 – ICT experts on key future projections: According to the ICT experts interviewed during the study, the future is difficult to predict but various ideas on the future technological projections were obtained. All the data was recorded and later transcribed. The author visited Finland twice during the research study and spent two months there during each visit. Several ICT experts from academia, living labs, government and private companies like Nokia were consulted. This enabled the author to get ideas from different people regarding their views on the future of ICTs. The experts were asked to state their projections based on their views and to rate each of the projections on the expectations. The weakness of these findings was that these projections were general and did not focus on rural areas, which are the focus of this research. The experts interviewed for the data reported in this research were made up of 20 ICT experts: 8 from Finland; 3 from India; 3 from France; 1 from the UK; 2 from China and 3 from the Netherlands. The detailed questions which were discussed during this study are attached in Appendix A, which contains the questions directly related to the workshop questions posed to ICT experts. The data obtained from the different experts on the future of ICTs is represented in Figure 5:4.

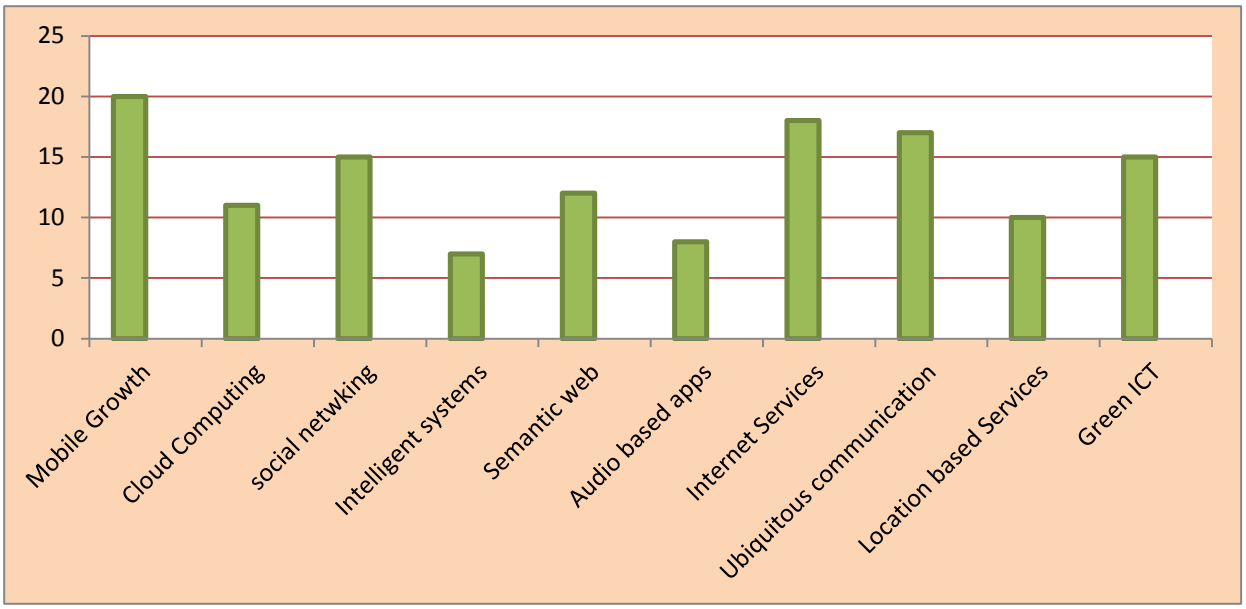

Figure 5:4 Future ICT projections

All the ICT experts were of the view that mobile applications seem to continuously grow and that most future transactions will be done via mobile devices. Social networking, internet services, ubiquitous communication, green ICT and cloud computing were the other common projections suggested by the ICT experts. All these views on projections were considered for the development of the roadmap framework. The author had to assess on the projections which could be applied in rural areas, as outlined later in this thesis. It was also interesting to figure out the factors that could affect the deployment of the future projections as indicated in Study 4.

Study 4 – Factors affecting the technological projections: In order to link the projections and factors which affect the projections, a bench-marking workshop was held in Finland. The goal of the workshop was to identify different factors which could affect ICT developments in rural areas and how these factors affect the implementation of some of the future projections. The workshop participants were randomly placed into three different groups. The number of people in the groups was 8, 8 and 7 respectively. All the members have ICT experience and are involved in ICT projects. The factors were divided into two categories; for example, they were split into the factors that promote ICT developments and those that discourage ICT developments and future projections.

Table 5:5 Factors promoting technological projections

Factor	Technological projection				
	Internet usage	***Mobile growth***	***Cloud computing***	***Social networking***	***Semantic web***
Improved infrastructure	X	X	X	X	X
Growth of mobile usage	X	X	X	X	
ICT education	X	X		X	
Access to global markets	X	X		X	
Growth of cloud computing	X	X			
Social networks growth	X	X	X		
Cheaper mobile phones	X	X		X	
Deregulation policies	X	X			
Internet availability		X	X	X	
Improved bandwidth	X	X	X	X	X
No skills required		X	X		
Easy access	X		X	X	
Sharing of information				X	

Figure 5:5 shows the different factors which encourage the implementation of different projections in most of the rural areas in developing countries.

The findings indicated that the presence of improved infrastructure in rural areas encourages almost all the projected future projections. The growth of mobile usage also enables ICT developments in low resource areas. Factors such as cheaper mobile phones, growth of social networks and improved bandwidth are some of the key factors which promote ICT developments. The workshop participants concluded that most of these favorable factors have been encouraged by government's efforts, as well as the efforts of non-governmental organizations and individuals attempting to improve ICTs in rural areas. The author incorporated all these ideas in the roadmap framework and discusses this further in Chapter 6, in terms of the assessing the framework. However, there are still various challenges and many factors which make it difficult for most of the projections to be achieved. These are shown in Table 5:6:

Table 5:6 Factors discouraging ICT developments

Factor	Technological projection				
	Internet usage	***Mobile Growth***	***Cloud computing***	***Social networking***	***Semantic Web***
poor infrastructure	X	X	X	X	X
no access to computers	X		X	X	
high illiteracy	X	X		X	X
low income	X	X			
low bandwidth	X		X	X	
socio-cultural barriers	X	X		X	
poor connectivity	X	X		X	
Government policies	X	X		X	
ignorance	X	X		X	
shortage of ICT educators	X	X		X	X
no power supply	X	X	X	X	X
security challenges	X			X	
fear of the unknown	X		X	X	
technological illiteracy	X			X	X

The workshop findings indicated that poor infrastructure could also discourage ICT developments. Lack of access to ICTs and high ICT illiteracy in most rural areas were also identified as some of the main factors contributing to delays in some projections reaching low resource areas. These factors are common in almost all rural areas of Africa and the author has also noticed them within the SLL. The factors were also linked to the ICT challenges discussed earlier in this chapter. It was concluded that a combination of different technologies, ICT devices and services could be integrated in order to improve ICT penetration. At the same time, all ICT stakeholders need to work together in ensuring that ICTs reach all people globally.

5.4 ICT usage and rural users view

Having an understanding of the ICT services expected the challenges at hand and the future expectations for ICTs, it was necessary to assess how ICTs are used in rural areas.

Study 5 – Ethnographic study: This study was undertaken to understand how rural community members use ICTs. The targeted ICT device was the mobile phone. The study was initiated by the Finland ICT research, and the findings from this study were important in this research in order to determine the current challenges that rural ICT users face. The findings are also important in understanding the specific user requirements for interface design. The study had two main objectives: to determine how rural people exchange ideas through the use of ICTs and the impact of technological changes within rural areas. The idea was to understand how poverty affects ICT usage and the current ICT trends and challenges faced in rural areas. This helped in gaining a better understanding of the rural ICT challenges and various technological stories within the rural areas. A research paper by Dhir *et al*. (2012a), which is also one of the research papers mentioned earlier in this thesis, was an output of this study.

Area of study and population statistics

The two rural areas used for this study were the Alice and Dwesa communities. The Alice community is more technologically advanced than Dwesa since Alice is located closer to larger towns. The study population is explained as indicated by Dhir *et al*. (2012a). The ethnographic study was conducted on two separate occasions. The study was done during May and July of 2011. The final study was in September 2011. During the ethnographic field study, mixed method research methodologies were practiced, where both quantitative and qualitative methods were used (Dhir *et al*., 2012a). Observation, focus groups and personal interviews as well as a contextual inquiry for performing this triangulation were used (Dhir *et al*., 2012a). Figure 5:5, contains the demographic information of the participants including males and females.

The findings from the study show that ICTs are not fully utilized in these rural areas (Dhir *et al*., 2012a).

Participants in the 1st Ethnographic study		
User group	**Community**	
	Dwesa	**Alice**
Youth	11M & 17F	16M & 13F
Women	14F	28F
Farmers	10M & 2F	5M & 3F
Old people	6M & 8F	6M & 8F
Teachers/workers	3M & 8F	6M & 6F
Totals	30M & 49F	33M & 58F

Participants in the 2nd Ethnographic study		
User group	**Community**	
	Dwesa	**Alice**
Youth	15M & 15F	11M & 10F
Women	15F	15F
Farmers	8M & 5F	8M & 2F
Old people	7M & 8F	7M & 7F
Teachers/workers	3M & 8F	6M & 6F
Totals	5M & 10F	6M & 9F

Figure 5:5 Ethnographic study population (1st and 2nd studies) extracted for (Dhir *et al*., 2012).

People travel long distances to get to health centres and the services are very unreliable, with no proper medication available. This leaves the community with no options except to rely on the traditional system of medicine.

> *"It is worse for our growing children who are prone to many diseases"* (Dwesa male, 62)

> *"We are just saved by God's grace in terms of health, so God protects us"* (Dwesa woman, 47)

As earlier mentioned in this chapter, in regards to the statistics related to ICT services which indicated that eHealth had a low figure, it was the second time in a separate study that this result was discovered.

The study also revealed that rural people have a different understanding of ICTs and would want ICTs for various reasons. Those who are working would prefer ICTs which allow them to have relevant information at the right time. Most of the working population uses online transactions and mobile phones to interact and search for information. However, the majority of the community members do not have these ICT benefits as they still do not own personal ICT devices and do not have access to the internet as a working population.

The 16 to 30-year age group stated that they used various means to get the necessary information. For example, for health information, they use ICT devices as indicated in Paper 5. The young children aged 8 to 12 years rely on schools and health clinics to access health information. Schools remain the main ICT source of information in the rural areas. These direct

quotations were used as they were said; this has been indicated in the research paper by Dhir *et al*. (2012a).

> *"Some news reaches the community after a long time, and we travel long* distances *to get information"* (Keiskammahoek farmer, male, 45).
>
> *"I just do what is good for me and I do not rely on Government as they are far from us*" (farmer, male, 45).
>
> *"Government is very far from us, and do not know what is here. I grow what I want and what gives me cash returns"* (farmer, male, 48).
>
> *"Government comes when there are elections, otherwise we do not see them"* (farmer, male, 52).

These results explain that government still has a bigger role to play in making sure that information reaches people in the rural areas. The main ICT challenges identified were the lack of technical skills and local content, making oral communication popular.

This is supported by what old people said regarding oral communication – the old people use traditional communication in the form of frequent gatherings with different community members, which keeps community togetherness. The older population emphasized the need for both traditional communication and new technological usage as these are important in everyone's life.

> *"Technology has come and oral communications are replaced by emails & Facebook, but here oral communication is still very vital"* (Alice resident, male, 24).

The other finding was that rural users in resource-constrained communities do not consider that technology will ever completely replace oral communications in future. This fear of replacement might lead to negative implications for technology use, in the minds of rural users (Dhir *et al*., 2012). These negative implications can even lead to a misalignment of the social life of community members and the community structure itself. However, the author believes that the use of technology will extend the reach of information, if analysed from the community level, i.e. mobile phones for getting weather updates. However, the use of technology might cause divisions within the community, especially among those who do not have the ICT devices.

The author noticed that there could be a lot of variations within a particular community. Depending on whom one is interviewing, the responses provided to the same question by

members of the same community could be very different. This means that people in rural areas, in certain cases, have different backgrounds and perspectives which have to be considered when offering ICT services to such communities. During this study, some comments made by community members clearly explain which ICT services are needed by rural people. The author found that bringing ICT to remote environments is a growing area of interest in various research communities and, as a consequence of this, the ethnographic study was necessary in building up to the roadmap framework. To support the ethnographic study the author investigated how technology is spread and accepted in rural areas, i.e. within the SLL community.

5.5 Technology diffusion in rural areas

After carrying out ethnographic studies in the rural areas, the author performed an analysis on how technology spread in these communities. The technology diffusion model was used to explain how new technological ideas spread in poor areas. This analysis was done based on literature on the Dwesa community and the author's observations. The applicability of the diffusion model was analysed, also based on the findings of focus groups discussions during the Dwesa community visits. The ideas of the technology diffusion model were borrowed and used to help in gaining a better understanding of how technology has spread in rural areas (see Figure 5:6).

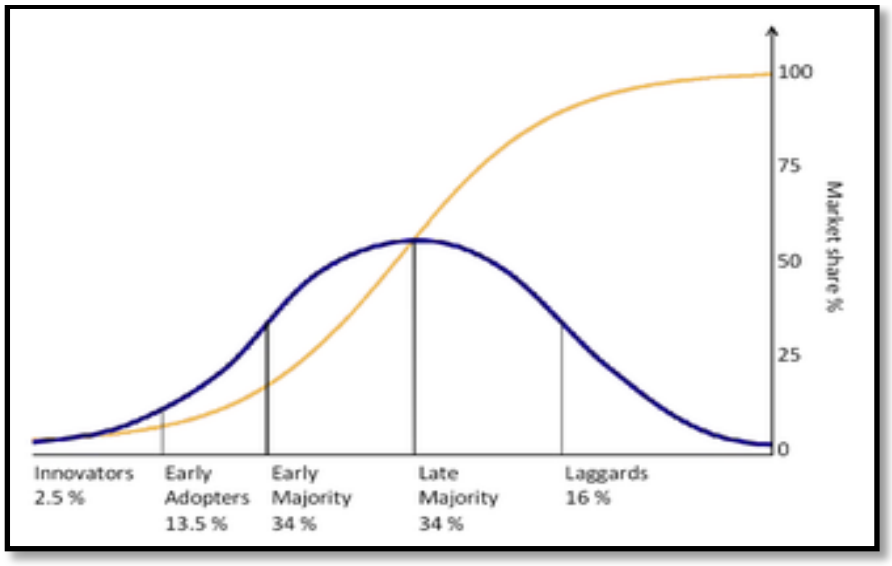

Figure 5:6 **Technology diffusion: Adopted from Rogers (1995)**

Technology diffusion of innovations: Rogers (1995: 12) explains diffusion as a "process by which new ideas are communicated using some means, for a period of time, within a particular area". The theory seeks to explain how, why, and at what rate new ideas and technology spreads in rural communities. The concept behind this theory is that once new ideas are adopted, communication takes place in order to spread the ideas. Within the communication process, evaluation and assessment of the new ideas occur. Then the rules and standards for which the innovative ideas should be implemented are clearly specified (Rogers, 1995). The diffusion process follows various levels and there are different terms used to explain each category of the innovative adopters.

Innovators: From the authors' findings, innovators in rural areas include teachers and a few entrepreneurs. These are the people in the community with a reliable income which allows them to acquire innovative tools. These are represented by a small percentage of 2.5%, which is almost equivalent to the percentage of their population in the rural areas.

Early adopters: The authors observed that the majority of early adopters in rural areas are the youth and a few entrepreneurs who are close to teachers – i.e. innovators. They share information and technological ideas within the community. This group is slightly bigger than the innovators; it is represented by 13.5%, which is almost equivalent to the percentage of jobless youth in rural areas and other school leavers.

Early majority: Rogers (1995) claimed that the "early majority experiences good interaction with other members but do not have the abilities that early adopters have". In the case of rural areas, most of these are women who are willing to learn ICTs and be part of technology. Many of them spend most of their time in the ICT training workshops which are available in their communities. These are fairly represented at 34% which is also a good representation of women in rural areas.

Late majority: The late majority includes some of the community members waiting for the majority until most of their peers adopt the innovation (Rogers, 1995). In rural areas, these are the fairly old individuals in the community; they are influenced by the children and some innovators or other local members. A higher percentage of 34% falls into this category linking it to the population of the old people within the rural communities.

Laggards: As mentioned by Rogers (1995), there is no significant difference between the ages of earlier adopters and later adopters, but this categorization and its characteristics are beyond the

scope of this study. These are the old and the rest of the other people within the rural community. They could be in any group, i.e. teachers, youth, women or entrepreneurs. They are the ones who want to see and learn from others and are represented by 16%. The way innovation is spread in a community is determined by different ICT factors within the community.

The ideas of the technology diffusion model were useful in classifying the various categories of people in rural areas. This also helped to track and assess how new ideas could be brought into rural areas. The diffusion model helped to identify the key technological drivers in rural areas, i.e. teachers and a few rural entrepreneurs. The youth are more active in the community and close to the working class; they will always try to compete with the innovators. Due to poverty and cultural beliefs, the old people will wait for the majority to have used the technologies, then join in later. As a result, old people in rural areas tend to be the last group to grasp innovative ideas. After an assessment of technology diffusion, the author was involved in the last study to check on the readiness of the SLL community to use ICTs. The details are explained in Section 5.6.

5.6 Rural community's eReadiness

After understanding the current state of ICT in rural areas, how ICTs are used, services expected, what has been said about the future of ICTs and how technology spreads within rural areas, it was important to understand the community readiness.

Study 6 – Community eReadiness: This study was conducted after carrying out the ethnographic study. Wesso (2010) defines e-readiness as "the extent to which a community is prepared to engage in communication via the internet using ICT and thus participate in the global knowledge economy". An eReadiness assessment was conducted in the Dwesa community to understand whether the community is prepared to use ICTs at the present moment. The findings from this study are also reported in one of the research papers by Gumbo Jere (2012); this article is listed amongst the author's papers mentioned earlier in the thesis. As indicated by various authors, an eReadiness initiative brings together different parties and discussions on ICT trends as well as the will to understand the knowledge that the community possesses (World Bank, 2001; Gumbo *et al*., 2012). The following steps were taken in carrying out the eReadiness assessment in the Dwesa community:

Communication with community representatives: These were represented by people from government departments, such as the Department of Education, as well as community members, Siyakhula Living Lab researchers and the teachers at various schools.

Assess the current state of ICTs in the community: This was to verify and identify the ICTs that are available and used in the community. The current ICT services, challenges and devices that are available in the Dwesa community were noted in this process. Again, the views of the community members on the ICT trends were gathered. A qualitative research approach was implemented in this study and several of the following research techniques were used:

Telephonic interviews: To set up appointments with the community members.

Focus groups: To get the views of the community after classifying them in different groups based their community roles.

Observations and audio recordings: The current ICTs in the community were observed. Photographs were taken and all discussions were recorded on a voice recorder. The meetings attracted a total of eighty-nine (89) as indicated in Paper 6. The eReadiness findings show that Dwesa rural community is prepared to learn to use ICTs and the internet. The community is also keen to be involved in ICT implementations in the community. As for ICT services, such as internet usage, the community indicated that it is ready and would be eager to enjoy the benefits of the internet despite the community members feeling they had been previously forgotten. There are already a lot of ICT developments within the SLL (Gumbo *et al*., 2012). The community members are also keen to be equipped with ICT skills (Gumbo *et al*., 2012). The discussions educated the community on some benefits of ICTs and the author also noted what the community already expects and its preparedness to use ICTs.

Table 5:7 shows the current state of ICTs for eReadiness in Dwesa rural community

Table 5:7 SLL schools current ICT state

School name	Total school learners	Total meeting attendees	Total literate educators	Total school computers	Electricity available? (Yes/No)	Furniture available? (Yes/No)	Security available? (Yes/No)	Straight line (km)	Distance by road (km)
Schools connected directly to the Ngwane mobile WiMAX base station and VSAT									
Ntubeni	227	12	2	5	Yes	No	Yes	5.54	17
Ngqeza	50	5	5	3	Yes	Yes	Yes	3.80	4.50
Ngoma	112	14	2	0	No	No	No	9.29	20.4
Lurwayizo J	243	12	1	2	No	No	Yes	11.70	27.2
Lurwayizo S	76	4	0	2	No	No	Yes	10.94	27.6
Schools connected directly to the Badi fixed WiMAX base station and VSAT									
Badi	512	14	1	33	Yes	Yes	Yes	0	0
Mevana	255	9	2	3	Yes	No	Yes	1.34	1.30
Kunene	120	9	1	0	Yes	No	Yes	3.41	4.2
Nquba	312	3	1	2	Yes	No	Yes	8.55	12.3
Hlabizulu	260	2	1	0	Yes	No	Yes	10.46	13.9
Zwelidumile	429	9	1	2	Yes	Yes	Yes	9.20	26.3
Totals	2596	89	17	52	8/11 Yes	2/11 Yes	10/11 Yes		

The author observed that most of the schools shown in Table 5:7 have some form of ICT infrastructure. However, the author noticed that, in almost all the rural schools visited, ICTs need to be improved, as the schools do not have adequate resources. Again, the author also observed that some of the ICT services within the community are insufficient to address the community needs. These findings were all useful in designing the ICT roadmap framework discussed in Chapter 6. In showing appreciation of, and interest in, the SLL initiative in the Dwesa community, one of the teachers said:

> *"In these rural areas we depend on textbooks of which some are outdated, therefore this project will be advantageous to us. Students and teachers will both be able to access helpful information on the internet that will increase their knowledge of their related subject areas. This project will also bridge the gap between students from more affluent communities and those from rural areas on their knowledge of computers"* (male teacher at one of the Dwesa schools).

The statement is important in implementing an ICT roadmap methodological framework as one can identify the ICT devices and the services that are required in a community like Dwesa. The eReadiness study helped to get the feelings of the community in getting improved ICT services, i.e. internet access. All these findings were important in shaping the roadmap framework development and explain the series of steps which were taken in this research for the framework preparation. A summary of the findings indicates that the key components of ICTs could be services, devices and infrastructure, as explained in the following section.

5.7 ICT roadmap development – infrastructure devices and services

The thesis focuses on explaining a solution that could address the findings which are explained from the six studies explained earlier. The roadmap framework suggests the need for ICT services, devices and infrastructure that could improve ICT service delivery in rural areas. This requires a sustainable ICT network infrastructure that allows ICT access and devices to be connected within rural areas. The supporting infrastructure comprises telecommunication services and computer servers, and software for servers also forms part of the networking required to improve ICT developments (Broadbenta, Weillb & Neoc, 1999). A wide range of technical ICT skills is required to be able to manage the ICT infrastructure, services and have knowledge on how to use ICT devices. Broadbenta *et al*., (1999) noted that these skills could be provided by ICT staff employed in rural areas, ICT consultants and technical ICT service

providers. Examples of ICT devices that rural ICT users should have skills in include: desktop computers, laptops, mobile phones, thin client computers, interactive whiteboards, data projectors, digital cameras and video cameras, printers and scanners.

The ICT infrastructural plan covers the following:

- Hardware, cabling and connectivity of different ICT devices
- The software requirements, including registered software
- Well-documented, step-by-step networking plans
- Rural telecommunication infrastructure
- ICT stakeholders' support and service providers.

An almost similar study on ICT services and devices was done, exploring the feasibility of ICTs within rural areas of South Africa and Kenya by undertaking a survey. The survey involved interviewing 400 women aged between 16 and 60 years from both Kenya and South Africa (Wafula-Kwake and Ocholla, 2010). Table 5:8 shows a summary of the findings of Wafula-Kwake and Ocholla (2010):

Table 5:8 ICT devices for different Services (Extracted from Wafula-Kwake *& Ocholla*, 2010)

ICT Device	Education		Health		Agriculture		Business		Social Communication	
	K%	SA%	K%	SA%	K%	SA%	K%	SA%	K%	SA%
Radio	77	80	88	81	65	71	65	55	77	80
Television	41	41	33	44	36	35	36	34	43	43
Mobile phone	12	13	20	18	07	14	07	13	07	14
Computers	03	11	00	06	00	01	01	03	01	06
Landline telephone	04	13	03	04	03	12	04	05	05	17

The survey was conducted in the following rural areas: in South Africa, in the Umlalazi, Amatikulu, Eshowe, Gigindlovu and Mtunzini districts in KwaZulu-Natal, and from the Kimoson, Makutano, Sinyerere and Sitatunga districts of Kenya. According to Wafula-Kwake and Ocholla (2010), the main ICT problems are accessibility and lack of ownership of ICTs devices. The most common ICT services in need are: landline telephone, mobile telephone, printing, photocopying, faxing and tele-working. The common ICT devices are: radio, TV and

mobile phones communications (Wafula-Kwake & Ocholla, 2010). Table 5:8 shows the popular ICT devices used in each of the countries and the variations of the devices used as the service changes. From the findings of Wafula-Kwake and Ocholla (2010), the author of this thesis observed that there have been dramatic changes in the ICT devices commonly used to access services. For example, the mobile phone and the computer are currently gaining popularity as the main sources of ICT information in rural areas. The author argues that with the growth of mobile phone usage, it should not be surprising that to date the mobile phone has gained more users in the same communities researched by Wafula-Kwake and Ocholla (2010). These ICT devices and services could be delivered if there is a well connected network infrastructure.

ICT services should be accessed through the network infrastructure within the rural areas. It is also important to mention the fact that there is a need to have support resources for the ICT network infrastructure roadmap to function (Broadbenta *et al*., 1999). These resources include:

- Human labour
- Borrowed and hired ICT services and well planned budgets.

These requirements identified indicate that there are many components and different user groups that have to be integrated to come up with a sustainable ICT solution.

5.8 Concept of ICT infrastructure

According to Broadbenta *et al*. (1999), an ICT networking infrastructure should explain how ICT users are able to share ICT resources. For Broadbenta *et al* (1999), ICT resources need a combination of both hardware and software. This can enable ICT users to access the available ICT services (Broadbenta *et al*., 1999). The hardware side covers the networking side and the infrastructure that could be setup to enable software installations and ICT service deployments.

Any sustainable ICT network infrastructure should be flexible to cater for ICT changes that can be found internally or externally. The ICT network infrastructure is important to allow new solutions and better service delivery. Hence, it should be dynamic and integrated; building a flexible infrastructure reduces the cost and complexities in cases where new future services are emerging. Again, this means considering the variety of user needs within rural areas that can be handled without modifying the infrastructure significantly.

In addressing the issue of ICT services, the current South African ICT roadmap plan in progress was used to explain the characteristics of expected ICT services which the roadmap framework should address. The examples of service characteristics addressed by the ICT roadmap methodological framework include:

To enable increased public and private investment in ICTs – by providing a means to predict new developments in targeted areas. This is possible after having identified the critical areas in rural areas that need to be developed to meet the socio-economic objectives of rural dwellers. This was also encouraged by conducting ICT research in rural areas and gaining an understanding of the current ICTs, ICT trends, market potential, priorities, ICT services expected and the infrastructure investment requirements

To come up with a platform for new technological developments in rural communities – As mentioned in the objectives section, this roadmap plan allows policy makers, ICT stakeholders and ICT service providers to be able to make decisions. This is possible by analyzing the infrastructure requirements which are stated in this chapter that provide more knowledge on what ICT infrastructure is required;

To bridge the digital divide – The framework is also important in clarifying how ICT infrastructure developments in rural areas could close the digital gap between these areas and urban areas. Once the rural areas are connected, the whole world could be reached. Of course, the author noticed the need to have an ICT infrastructure that allows applications to be deployed in local content which addresses the local needs and also enables foreign ideas to be included.

The classification of the studies' findings was important as it provides a clear view of what the framework should address. Figure 5:7 explains the classification of the components based on the findings from the studies 1, 2, 3 and 4 mentioned earlier in this chapter.

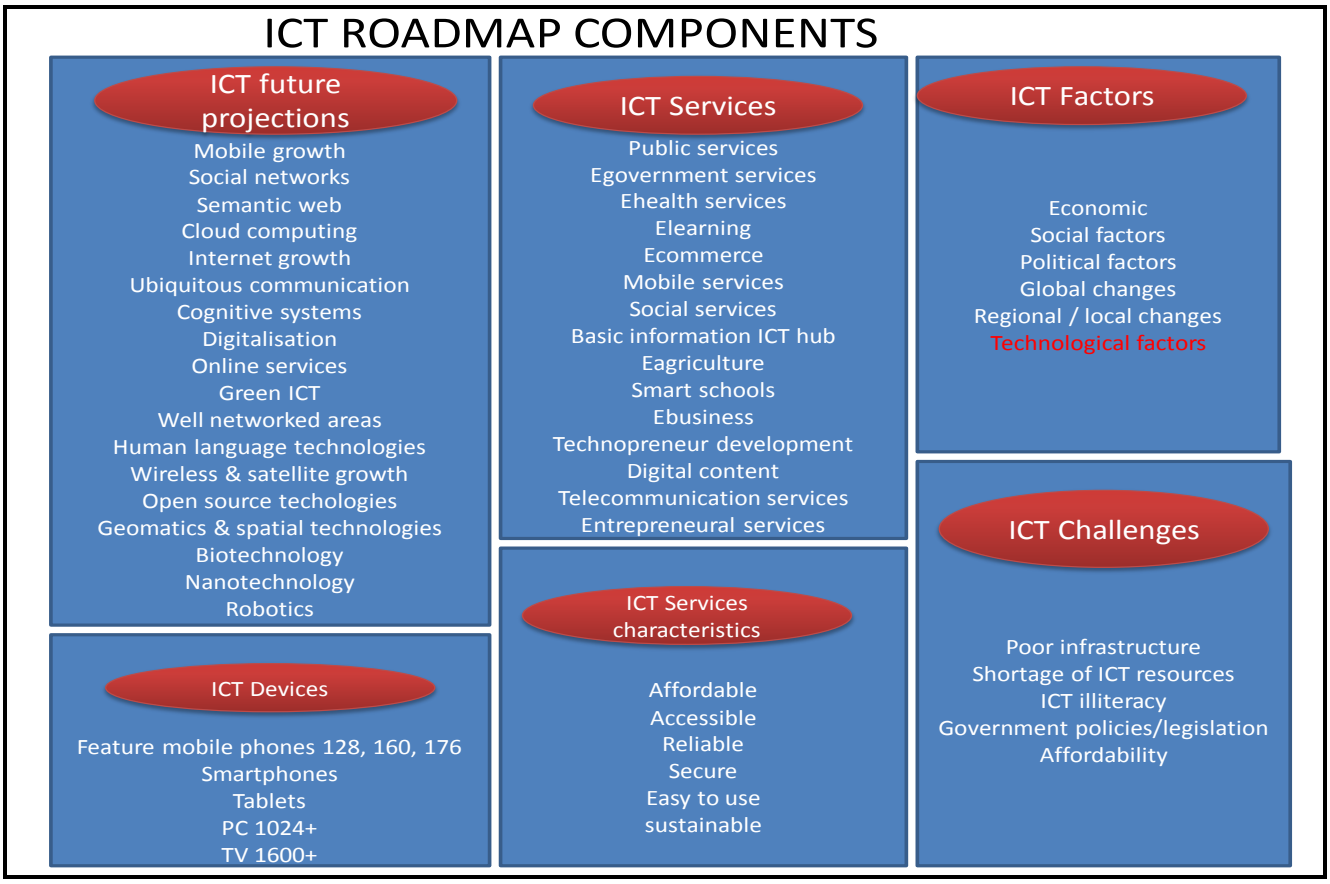

Figure 5:7 Roadmap of future projections

After an understanding on the direction of current ICT trends, the future of ICTs, the characteristics of ICT services expected and emerging technological devices, the author went on to address one of the research questions, which was: *What ICT services, devices, infrastructure mix is applicable in rural areas?* This could enable rural areas to benefit from advanced and emerging ICT services to be deployed within the communities. Based on the roadmap of future projections, many Africa countries are aiming to have better infrastructure by 2015 to 2020 to improve service delivery. As an example, the 2012 State of the Nation address by the President of the Republic of South Africa, Jacob Zuma, emphasized the infrastructural plan for 2014.[10] This should enable ICT services and better service delivery in Southern Africa, with some of the ICT services targeted for 2015 and some, which might need more time, targeted for 2020. As an

[10]State of the Nation address By His Excellency Jacob G Zuma, President of the Republic of South Africa: http://www.info.gov.za/speech/DynamicAction?pageid=461&sid=16154&tid=27985

example, concerning infrastructure, developing nations need to have wireless networking platforms in rural areas. The roadmap framework discussed should be open-ended to accommodate all future advances in technology to enable ICT service implementation.

5.9 Technical requirements for roadmap methodological framework

One major requirement of the framework was an understanding of the hardware, software, services and the telecommunication infrastructure requirements before the implementation of the ICT roadmap framework. This involves the provision of a telecommunication infrastructure which includes mobile service providers already available in all African nations (ITU Report, 2007). Well networked telecommunications enable software and service delivery (Taylor *et al*., 2008). They also enable broadband availability and internet connections and also encourage mobile usage. The author based the framework requirements on the findings on ICT services, trends, future projections and ICT rural users' expectations. The technical plan for the ICT roadmap framework infrastructure is shown in Figure 5:8:

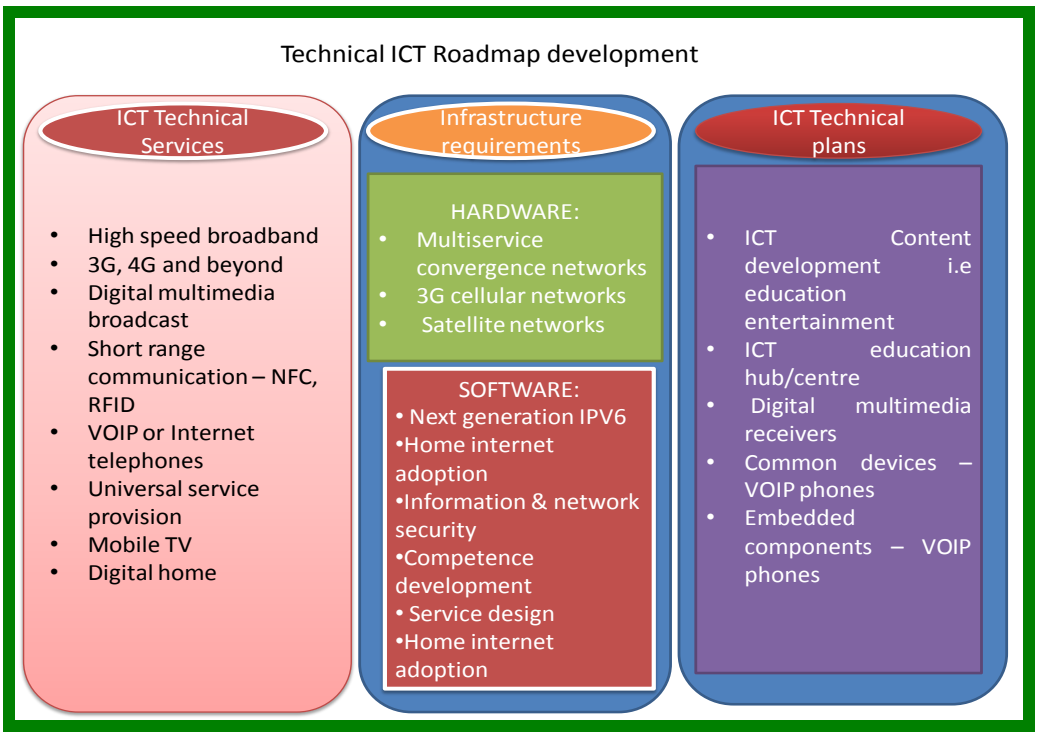

Figure 5:8 ICT technical requirements

The technical view of the ICT roadmap framework should consider the technologies, infrastructure, devices and the sustainability plan as represented by Figure 5:8. The technical plan enables the development and establishment of an ICT infrastructure which should be

required for all rural areas to implement the ICT roadmap framework in this research. High-speed broadband is required for most of the services to be accessed (ITU Report, 2000). However, according to the ITU Report (2007), before there is high-speed broadband, multi-service convergence networks should be in place. There is also a need for 3G, 4G services and mobile networks to be in place before high-speed broadband is achieved (ITU Report, 2007). This entire infrastructure has to be supported by proper hardware and software components, as indicated in Figure 5:8. Proper ICT strategic plans should be in place to support the infrastructural development (Taylor *et al*., 2008). The proposed framework gives a guideline on the order of the infrastructural developments, i.e. what ICT infrastructure should be available first or what should be done first to support various technologies is explained.

5.10 ICT roadmap development based on studies conducted

The study on the ICT services expected and the observation of the current ICT services available in rural areas were used for Figure 5:1. The current ICT initiatives supported by stakeholders, government, NGOs to improve ICTs in rural areas were useful to determine the expected ICT services. The interviews help with ICT stakeholders and focus groups in rural areas helped to provide the current and future ICT services expected in rural areas. The findings of the study on the ICT services as explained in Study 1 were used to summarise and project for the possible future services as in Figure 5:9. To determine the current and expected services up to 2015, the findings of Study 1 were used. In addition to this, literature on future ICT services was used to determine expected ICT services beyond 2015.

ICT for development in Africa involves the provision of ICT services to improve the economy. These services can include commercial, knowledge enrichment and legislative services (World Developments Report, 2009; Harris, 2004). ICT services require secure infrastructural network that is reliable to deliver public services and these services should be accessible to everyone and require support of various ICT stakeholders (World Developments Report, 2009).

According to the United Nations, ICT services include different application services such as those that support business, education and health. The United Nations also mentions the need for a proper ICT infrastructure to support the ICT services (UN, 2009; World Developments Report, 2009). The ICT services are improving rural livelihoods and are changing how individuals communicate, do business transactions and benefit from the ICT usage. Some ICT e-services

identified by many authors include government, eCommerce, health, eLearning, agriculture postal, voice telephone, basic access to information and interactive communication (Dymond & Oestmann, 2004).

Other authors mention ICT services such as**:** Internet services e.g. emails, computer training, content services on education, career development, content development and entrepreneurship, banking and insurance services, social facilities such as youth clubs, womens' clubs, farmers' clubs and better telecommunication services, internet of things, home internet, intelligent services and advanced secure services as noted by Harris, (2004), Qiang, Clarke and Halewood (2006:66). All the developing nations are focusing on ensuring that public services reach rural areas.

Using the current literature on ICT services and the findings of Study 1, the author classified the ICT services as follows: the findings of Study 1 as summarized by Table 4:1 and as indicated by both ICT experts and rural users were added to get the total percentages. For instance this gave the following results eCommerce (39+28 = 67%); eHealth (42+21 = 63%); eGovernment (46+33 = 79%); eLearning (37+36 = 73%); eJudicary (36+27 = 63%); Social services (28+42 = 70%); Mobile services (44+42 = 86%); Basic ICT services (37+49 = 86); Agriculture information (41+32 = 73%). The author classified all those services with at least 70% support as current. This percentage shows that both rural ICT users and ICT experts were in support of these services. The complexity of services as eHealth can be seen with statements such as:

> *"I am now 58 years old and I am strong. I was born in that hut and have never been to a clinic. If I have a problem I consult a traditional healer, so I do not visit clinics,"* from a Dwesa community member.

The rural users suggested services which would support the specific skills they have and services which suit their interests: For example one of the youths in Dwesa said: *"If I am into music and like singing, bring me a guitar so that I can play to practice,"* and one old man was of this opinion: *"We are not all farmers, I do not like farming, so why do you want me to attend eAgric ICT training?"*

The above statements made it difficult to classify the services. However, based on the polarity of services such as health services in literature on ICT services, enabled the author to classify such a service under current services despite a low percentage total.

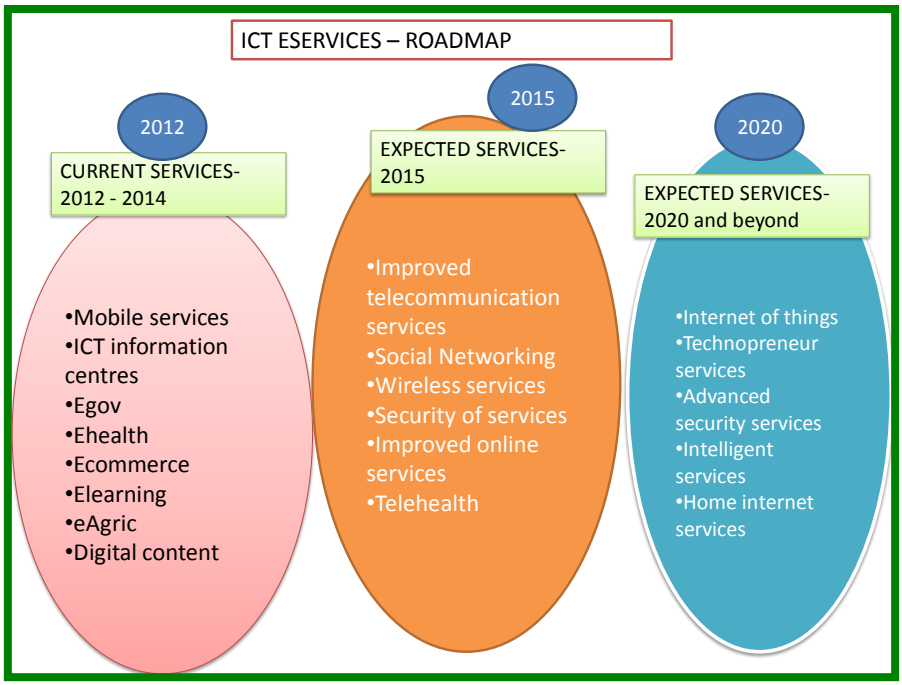

Figure 5:9 ICT services

The ICT services such as: content development, career development, better communication services, interactive communication, home internet, telehealth and advanced secure ICT services were included due to popularity in current literature on ICT services. The current ICT services and the projected ones are shown in the roadmap in Figure 5:9

The findings of Study 3, explained in this chapter, were used to come up with Figure 5:10. In this case, the ICT experts' views on the future of ICTs were used. The experts' views on the current projections and the projections expected in the near future were used. Currently available literature on future projections, i.e. Gartner's research group on the future of ICTs was also used. Figure 5.10 explains the future projections: These projections were summarized based on what both experts in developed and developing countries said: For developing nations the highly future projections been talked about are:

Growth of wireless connectivity, well networked environments, human language technologies, portable devices, open source applications and internet services. The future projections for developed nations include the following key ICT future projections: social networks, cloud

computing, openness, ubiquitous communication, cognitive systems, digitalisation, online services, green ICT, globalisation and smart spaces (Ruuska *et al*., 2010).

Factors affecting the technological projections: From a summary of existing literature researched by the author there are different factors encouraging the implementation of different projections in some areas such as: improved infrastructure, growth of mobile usage, ICT education, access to global markets, and growth of social networks, cheaper mobile phones, and deregulation polices, internet availability, improved bandwidth.

However, it should be noted that there are still challenges and factors which make it difficult for most of the projections to be achieved. *These are: poor infrastructure, no access to computers, high illiteracy, low income, low bandwidth, socio-cultural barriers, poor connectivity, government policies, and shortage of ICT educators, no power supply, and security challenges*.

Using the findings of Study 3, the author picked up the future projections that have at least 75% support of the ICT experts involved. These projections were classified under current projections due to popularity. One of the explanations for the variations in ICT projection was that the current ICT challenges facing rural areas do not call for green ICT at the moment and with the current ICT infrastructure supported by the main factors affecting ICT projections, one cannot talk of ubiquitous communication any time soon in rural areas. Despite most of the ICT experts mentioning the growth of cloud computing and comparing this to the current ICT challenges in rural areas as summarized in Table 4:4, the author had to include cloud computing under expected projections (2015). Open source software has been witnessed in some rural areas like within the Siyakhula Living Lab; however, it was observed that most of the ICT initiatives are funded by NGOs and private companies who provide proprietary software like the Windows operating system. Hence, the author includes this with expected future services. Due to high illiteracy in rural areas and current ICT applications in rural areas, audio-based applications were included in the current projections despite the ICT experts' low percentage support for them. Human language technologies are also projected for rural areas to accommodate the illiterate ICT users in these areas. Adding other common projections based on observations and literature on future projections, digitalization was added on current projections as this has been witnessed in most of the rural areas. This also applies for wireless connectivity in rural areas, supported by

mobile infrastructure developments. Using this analysis, the future projections were represented as follows: Figure 5:10

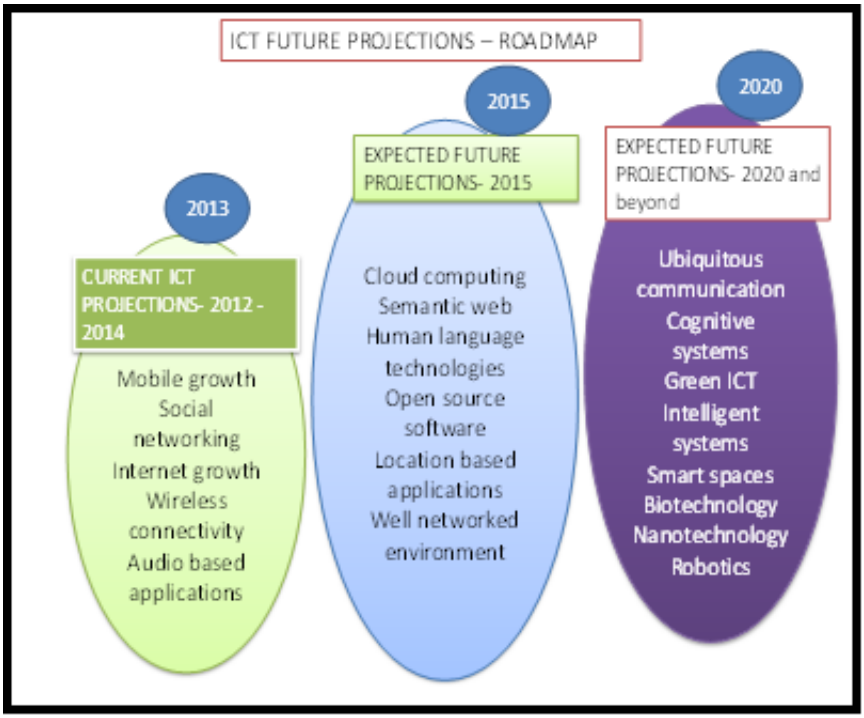

Figure 5:10 Future projections of ICTs

In order to achieve most of the projections for example cloud computing, an infrastructure is required that springs from services, high quality services that are always accessible, on any device, i.e. mobile and fixed, at any connection (ITU Report, 2007). The availability of communications infrastructure is critical for all public services and business-related applications in developing countries (ITU Report, 2000). It gives people the opportunity to connect and share information, thus maximizing productivity and creativity. Having the services accessible and available to rural communities could enable the introduction of some of the future projections similar to the ones highlighted by ICT experts during the studies.

To offer services and meet the future projections in rural areas, supporting infrastructure with the right technologies and devices is required (ITU Report, 2000). The author also acknowledges the fact that due to some of the current ICT challenges noted during the studies, some future projections might take a while to reach rural areas. However, with the help of a guided framework explained in the next chapter, this is possible. Based on the general technical ICT

roadmap in Figure 5:8, the author has expanded each of the components, e.g. the ICT technical services, infrastructure requirements and ICT technical plans to explain the projected expectation to rural areas. Again, this expansion was based on the findings from the studies. The idea was to show the current state and predict how the future could be, based on the scenarios explained in Chapter 4. The technical roadmap and future projections enabled the development of the infrastructural roadmap plan shown in Table 5:9.

Table 5:9 Infrastructural roadmap plan

Infrastructural requirements roadmap			
ICT infrastructure	**Current (2012)**	**Near future (2015)**	**Future (2020 & Beyond)**
Mobile phone networks	Deployment of Mobile infrastructure	M-Services supported by Mobile infrastructure	All rural areas with 3G network services
Wireless Local Area Networks	Introducing high speed data	Fast mobile data services	Connectivity in all areas
Satellite networks	Policies on Satellite network coverage	Satellite supporting ICT services	Important ICT services available on satellite networks
Radio/TV Broadcast	Packet radio, microware links	Digital, radio & TV signals	Community radios accessible for all
Digital Multimedia broadcast	Standards adopted DTTB trials	More household coverage DTTB	Almost all areas covered
Multi service convergence network	Migration of platform based services	ICT service development -	Majority of rural households With internet access

Table 5:9 highlights what is currently happening and what is expected in the near future in rural areas. The author used the data from the studies which were explained in Chapter 4, mainly focusing on the services expected and the readiness of the SLL community. Using these findings Table 5:10 provides a probable roadmap for infrastructure and services for rural areas. This is used in the next chapter for the development of the ICT roadmap framework.

Once the infrastructure is in place, the following technologies could become available in rural areas:

Table 5:10 Technologies for roadmap

Technologies for Roadmap			
Technologies	**Current - 2012**	**Near future - 2015**	**Future– 2020& beyond**
High speed broadband	Initial penetration	Slowly penetrating	Increase broadband penetration
3G, 4G & beyond	Slowly penetrating few subscribers	Better polices increasing subscribers	Almost all users subscribed
Short range Communication – NFC, RFID	NFC & RFID awareness	More users starting using	Widespread usage
VOIP or Internet telephones	Establish QOS & PSTN access	Used for rural business	High quality & cheaper voice services
Mobile TV	Pilot surveys	More people start adoption through mobiles	Services anytime, anywhere – majority of mobile users using it
GPRS	Promoting location based services	Increased sensor based applications	Location based services connecting communities

Table 5:10 focuses on the technologies which will probably be found in rural areas in the future. These technologies are driven by the future services forecasted in rural areas. Thus, such technologies should be in place and could assist in meeting the future ICT changes in rural areas. Again, this played an important role in the actual framework development.

These predictions are based on the current ICT developments and roadmap plans which are available within developing nations. It should also be noted that the success of this depends highly on Government ICT polices in the respective countries, ICT stakeholders initiatives, community engagement and ICT awareness programmes. For the ICT infrastructure and technologies to succeed, there is need for stakeholder involvement. Table 5:11 shows the key actions which are required for the ICT infrastructure plan to benefit the communities:

5.11 ICT roadmap framework plan of action

There should be a continuous assessment plan in place while the ICT infrastructure roadmap plan is implemented. The action plan should encourage research, new ideas and practical case study examples. This could improve ICT initiatives and services and ensure sustainability of ICT projects in rural areas.

Table 5:11 ICT technical plan of action

ICT ACTION PLAN FOR ROADMAP DEVELOPMENT	
ICT Action	Technical plan 2012–2020
Content development	Promote creativity awareness – with ICT stakeholders – relevant
ICT services	Content development that contributes to effective communication in rural areas
ICT Technical education hub/Centre	Promote ICT learning, through high quality ICT training, creation of rural ICT centre of excellence offering ICT courses & education
Digital Multimedia receivers	Digital content producers should come from respective rural areas, supported by ICT devices such as community radios and mobile TVs
ICT communication devices eg VOIP	Prototypes of ICT devices used for communication in rural areas. Rural based communication devices for business and ICT service access.
ICT awareness programmes	Set up community radios, plan ICT awareness campaigns in rural areas
N.B. The success of these ideas requires the working together of different ICT stakeholders	

It is clear that the technological changes require a lot of technologies and infrastructure to be in place. The technologies which are necessary to provide ICT services in rural areas as mentioned by ITU (2007) include:

Sufficient bandwidth – For ICT users to be able to access and trust the services provided, bandwidth is very important. For internet based services, bandwidth has to be available to enable file download and improve service access speed.

Internet – This is the primary infrastructure component. An internet connection is a necessity for most types of latest ICT services (ITU Report, 2007). The presence of internet makes it easy to implement majority of the ICT services both in advanced and developing communities. This Electronic based services are enabled by the availability of internet.

Broadband wireless deployment **–** Wireless access seems to be a solution in African rural areas which are difficult to connect through fixed lines (ITU Report, 2007). Wireless connectivity includes both WiMAX and 3G technologies such as EDGE and EV-DO: Horizon Wireless launched a 3.5 GHz broadband wireless network in Nigeria recently (ITU Report, 2007). World Telecom Uganda selected Motorola to deploy a WiMAX network, as it already had experience deploying such a network in Pakistan. MTN Rwanda also plans to establish broadband wireless access with the service of Cambridge Broadband Networks in its capital, Kigali (ITU Report, 2011). This could enable the deployment of cloud-based services and improve social networking with mobile applications.

The other technologies that are important include: *Multimedia terminals and voice telephone.* These types of technologies are easy and cheaper to implement in low resource areas. In most cases such technologies are important in providing services such as: "e-mail, voice and video communications are becoming available through non-traditional devices, such as home entertainment systems" (ITU Report, 2007). Multimedia terminals are important in rural areas for information disseminating. Currently, a wide range of new services such as e-mail, eCommerce, tele-education and tele-medicine, among others, have made access to interactive multimedia services as important as voice connectivity alone (ITU Report, 2007).

There is a need to understand the ICT infrastructure that is required to support ICT services and devices. Some of the possible tips for implementing sustainable ICT infrastructure in developing countries as said in the ITU Report (2007) are based on the following:

- Coming up with low-cost ICT solutions
- ICTs that are readily available and easy to set up
- Carrying out routine check-ups and infrastructure updates
- Offering basic ICT infrastructure for rural areas.

These characteristics of ICT infrastructure required in rural areas are important to understand in an effort to offer sustainable ICT solutions.

5.12 Conclusion

The findings explained in this chapter were important for the preparation of the ICT roadmap methodological framework. These findings explain the current state of ICTs in rural areas, the expected ICT services, the ICT challenges currently experienced and the future of ICTs and services. Several factors influencing these projections and ICT developments were also highlighted. All this was used as a build up to the ICT roadmap. These findings were used to forecast the future of ICTs in rural areas. The ideas on ICT services, devices and infrastructure explained in this chapter were generic enough to advise ICT stakeholders on some possible future expectations. This enabled the formulation of the different components of any sustainable ICT roadmap for rural areas. The chapter has explained the ICT services, technologies and devices that could be important for rural areas. The author used the details of this chapter to predict the probable ICT trends for the development of the ICT framework explained in Chapter 6. An analysis of the technologies, services and devices helped in developing the roadmap framework to be explained in the next chapter. Chapter 6 shows the specific services, devices and infrastructure which were proposed for a successful ICT roadmap framework.

Chapter 6:
ICT ROADMAP METHODOLOGICAL FRAMEWORK DEVELOPMENT

The roadmap framework produces a set of guidelines that the developers of emerging eServices will follow to make sure that these people benefit and know how to gain access to the services.[11]

6.1 Introduction

The previous chapters have explained the current literature, studies conducted in relation to this particular research and results from the studies conducted. The earlier chapters explained the views of ICT stakeholders and researchers. These views are important in providing vital information that helps in understanding the requirements and expectations of users. This has enabled the author to summarise the key requirements of the ICT roadmap methodological framework, which is the focus of this chapter. The exact services, technologies and devices for the roadmap framework are provided in this chapter.

6.2 ICT services, devices and infrastructure

There is no doubt that ICTs have been explained in different forms. ICTs affect economic, social, political and technical aspects as indicated by the methodological framework in Figure 4:5. The thesis has focused on the technical aspect and it is acknowledged that the other aspects are all as equally important as the technical aspect. However, for the purpose of this thesis the rest of the aspects are assumed to be addressed first for stakeholders to fully plan for sustainable ICT roadmaps. After analysis of literature on ICT trends, developments, challenges, future projections and ICT initiatives by different nations explained in Chapters 2 and 3, the author decided to consider the main ICT components in terms of services, infrastructure and devices. In support of this decision, a summary of the studies conducted as explained in Chapter 4 and currently available literature is given in this section: the author randomly selected statements which were initially used in Chapter 2 to justify the importance of ICT services, devices and infrastructure:

[11]Author's perspective on the developed ICT roadmap framework.

- ICT stakeholders support the idea that everyone should use and access ICTs to get public services and share information at minimal charge
- Many ICT authors noted that in order to get public services, rural people have to travel long distances to nearby towns (Munyua, 2007). Schools are common sources of ICT access in rural areas and the majority of the schools have ICT illiterate teachers (Moshapo & Hanrahan, 2007; Chigona *et al.*, 2010).

The literature has shown that for *ICT services to reach that everyone, it does not depend on improved telecommunications infrastructure alone, but requires all other ICT stakeholders to work together and ICT policies to be in place.*

The growth of mobile penetration as supported by 90% availability of mobile phones to the world's total population, i.e. covering 5.3 billion people (UNESCO Institute for Statistics, 2010), indicates the spread of mobile devices.

The ITU report mentions that companies have to start considering the best ICT strategies to venture into this big market opportunity in developing nations (ITU, Report, 2011). Furthermore, this involves developing usable devices for ICTs and having business models which suit the requirements of the emerging markets. Of course, many people in developing countries are poor, but proper business models enable businesses to make profit in such areas (ITU Report, 2011; Guislain *et al* 2006:8).

The low usage of ICTs in Africa was also a finding by different other researchers such as Mosia and Ngulube, (2005) and Kweku (2006). *The main problems for poor technological improvements are: poor infrastructure, no reliable markets, high illiteracy levels, poverty and poor regulation polices* (Caspary & O'Connor, 2003; Munyua *et al*., 2003; Richardson, 2006, Chigona *et al*., 2010). Nicholson (2011) noticed that because of the poverty in Africa, most Africans mainly in rural areas *will never have personal technological devices such as laptops, Kindles or mobile phones* (Nicholson, 2011). This means that there is need for proper planning on ICT services and devices to be used if ICTs are to benefit the rural poor. These ICT challenges suggest the need for ICT stakeholders to work together in providing solutions. The proposed solutions in this thesis could be through well connected areas and improved ICT infrastructure with affordable and accessible devices. The idea of choosing ICT services, devices and infrastructure is supported by the reviewed literature on different nations including those in

Asia, Africa and Europe, which explain ICTs by providing services and infrastructure. All the countries reviewed in this thesis clearly show that ICTs are essential in service provision if ICT infrastructure is available. A few countries are selected and used as indicated here:

Support from other countries:

The Bangladesh ICT plan was developed by the government of Bangladesh to *empower the people with ICT services.*

The Philippine ICT roadmap plan draft document focuses on the *government's strategies and programmes meant to enable its citizens to access ICT solutions* (Ramon, 2006).

The Pakistan vision for 2015 was on the premise that if some of the best international practices in ICTs usage are applied in Pakistan under a joint action by all stakeholders, then by 2015, Pakistan would be developed. Hence, the ICT roadmap for *Pakistan focused on addressing the key services needed, which could be accessible using ICTs* (Jaffri, 2008). The idea was to provide these services to all citizens.

The government of Malaysia saw the importance of ICT to the national economy and planned to have an ICT roadmap as well. A report to improve ICTs which was prepared by the National Information Technology Council of Malaysia (2010) explains the government strategy to improve ICTs. "*The focus was on offering eServices to the people. Some of these services were, e-community, eLearning, e-sovereignty, e-economy, e-public services, e-business and eGovernment"* (Dato, 2008). The main priority in accessing these eServices was given to the public and the rural people. The plan was to achieve this through the convergence of technology e.g mobile telephony, internet and broadcasting (Dato, 2008).

The Government of South Africa planned to improve ICT access in these areas by drafting a roadmap strategy aimed at connecting rural areas. The focus of the roadmap was to improve rural areas and reduce poverty in these areas through *ICTs by deploying an infrastructural plan that will improve service delivery.*

The government of Lesotho through the Ministry of Communications, Science and Technology came up with an ICT Policy to guide the country in addressing the ICT challenges faced by the majority of the Basotho (Motsoahae, 2005). The policy was proposed to bring together the government, private sectors and all the people. *The idea was meant to get the ICT services and*

need required by the people so that the government can implement a solution that is people-centered (Motsoahae, 2005).

The findings from Studies 1 to 6 explained in Chapter 4 show what the rural people are expecting. In summary, there is need for better service delivery in rural areas. However, there are factors and barriers which affect the delivery of service in these areas. The results of Study 1 show the services that rural people are expecting and the main challenges faced. Using the results from Table 4:4 on ICT challenges, the author selected the challenges that had a percentage representation of more than 75%. That means these were indicated as the most popular challenges during the study and a summary of these include: *lack of resources, poor infrastructure, economic challenges, technological illiteracy and no access to ICTs.* The author did a further analysis of these challenges and concluded that economic challenges affect the people in that they are unable to own personal ICTs, which increase the chances of high technological illiteracy. The summary in Table 4:7 on the state of rural schools visited show that those *schools with ICT devices and improved infrastructure offer better services*. The findings of Study 4 on the factors promoting technological projections indicate *that improved infrastructure, growth of mobile usage, improved bandwidth and ease access to ICT resources can enable rural areas to benefit from the future projected ICT services*. The ethnographic study – Study 5 – explained the grievances of the communities and it is clear that rural people are in need of *ICT services that are readily available and accessible to them*. The gap to access services between the poor and the working class in rural areas, i.e. working class accessing services over the *mobile and have internet services readily available while the poor rely on schools and do not own resources,* was the other finding from Study 5.

The conclusion was that for rural people to have ICT services, proper infrastructure should be in place, with the required ICT devices. *There is no doubt that this requires a lot of other actions, i.e. proper ICT policies, stakeholders' engagement and supporting business models*. However, for the purpose of this thesis the author chose to focus on the three components, assuming that there is a lot of work required from ICT stakeholders like ICT infrastructure, devices, services polices and technical business models to be available to enable the ICT roadmap framework to benefit in roadmap process.

The two figures 5:5 and 5:6 show the ICT services required by rural ICT users and supported by ICT experts. The figures also show the future projected services and applications which are likely to be noticed in rural areas. The projections were made by ICT experts. An understanding of the ICT services and projected services helped in coming up with the ICT roadmap framework. The ICT services and the projects gave an idea of what is expected and the author had to determine the supporting infrastructure and devices. For ICT services to be available, accessible and benefit rural people, there is need for reliable infrastructure and affordable ICT devices. ICT policies, proper business model, societal considerations and the benefits of ICTs should be available to support the infrastructure and devices.

6.3 ICT roadmap methodological framework description

As earlier mentioned, under the methodology in Chapter 4, a literature and technical review on various ICT-related services, technologies, devices and infrastructures was conducted. Some of the data in this study was collected through field visits and interviews in rural areas and with ICT experts. These techniques, combined with existing ICT developments, were used to classify the ICT services, devices and infrastructure as shown in Figure 6:1. ICT services were classified to address the rural user ICT needs, as was discovered in one of the studies outlined in Chapter 4. The classification of various ICT devices was also noted using studies which were carried out by different ICT researchers. The required ICT infrastructure was mainly determined through the author's observations and internet searches on rural infrastructure; the classification was done based on these. The classification of the ICT roadmap framework is concrete and generic enough to cater for the ICT services, devices and infrastructure identified.

The ICT services and devices available in the communities depend on the existing technologies and infrastructure in a particular area. The current ICT infrastructure trends and rural developments reveal that a different ICT infrastructure is available in rural areas. Several classifications can be used to group infrastructure in rural areas, but the author has used observations and current literature on ICT infrastructure within rural areas to devise the classification shown in Figure 6:1 under ICT infrastructure. It should be noted that there are dependencies between ICT services, devices and infrastructure. These dependencies meant that there are different links and relationships that are available amongst ICT services, devices and infrastructure. In order to cater for the ICT dependencies, the services, devices and infrastructure

were accessed, analysed and categorized. The services were classified into seven categories with the idea of accommodating all the expected ICT services in rural areas which should be considered in the roadmap framework. This classification accommodates any service which is required in rural areas. The ICT devices were grouped into four different types and the suggested infrastructure is classified into five classes. The classification is presented in the form of a diagram in Figure 6:1.

6.4 ICT services

The roadmap framework aims to cater for the ICT services suggested for rural areas, including the following:

Addressing social services – The author proposes the development of technical education programmes for creating digital content for electronic games, especially immersive online games to address some social services expected in some rural areas (ITU Report, 2007). This should create togetherness and enable ICTs to be used in sports development in rural areas. Furthermore, this should be geared to assist creative people such as artists, designers, writers and educators to provide content for the current and next generation of games and education simulations (ITU Report, 2007). The idea of enabling ICTs to bring people together is premised upon achieving the social goals necessary to satisfy their desire for social services in rural areas.

Addressing entrepreneur services – The framework encourages entrepreneurs in rural areas to use ICTs to enhance businesses in rural areas. The 3D internet applications should be used to assist entrepreneurs in offering commercial services in rural areas (ITU Report, 2007). All services should be available online within rural areas. Also, m-Commerce could be promoted through the use of mobile phones in rural areas. The author supports the idea of software development that supports ICT services in rural areas. The software should be combined with business ideas so as to improve ICT economic sustainability within rural areas.

A series of business model workshops were also attended by the author to identify the business needs of rural people through ICTs. Several ideas were raised to support the type of ICT services, the possible ways in which rural people could benefit from ICT initiatives and some key partners required for the success of ICT projects. The business model discussions are not included here as this was beyond the scope of this thesis; however, a sample of an ICT business model for ICT services is provided in Appendix D. It is, however, meant to support some of the

findings and to demonstrate the methods that could be adopted to address rural ICT needs. Understanding the need for a proper ICT business model ensures better ICT project planning and allows for the working together of different partners involved in ICT initiatives, thus resulting in a sustainable solution. A sample of a technical business model for ICT services, based on the workshops which were attended, is included in the recommendations proposed later in the thesis.

6.5 ICT services, infrastructure and device classification

The classification of the ICT devices was also based on the common devices which are available and used in most rural areas. Although ICT devices come in different forms, this classification includes any ICT device that could be used in resource constrained areas. There are some ICT devices that seem to be more common in the majority of rural areas, but a wider possible range of ICT devices is provided. These devices are mainly used to access much needed ICT services and are dependent on several factors. The factors include the affordability of devices, as well as their usability, simplicity, sharability and low power consumption. The ICT services required have a strong effect on the devices to be used.

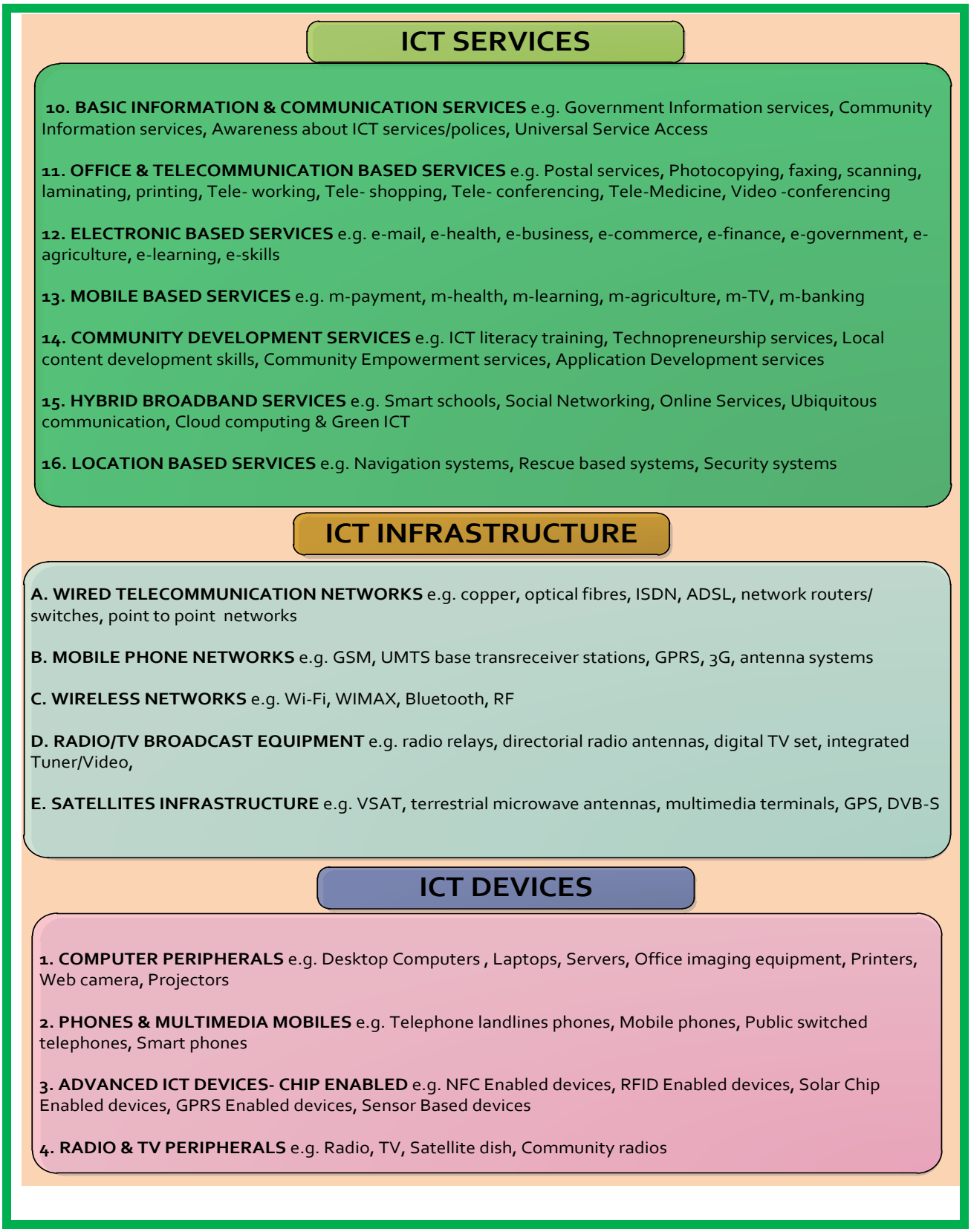

Figure 6:1 ICT services, devices and infrastructure all-in-one

The ICT services were classified based on their types this was done based on the author's own classification. The idea of the classification was to enable the identification of possible linkages between services, devices and infrastructure. The order of the classification of ICT services, devices and infrastructure does not matter since all three ICT components are linked and depend upon one another. The ICT infrastructure was classified based on the common infrastructure currently dominating and expected to be popular in rural areas. This is the same for the ICT services and devices.

6.5.1 ICT service description

After conducting studies and workshops which engaged rural ICT users and ICT experts, as indicated in Chapter 4, seven different classes of possible ICT services were derived for this thesis. The numbers 10 to 16 were used to name these services so as to enable easy referencing when drawing the diagrams that would represent the roadmap framework. Thus, for this thesis, the numbers 10–16 are used to describe the various services. The classification was concluded after consultations with various stakeholders involved in ICT service delivery and was evaluated to accommodate all possible ICT services that could be provided in rural areas. Besides the rural users' expectations and ICT experts' views on ICT services, the existing literature was also used to list all the relevant ICT services. Question 5 in Appendix A queries the matter of ICT services; it provides a list of some possible ICT services which were used for this classification.

Explanation of ICT services:

- It was noted that, in most cases, rural areas are in need of basic information for almost all important services. These basic services could be communicated through radios, TV, using mobile phones or micro phones. The idea is to create awareness and equip the communities with important information. In this thesis, such services are classified as **10 – *basic ICT services***.
- There is a need for rural people to share, transfer and disseminate information within their communities. Moreover, rural people also want to communicate with relatives and friends in urban areas and exchange documents and other day-to-day bits of information. Such services were classified as **11 – *office and telecommunication based services*** in this thesis.

- The spread of the internet within rural areas has awakened the interest of many rural ICT users. Many of them now prefer to use the internet to search and perform services, mainly through the use of computers. These kinds of services were referred to as **12 – *electronic based services***.
- The growth of the internet in rural areas has also been followed by an increase of mobile users in rural areas. The development of various mobile applications, which are easy to access and very useful for rural areas, has encouraged rural users to ask for mobile services. All the services which could be accessible over mobile phones were classified under **13 – *mobile based services***.
- As technology changes and becomes too complicated for the majority of rural users, there is a need for services that could help in educating rural ICT users. This was reiterated by some rural users, during the studies, who stated that they would prefer ICTs that benefit and improve their lives. ICT experts also mentioned services that could empower rural users with ICT skills and knowledge. The ideas were combined into category **14 – *community ICT development services***.
- The future of ICT changes were some of the important research aspects which were considered in this thesis. The different changes supported by several ICT future projections resulted in the classification: **15 – *hybrid broadband ICT services***. These services include all the current future projected services which could be deployed in rural areas. These services are supported by technological developments such as internet growth.
- Many rural people now look for services that can help them to locate various important items that could be useful to them. For example, rural farmers would like to monitor and track their animals during the day; rural travelers might want to locate buses or possible transport. The possible use of sensor-based services for healthcare and private security in homes, rural shops and schools has also been mentioned. Considering all these, the category: **16 – *location based services* was proposed**.

This classification of services has helped in developing the roadmap framework and any other class of services could be added to this list.

Description of selected ICT services: The ICT services required for rural areas are briefly explained in this section. The services explained herein were chosen at random to provide a brief understanding of particular services. Some of the selected services are:

eAgriculture – Agriculture is one of the common income generating activities in rural areas. This means that it needs support from ICT stakeholders. This has increased the need for fast and reliable services for farmers. Some of the farming services make use of ICT devices such as mobile phones, radio, CDs and DVDs. According to the report on Zambian rural ICTs (2011), agriculture is very important part of the economic sector and ICT developments in agriculture could improve income in rural areas. This is also true in almost all African countries.

eGovernment – This allows the public to access the basic government services which they require. Everyone is in need of such services and all governments are making efforts to ensure that such services reach all the people in their areas.

eHealth – Providing health awareness services and information on medication is vital in rural areas. By improving health services at rural medical centres, African governments will save a lot of lives. Rural clinics require an ICT infrastructure that allows internet access and the sharing of health information. The benefits of deploying eHealth include: up-to-date medical information within communities as well as the connectivity of health practitioners, which enables the sharing of information in order to equip those who live in rural areas with adequate health news.

Mobile TV – According to Mittermayr (2006), the near future will see many people in rural areas using mobile TV services. This has been necessitated by the increase of mobile users in all areas. The presence of mobile infrastructure in rural areas also encourages mobile TV services.

Universal access – This refers to access, by everyone, to quality communication services such as telephony or the internet at affordable prices, all the time. This means services are available, reachable and usable at low cost.

Local content development – There is a need to develop ICT solutions that address local needs. Due to cultural and language differences, ICTs should be localized to satisfy the communities for which they are developed. ICT services should satisfy the local needs and should contain information that is relevant to the targeted community.

6.5.2 Description of ICT devices

Having noticed that for each particular service and infrastructure, an ICT device to support and help to access the service will be needed, a list of all possible ICT devices was made and the same procedures that were used for services and infrastructure were followed in this regard. The majority of the people do not own some of the ICT devices, but it was observed that they are shared in most cases. The idea of sharing ICT devices is supported in this thesis, and the use of existing and available devices is also very important. It was observed that many rural areas rely on schools to access ICT devices such as computers, and schools are also used as the common place to recharge some of the devices, such as mobile phones.

Classification of ICT devices: The ICT devices common to rural areas were classified into four categories. The numbers 1, 2, 3 and 4 are used to name these devices. For the diagrams used for this thesis, the devices are named as D1, D2, D3 and D4. After noticing the presence of devices such as computers, printers, overhead projectors and scanners in rural areas, a class of devices was derived. These devices are all categorised under **1 – *computer peripheral devices***. These devices are largely popular in rural schools. The schools could be used to access almost all the services described and could also utilize almost all the possible infrastructure available.

The need for instant feedback and the use of VOIP has encouraged the use of portable devices such as mobile phones. In some areas, land line phones are also very significant. These kinds of devices are categorized as **2 – *phones and multimedia mobile devices***. The use of mobile phones in rural areas requires mobile infrastructure and mobile services.

The need for electronic transactions, sensor-based systems and navigation services could also increase the need for chip-enabled devices. This class of device includes any device that could contain a chip which can improve its functionality. This could include solar chip-enabled devices which allow ICT devices to be charged by solar energy. In this thesis, such advanced devices are referred to as **3 – *advanced chip enabled devices***.

To support the current ICT devices and utilize the existing infrastructure, broadcasting devices are also important. These devices are classified as **4 – *radio/television broadcasting peripherals***. These devices are useful in disseminating information in rural areas. On occasion, community members gather to listen to or watch programmes, videos, movies and the latest news in their area over the radio and television, so utilizing these devices can benefit many people.

The three components described, i.e. ICT services, infrastructure and devices, are at times inseparable in terms of efficient service delivery. This was also observed during the development of the roadmap framework. However, there was a need to consider the minimum possible requirements for any community to at least gain some services. The idea was to consider the best service that could be offered under a particular infrastructure by using certain devices. The ICT service, devices and infrastructure diagram (Figure 6:2) shows a detailed summary of which services could be offered; it specifies the devices and required infrastructure.

6.5.3 ICT infrastructure description

The same techniques which were used to classify services were borrowed for the classification of infrastructure. Infrastructure was considered critical in this thesis as this was an attempt to address a common ICT challenge in rural areas. In this case, poor ICT infrastructure was one of the frequently mentioned challenges. The thesis identifies some possible ICT infrastructure that should be provided for rural areas. Besides some discussions which were held with ICT experts in order to gain an understanding of infrastructure developments, a literature review was also used to help in classifying ICT infrastructure. For this thesis, the letters A to E were used to name the types of possible rural ICT infrastructure.

Explanation of ICT infrastructure: The basic common and easy to set up ICT infrastructure, especially where landline telephone lines are used, is the wired network. This type of network is classified as **A – *wired infrastructure*** in this thesis. However, the mobile growth developments have encouraged many ICT infrastructure stakeholders to deploy more mobile infrastructure. This is to support the emerging mobile devices within rural areas. To accommodate mobile usage, the deployment of mobile infrastructure has been called for. This was classified as **B – *mobile infrastructure***. The mobile infrastructure and poor road networks, poor terrain and hilly areas in rural areas have increased the demand for wireless infrastructure. The literature shows that many rural areas are linked through wireless networks. Thus, this proposed infrastructure is labeled **C – *wireless infrastructure***, in this thesis. Some respondents mentioned the use of already existing infrastructure, and for this the broadcasting network was suggested. Therefore, in this thesis, **D – *radio/TV broadcast infrastructure*** is required in rural areas. The last class of infrastructure is **E – *satellite networks***; this category is encouraged by wireless networks and there is also evidence that a need for such infrastructure exists in rural areas.

The roadmap methodological framework discusses various technologies which are required and could be used in ensuring that ICT services reach all the necessary individuals. The suggestion is to deploy all the technologies which can facilitate the required services. Examples of these technologies are:

Localization based technologies – Traditionally, GPS, WiFi, and GSM technologies are used for localizing users. Google Maps Mobile for mobile phones primarily uses GPS and WiFi for localization. However, the GPS and WiFi technology can be used only on high-end phones with those capabilities (Gaonkar *et al*., 2008). Since most low-end phones lack GPS and WiFi capabilities, GSM-based localization is a good alternative as it only requires an active cellphone connection. Further, GSM-based localization is more economical and energy efficient than GPS or Wi-Fi (Gaonkar *et al*., 2008), and is recommended in this framework.

6.6 Roadmap methodological framework process

After going through the existing roadmaps and conducting an analysis of the future of ICTs, the author began the roadmap methodological framework process. This process followed a step-by-step procedure to come up with different graphical representations, as explained in this chapter. These steps were considered to be simple, realistic and would produce a reasonable ICT roadmap framework. Several other steps were taken, but the following ten steps were used to summarise the analysis and development of the ICT roadmap framework.

Step 1: Identifying three roadmap framework components, i.e. ICT services, devices and infrastructure.

Step 2: Classifying each of these into different categories as shown in Figure 6:1, i.e. seven categories of services, 4 categories of devices and 5 categories of ICT infrastructure.

Step 3: Establishing the relationships between services, devices and infrastructure – to see which services could be offered on certain devices under a particular infrastructure, as in the ICT services, devices and infrastructure diagram.

Step 4: Identify dependencies between the three components – specifying the exact services and devices, while showing the infrastructure required.

Step 5: Factoring out ICT infrastructure to see the combination of ICT services and devices as in Figure 6:3.

Step 6: Cross-checking on the devices and services that could be provided on a particular infrastructure.

Step 7: Step 5 repeated – taking out ICT services – this enabled the comparison of ICT services to devices and infrastructure.

Step 8: Step 7 repeated, factoring out the ICT devices – to be able to compare these to services and infrastructure shown in Figure 6:5.

Step 9: Different graphical representations were drawn to represent the roadmap framework, i.e. Figures 6:6, 6:7, 6:8 and 6:9.

Step 10: The provision of an explanation of the ICT roadmap framework leading to the assessment process.

Before the actual development of the roadmap methodological framework, there was a need to clarify and explain the relationships between the three ICT roadmap framework components. The following diagram explains the beginning of the ICT roadmap methodological framework process:

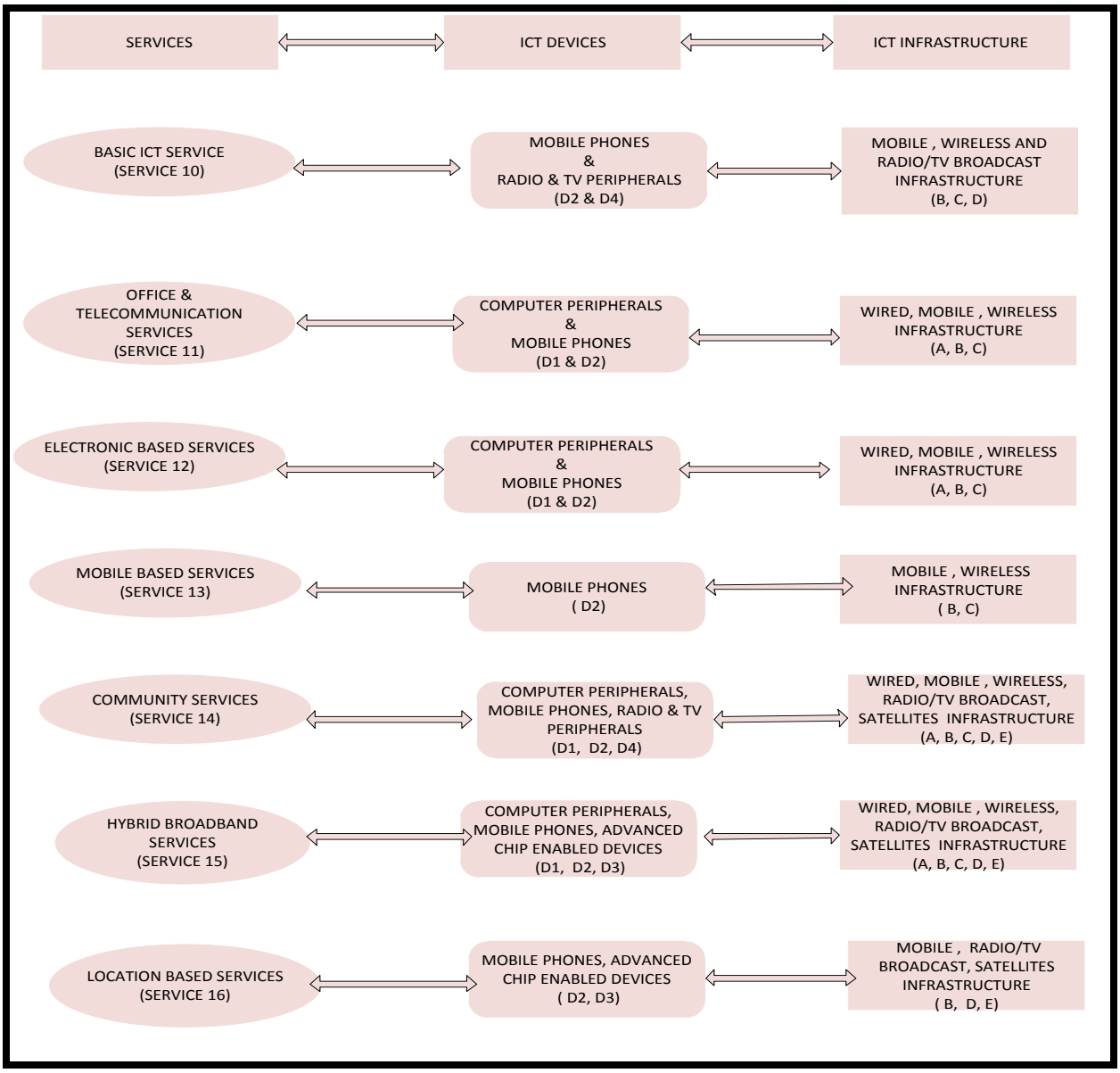

Figure 6:2 ICT services, devices and infrastructure

Figure 6:2 **ICT services, devices and infrastructure**shows all the services which are proposed for rural areas. The services are matched to different devices which could be best suited for the specific services. The required infrastructure for each of the services is also identified therein.

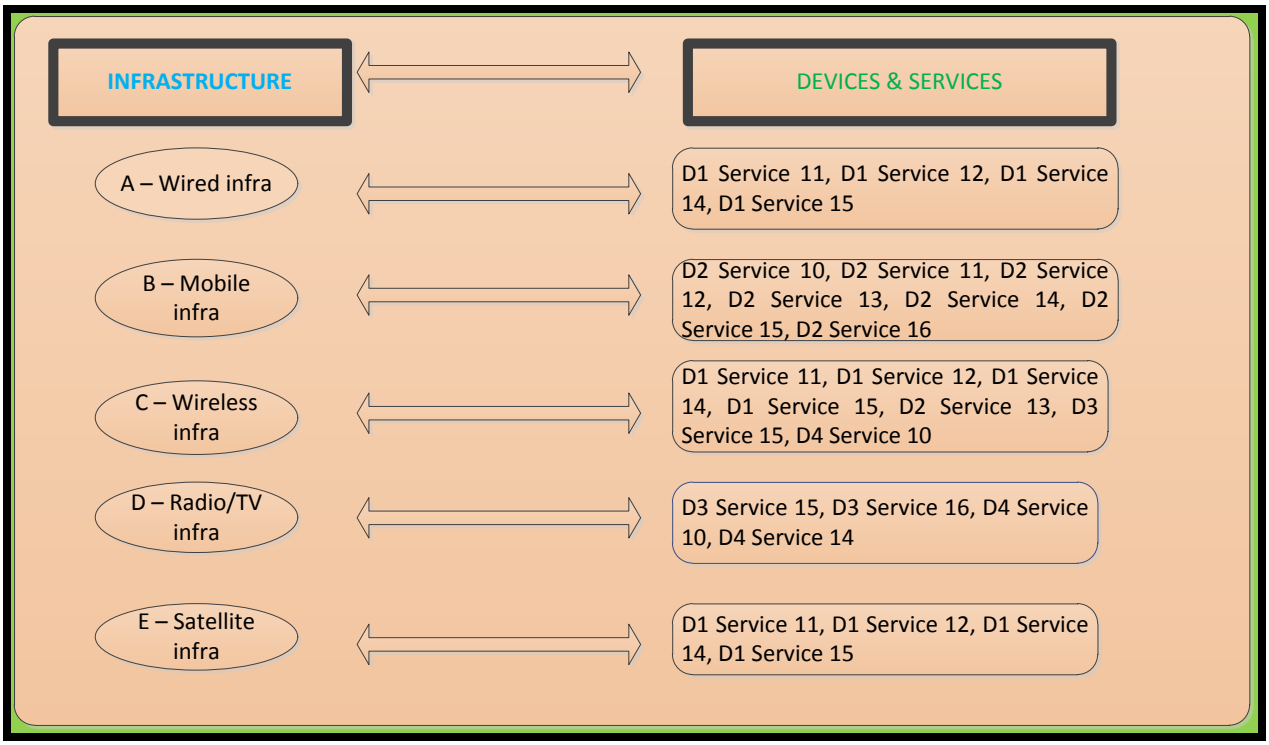

Figure 6:3 ICT infrastructure for ICT devices and services

Figure 6:3 shows the exact infrastructure that could be required for specific services which use any of the possible devices. This figure provides an overview of all the possible services and devices that could be supported by a particular infrastructure.

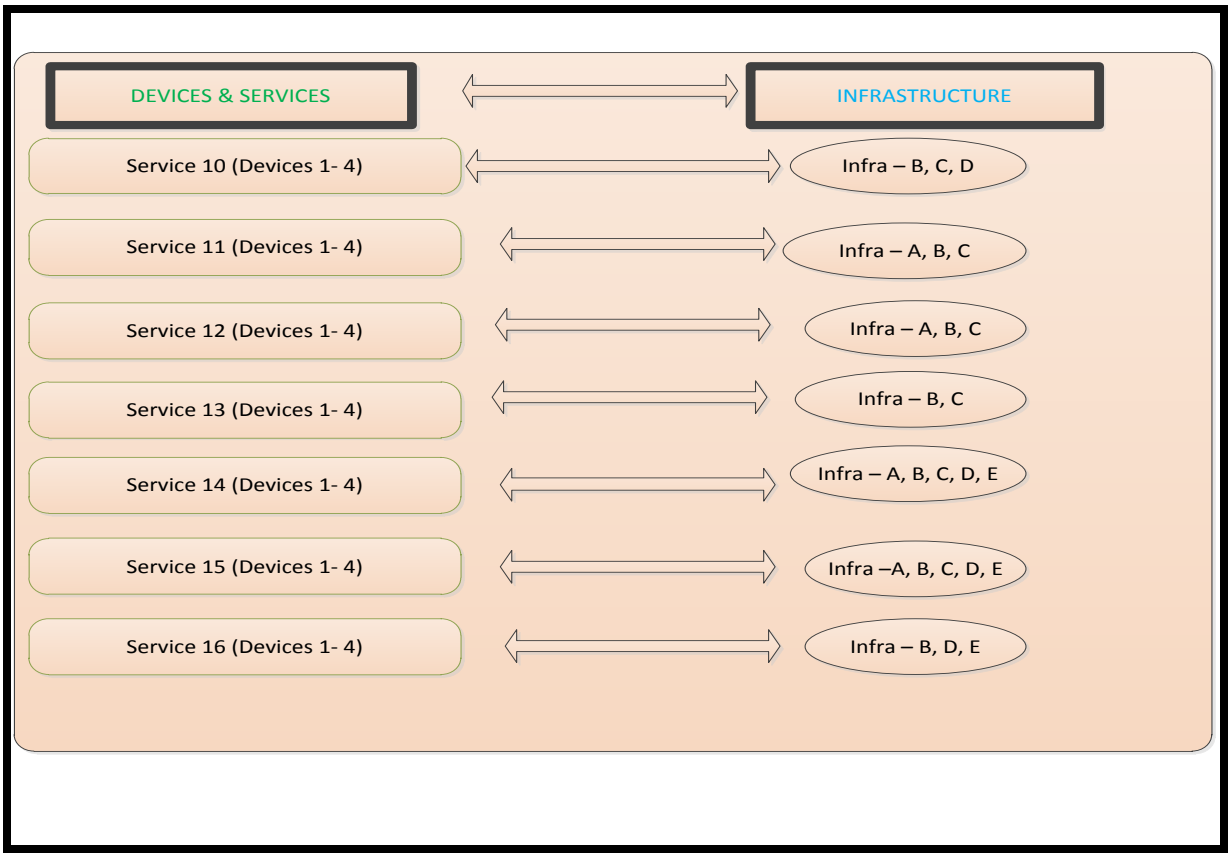

Figure 6:4 ICT services and devices related to infrastructure

Figure 6:4 shows the specific services available on all possible devices and the supporting infrastructure for each. It could be noted that at least three different ICT infrastructures are required to be able to receive any service. Figure 6:4 displays the linkages which could exist between infrastructures on supporting ICT services and devices. There is only one case in which only two infrastructures could be enough to provide a service; this is only relevant for service 13. For advanced services which are projected for the future, all the suggested infrastructures could be required. For instance, for service 15 and 16, five infrastructures (A to E) are required. This shows the complexity of future projected services, which might reduce the likelihood of the deployment of such services in rural areas. This is due to the fact that it could be expensive to have all the five proposed infrastructures in one area or it might not be necessary. This can delay the witnessing of some future projected services in rural areas.

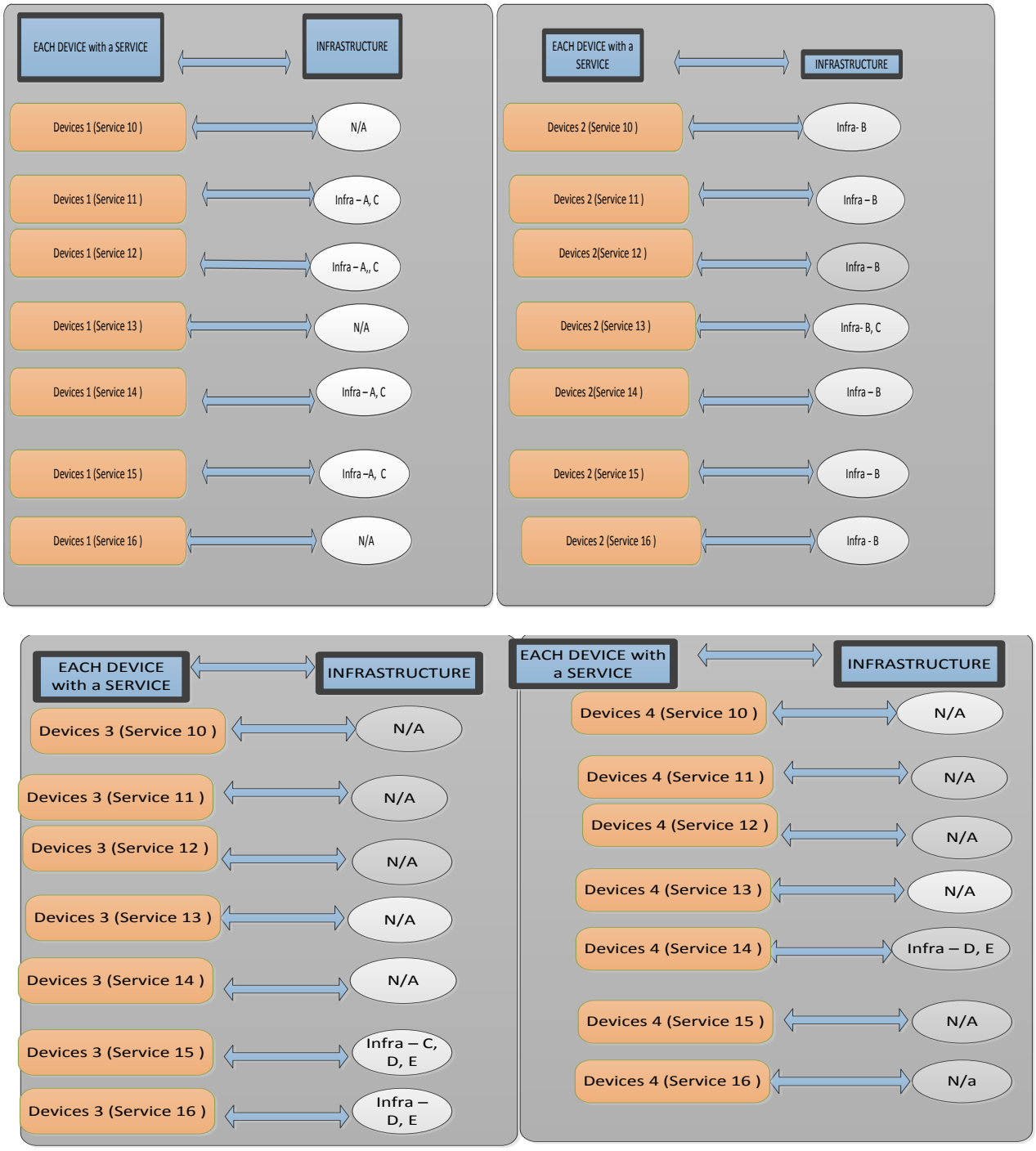

Figure 6:5 ICT devices for services related to infrastructure

This displays how each of the devices paired with each service is related to the infrastructure. It highlights how each of the devices under a specific service could be supported by infrastructure. From these figures, one can identify those devices that might not be required much. It shows that

devices 1 and 2 are more popular and can support many services. For instance, device 2 is required for all services from 10–16. Figures 6:2, 6:3, 6:4 and 6:5 were important in developing the ICT roadmap methodological framework.

6.7 Explanation of ICT services & technologies

All the above diagrams explain the steps which are stated in Section 6.4 and the diagrams below explain how the roadmap framework was derived. The diagrams are meant to assist in clarifying how the different roadmap framework steps were implemented.

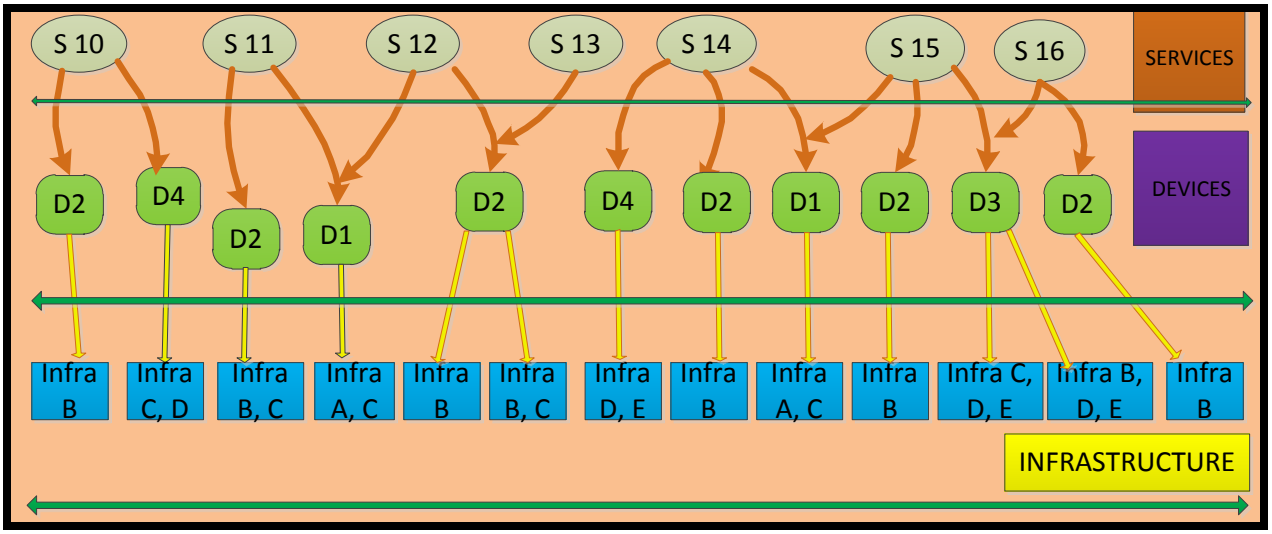

Figure 6:6 Generic ICT roadmap framework

The key for Figure 6:6 is as given:

D1–D4 represent the ICT devices that are shown in Figure 6:2

SE10–SE16 represent the different ICT services as indicated in section 6.2

Infra A–Infra E show the different proposed ICT infrastructure to support ICT services and devices.

Figure 6:6 shows all the proposed services, matched to devices and infrastructure. Each service and the specific infrastructure stating the exact devices required are provided in this figure. Some services share a particular device and infrastructure. The popularity of device 2, shown as D2, is also noticed across all services. The presence of infrastructure B, represented as Infra B, is also acknowledged. A common finding from these illustrations is that a device such as D2, which is

a mobile device, is suggested to be popular for rural service delivery. Again, some devices can be shared on some services and, in some cases a particular infrastructure could support more than one service.

The understanding of ICT services and devices together with the different technologies enabled the development of the 3-in-1 roadmap framework. The framework combines the services, infrastructure and devices, hence the term 3-in-1 is used in this thesis to refer to the framework. It shows the services that could be offered within a community, whilst clearly stating the infrastructure that is required. At the same time, it explains the devices that could be used for accessing some of these services and the required infrastructure. The author appreciates the current ICT roadmaps within many developing countries, but noticed that very few of these roadmaps have considered all three ICT components in one roadmap, i.e. some roadmaps focus only on service provision and do not provide further details of the infrastructure and devices required. The majority of African nations are currently focusing on an infrastructural roll-out plan that concentrates on the required infrastructure, but does not indicate the services that could be offered on that infrastructure. The analysis of the dependencies on ICT devices, services and infrastructure is shown in the ICT roadmap framework diagram that follows.

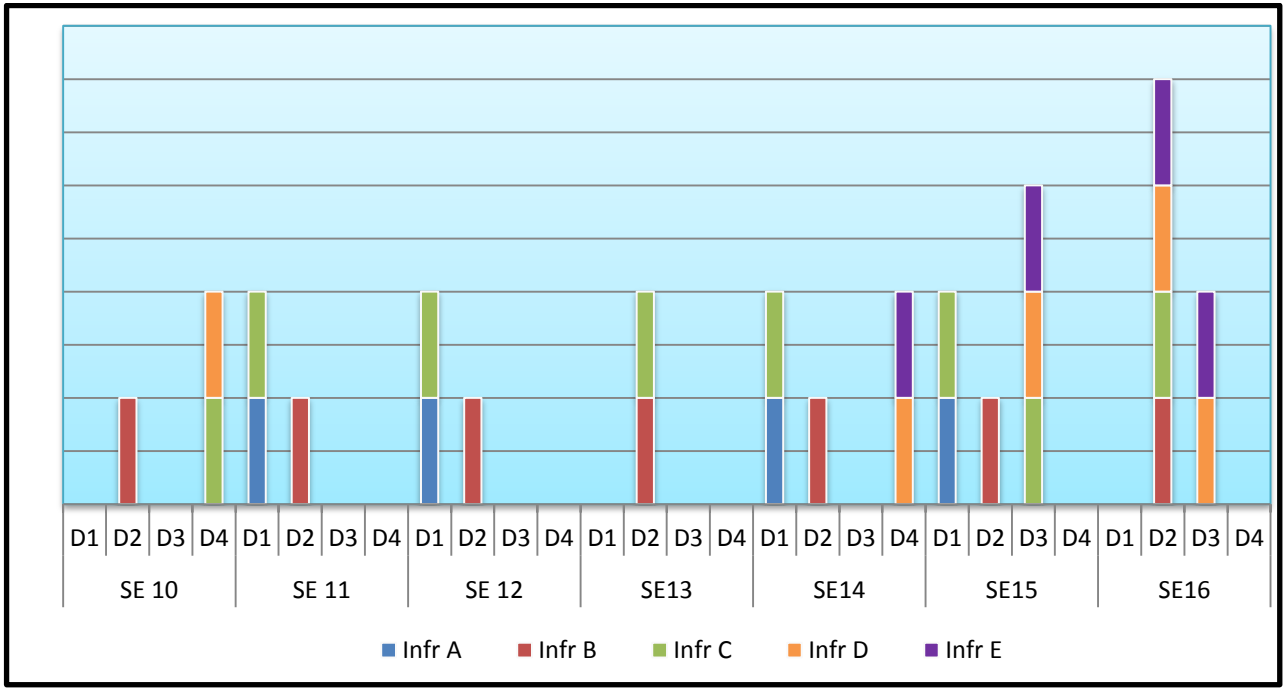

Figure 6:7 ICT roadmap framework process

Figure 6:7 shows the ICT services than can be accessed on a particular infrastructure using certain devices. In this case the ICT roadmap framework shows that, for service 10 – Basic ICT services – there is no need for Infrastructure A and E, and devices 1 and 3 are not required for such a service. A brief explanation of this figure is as follows:

For Service 11, there is no need for infrastructure D and E, and devices 3 and 4 are not very important.

For Service 12, there is no need for infrastructure D and E, and devices 3 and 4 are not very important.

For Service 13, only infrastructure B and C are required. Devices 1, 3 and 4 are not required for this service.

For Services 14, 15 and 16, the entire ICT infrastructure is required (infra A–E), but D3 is not required for Service 14. D4 is not important for Service 15, while D1 and D4 are not important for Service 16.

ICT roadmap methodological framework key conclusions

Device 2 and infrastructure B are common and required for all the services. Infrastructure C is equally crucial, almost like Infrastructure B. This shows that mobile and wireless infrastructure is highly recommended in the ICT framework. The continuous growth of mobile usage is also indicated in the framework graph, by the need for mobile devices on all the ICT services that any rural user might wish to access. After developing the framework, it was decided to represent the required infrastructure across all services and devices, as shown in the framework. The purpose of this was to show the exact infrastructure and the one most common to all the services using the different ICT devices.

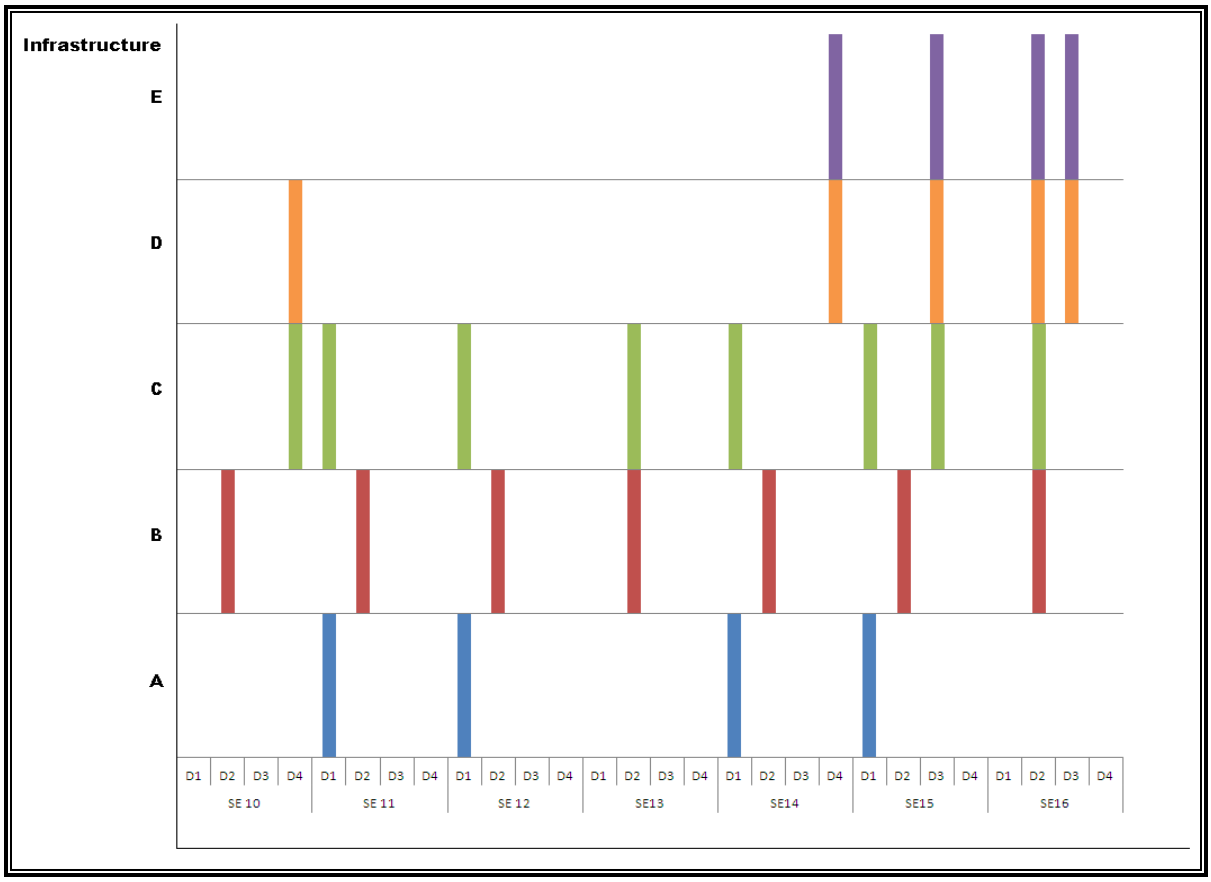

Figure 6:8 ICT roadmap process for each infrastructure

For advanced services such as 15 and 16, a variety of ICT infrastructure is required. This shows that there is a need for convergence and quite a lot of infrastructural resources to access some advanced services. The author discovered that this could make it difficult for some modern and advanced services to be implemented in some rural areas.

The findings and explanations for Figure 6:8 are included in the section on key findings of the ICT roadmap framework. Mobile and wireless infrastructure, as represented by infrastructures A and B respectively, is common and required for all the services.

Figure 6:9 indicates the dependencies between the three ICT roadmap components. This is represented in the Venn diagram. As indicated earlier in this chapter, the methodological framework is represented using different diagrams.

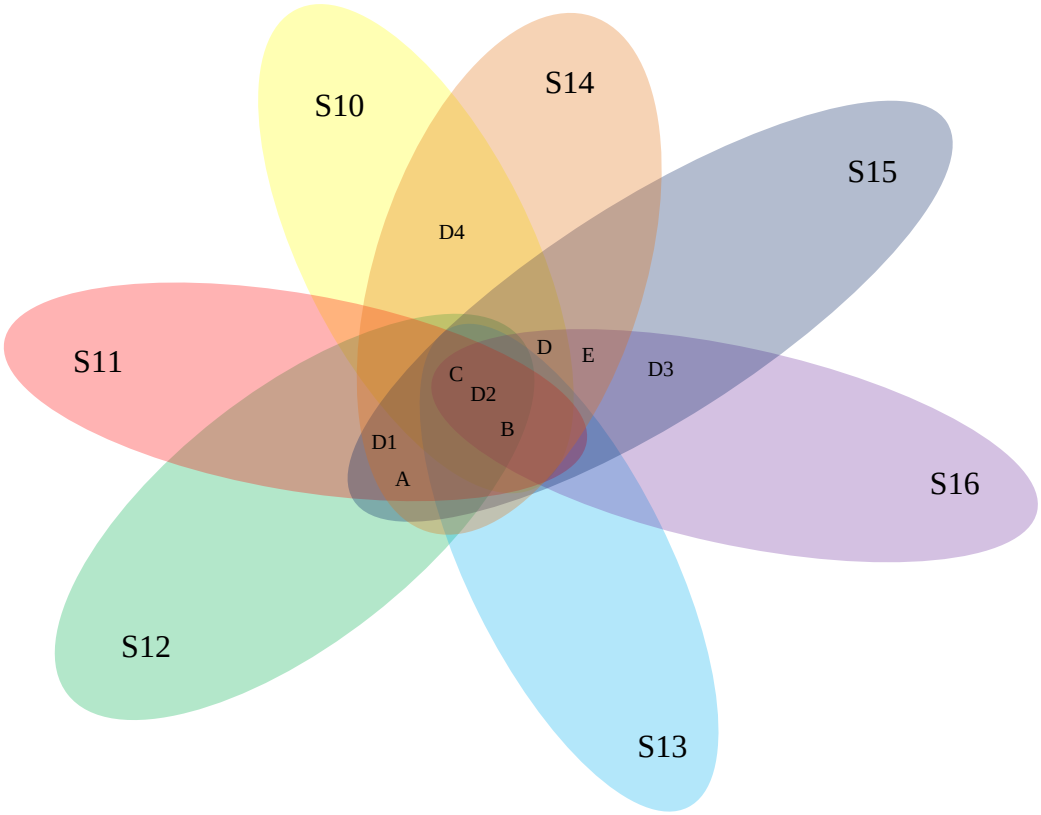

Figure 6:9 ICT roadmap framework Venn diagram

Key

S10–S12 – ICT services

D1–D4 – ICT devices

A,B–E – ICT infrastructure

Explanation of ICT roadmap methodological framework – Venn diagram

The Venn diagram theory concept was adapted for the development of Figure 6:9. It shows how various ICT services can be accessed on particular infrastructure under some devices. The explanation for the Venn diagram is almost similar to that of the previous two figures, Figure 6:8 and Figure 6:7. For example, the infrastructure B (mobile infrastructure) and device D2 are at the centre of the Venn diagram, showing the importance of a combination of this particular infrastructure and the device. The Venn diagram also shows the presence of all infrastructure (A–E) for service 15, indicating the complexity of projected future ICT services. This also means that the projected future ICT services require greater costs in setting up the required ICT infrastructure. The key difference is that the former shows some intersections that indicate which infrastructure could be shared on some services. For advanced services, such as 15 and 16, a variety of ICT infrastructure is required. This shows that there is a need for convergence and a significant amount of infrastructural resources are required in order to access some advanced services. The author discovered that this could make it difficult for some modern and advanced services to be implemented in some rural areas.

The findings and explanations for the Venn diagram are included in the section on key findings of the ICT roadmap framework, later in the study.

6.8 Contribution of the ICT roadmap framework

The author came up with a generic ICT roadmap framework that caters for all communities. In cases where computer scientists could apply artificial intelligence, this framework could be used, where different factors can be plugged into the framework in order for it to produce results. Any ICT roadmap components can be put into the framework with the application of knowledge based systems to draw up a roadmap. The ICT services, infrastructure and devices available at any place can be fed into the framework and it will display all the dependencies that are needed for that area. This is going to enhance decision making by ICT stakeholders to improve ICT developments, especially in rural areas. The developed roadmap framework was constructed from the findings of the studies explained in Chapter 4. The author clearly classifies the ICT services in terms of the need for them in rural areas. The findings included feedback on ICT services, characteristics, challenges and trends in rural areas. Furthermore, ICT experts' views and technological futurists' suggestions were also important to the development of the

framework. The rural ICT users' expectations, together with the ICT stakeholders' initiatives, were captured and used to develop the roadmap framework. These ICT services require ICT infrastructure that is also explained in the framework. The exact devices which are used on the provided infrastructure are given. The three main ICT components, i.e. services, devices and infrastructure are linked to each other so that the dependencies of the three are noted. The framework which is been developed is useful for ICT policy makers when coming up with ICT roadmaps for rural areas. It allows current ICT solutions to accommodate the future and enable sustainabile ICT solutions for rural areas. The framework educates ICT service providers to provide exact ICT components that can be fully utilized to benefit rural communities. This assists in making sure that the available ICT resources are fully utilized to access services.

6.9 Chapter conclusion

This chapter has provided the details of the exact ICT services, devices and infrastructure required for the roadmap framework. The classification and matching of the three components was done using the personal analysis and understanding the three components. The chapter highlights a critical aspect of the thesis and the author used ten key ICT roadmap framework steps. These steps could be followed and this idea is applicable to any community. The chapter illustrates different diagrams which represent the development of the framework. Chapter 7, which follows, presents the key findings from the roadmap framework, and how the framework was assessed.

Chapter 7:
ROADMAP FRAMEWORK FINDINGS AND ANALYSIS

Any effective, sustainable ICT roadmap framework has to be evaluated and needs to be continuously monitored.[12]

7.1 Introduction

This chapter explains the findings and how the ICT roadmap framework was assessed and analysed to check its validity and applicability. The roadmap planning processes, from the studies explained in Chapter 4, were all critically analysed. The identification of ICT services, devices and infrastructure explained in Chapter 6 was examined to eliminate repetitions and similarities in all three components. A solid methodological plan, summarized by the framework in Figure 4:5, the selection of existing roadmaps, ICT experts engaged with and workshops conducted were all properly planned for; this improved the validity of the ICT roadmap methodological framework.

The inclusion of successful existing roadmaps and the analysis of the current state of ICTs also made it easier to draw up a realistic ICT roadmap framework. The combinations, links and all possible ICT requirements were well calculated and different computations were done to ensure that the roadmap framework helps ICT roadmap planners. The selection of ICT experts in rural areas, academic institutions, government officials and workshop attendees was also critical in building a framework that could be applied to and implemented in any nation. The visits to Finland, where there are some successful ICT roadmaps such as that for the health sector, also equipped the author in coming up with a framework which is useful for roadmap development.

[12]Author's perspective during the roadmap assessment process. This is supported by the existing literature on ICT frameworks.

7.2 Findings after ICT roadmap framework development

The studies conducted during the research, as explained in Chapter 4, enabled the development of the roadmap methodological framework. Most of the findings already explained the current state of ICTs, the future of ICTs, community eReadiness and the discussions held during workshops offered input into the design of an ICT roadmap framework. After developing the framework, several ideas came out. This section explains the discoveries after the actual ICT roadmap framework was designed.

The key findings were based on the ICT services, devices and infrastructure required in rural areas. The findings highlighted that *ICT developments are based on three main components i.e. services, devices and infrastructure.* In regard to ICT services, the findings show that the main ICT services needed in rural areas can be classified into seven categories. These are: basic information ICT services; electronic-based services; office and telecommunication services, mobile-based services; community development services; hybrid broadband services and location-based services.

For ICT infrastructure: The findings show that the common *ICT infrastructure required to support the services listed could be categorized into five categories: wired telecommunications, mobile infrastructure, wireless networks, radio and TV broadcast and satellite networks.*

The findings show that the *ICT devices preferred in rural areas include: computer peripherals, phones/multimedia phones, advanced ICT enabled devices, radio and TVs.* An actual description of these ICT components is provided in section 6.2.

For community development services, advanced broadband services and location based services, the entire ICT infrastructure is required, i.e. wired telecommunications, mobile infrastructure, wireless networks, radio and TV broadcast and satellite networks, but advanced ICT enabled devices are not required for community development services. Alternatively, radios and TVs are not important for high hybrid broadband ICT services, while computer peripherals and radios and TVs are not important for location-based services. For services such as office and telecommunication services, there is no need for an infrastructure radio or TV broadcast network and satellite network, and devices such as advanced ICT enabled devices and radio and TV are not very important.

The other findings include the need for the convergence and dependencies of ICT infrastructure, services and devices. In regard to this ICT roadmap framework development, the author found that there is increasing evidence for ICT convergence within each of the three components, i.e. services, devices and infrastructure. There is a need to have a compatible ICT infrastructure that can support services and ICT devices. As indicated by Sunderland (2007), convergence and reduced costs allow easy service delivery and sharing of ICT resources, thus making it a viable solution in areas with scarce resources. ICT convergence allows different ICT stakeholders to work together and encourages the success and sustainability of ICT solutions. Convergence can also help in addressing the different needs of rural ICT users and satisfy rural users.

The current ICT roadmaps in developing nations do not comprehensively consider all the three ICT components i.e. services, devices and infrastructure, and neither do they consider future ICT services. From the ICT roadmaps currently available for developing countries that the author has reviewed, there are very few cases where the roadmaps state the expected ICT services together with the devices and infrastructure required. The majority of the roadmaps used in this research mention the ICT services to be provided, but do not highlight the required devices or infrastructure. Of all the ICT roadmaps within developing countries studied for this research, none of the roadmaps discuss future projected services such as internet-based services, cloud computing services, social networking or location-based services. The existing roadmaps for developing countries focus on the provision of basic ICT services and internet-based services.

The other finding was that *roadmaps in developing countries are mainly initiated by government and focus on empowering people with ICT services, skills and access*. This is achieved by providing the ICT services which are needed, together with the necessary infrastructure and common ICT devices. However, *roadmaps for developed nations are developed by both private and public sectors with the aim of improving business growth*.

Some of the notable findings are:

Mobile phones are the most popular ICT devices and mobile services require mobile and wireless infrastructure – Mobile phones are the most common ICT devices currently in use. ICT devices such as laptops, televisions and radios are also used to disseminate information in rural areas. Despite the presence of these other ICT devices, the ICT roadmap framework indicates

that the mobile device is common for the majority of the projected ICT services. The popularity of the mobile phone is supported by the following mobile features:

- Readily available with mobile infrastructure setup
- Lower cost and affordable mobile devices
- Various applications supported on mobile phone to speed up service delivery.

M-PESA is an example of a mobile application that allows mobile payments in Africa, mainly in East of Africa, i.e. Kenya. M-PESA has over 14,000 agents and close to 10 million users (Mobile Africa Report, 2011). The other example is the South African instant messaging platform Mxit, which now supports 250 million messages per day (Mobile Africa Report, 2011). These statistics clearly show the growth of mobile application usage and rural areas of Africa are benefiting from such services. The success of the described mobile application is based on the appropriate technical business models.

Popularity of wireless over wired infrastructure in rural areas. The geographical location of many rural areas makes it difficult to run wired telecommunications infrastructure. This is due to the presence of physical obstructions such as mountains, valleys and poor terrain which make a wireless solution the preferred idea in rural areas. The case studies and the observations made during the visits to various rural areas make it clear that wireless infrastructure is currently the most popular in rural areas. This has been implemented in different forms such as VSAT, satellites, WIFI and WIMAX. The deployment of mobile infrastructure in rural areas also helps to improve wireless services in these areas (Buys *et al*., 2009).

ICT devices such as radio and TV are useful in disseminating ICT information in rural areas. Different ICT devices could be used and the services provided should be accessible on these devices. The list of some possible devices which are suitable for rural areas was explained in the previous chapter. The notable devices remain both the traditional ones such as radios, TVs and emerging devices like mobile phones and laptops. A variety of these devices were discovered by Farrell (2009) in research conducted on ICTs for education in 53 African countries. In addition to the ICT devices, the author observed that users' pocket devices become more and more versatile. Radios and TVs can easily be shared amongst households in rural areas. In public places, TVs are used and attract rural ICT users; for instance, South Africa has over 30% of all its households

with licensed TVs (Fourie *et al*., 2008). The statistics show the importance of TVs and radios as important ICT devices for information sharing in rural areas.

Schools are the common places for accessing ICTs in rural areas. This finding cannot be traced directly from the ICT roadmap framework, but the author discovered this while conducting studies in rural areas. The author observed that rural schools play a pivotal role in ICT developments. Schools act as the main place of ICT access in most communities. The deployment of ICT infrastructure at schools can lead to smart schools and can improve information sharing through ICT usage in low resource areas. Omidinia, Masrom and Selamat (2012) saw the importance of rural schools and suggested deployment of ICT infrastructure to these; the kinds of infrastructure suggested are points of ICT access with internet access services. However, computer kiosks and community learning centres, which are present in most rural areas, are some other possible points of access (UNESCO, 2010).

These findings were noted after the development of the ICT roadmap framework. The key contribution of these findings is that ICT stakeholders are now able to determine the ICT infrastructure, devices and services required in rural areas. It was important to evaluate and assess the designed framework. This chapter also covers the research areas that were used for the assessment of the ICT roadmap methodological framework.

7.3 Roadmaps for rural development

The idea of using roadmaps could improve ICT development in rural areas. The requirements of the roadmap process enable ICT stakeholders to share ideas, map the future and plan for sustainable ICT solutions. This is critical in helping rural areas to enjoy the benefits of ICTs. It is clear from the literature on ICTs that most of the ICT solutions are not sustainable enough to improve rural areas. Roadmaps can benefit rural areas in different ways, such as:

- Roadmaps involve engaging the exact stakeholders, which improves the decision making process
- Roadmaps assist in providing the ICT services in need, infrastructure required and advice on the best ICT devices to be used
- Roadmaps provide the vision, direction and clear areas that have to be addressed, leading to higher chances of attracting financial donors

- Roadmaps allow sustainability and maintenance of ICTs. This is encouraged by clearly a defined ICT review plan in the roadmap.

Based on the benefits of successful roadmaps in different countries, the author recommends that ICT stakeholders plan properly for the development of the roadmap and thus proposes that the ICT roadmap methodological framework be used in assisting roadmap development.

7.4 ICT roadmap framework assessment using existing ICT roadmaps

The tangible results of the roadmap can take a few years to notice as it requires full implementation of the actual roadmap. In this thesis, the roadmap framework was assessed to check the applicability of the framework when developing roadmaps. In this case, the term assessment refers to the verification of how the framework can be used to assist in roadmap development. In some cases, the assessment process could be referred to as validation, but the author chose the former to explain the framework analysis. The assessment was done to check how the framework can be used, based on existing literature and current roadmaps, i.e. what services, devices and infrastructure have been mentioned in current roadmaps.

The ICT roadmap assessment process was an ongoing process that continued throughout this research. All the studies explained in Chapter 4, including workshops and interviews were analysed in order to gain reliable and accurate data from external ICT experts and rural ICT users. The following aspects were also considered for the roadmap framework assessment:

- Identification of key ICT services, devices and stakeholders
- Identification of key enabling technologies
- Roadmapping of key technologies
- Roadmapping of key functions.

Current ICT roadmaps for selected nations and the key ICT aspects explained in Figure 4:5 were also used to assess the ICT roadmap framework.

The ICT roadmaps which were initially discussed in Chapter 3 are used in this chapter to assess and analyse the ICT roadmap framework. The existing roadmaps in developing nations, and some successful roadmaps from developed countries, were considered for the assessment process. The focus was to look at the key aspects of each roadmap, including services, devices

and infrastructure, which were considered for each particular roadmap. A set of comparisons between the current state of these roadmaps and the ICT roadmap framework were made.

7.4.1 Bangladesh roadmap

As previously mentioned, the roadmap plan for Bangladesh focuses on identifying the following:

- Stakeholders' engagement
- Policy mapping
- Empowering users with universal community based services – mainly ICT education and eGovernment
- All the plans and activities for the roadmap were evaluated and there is continuous monitoring of the ICT plans.

The Bangladesh roadmap is meant for the whole nation and it has mainly been successful in urban areas, where supporting infrastructure is available. The roadmap did not address all the ICT services which could be required in poor rural areas. The roadmap framework explained in this thesis shows the need for proper ICT polices and the need for all stakeholders to be involved in rural ICT developments. The framework outlines the possible devices that could be used to access the services as well as the required infrastructure; however, this is missing from the Bangladesh ICT roadmap. All the possible services, devices and infrastructure are demonstrated in Figure 6:1 in Chapter 6. This framework could have been of benefit to the Bangladesh initiative if it was available before the development of the Bangladesh roadmap.

7.4.2 Pakistan – vision 2015 roadmap

The Pakistan roadmap focuses on providing different ICT services such as health, education, agriculture, governance and national integration – this includes the localization of its ICT content (Jaffri, 2008). The plan for the Pakistan vision is to concentrate on providing economic opportunities for every citizen. The services to be delivered are all included in Figure 6:1, as presented in Chapter 6.

The main challenge which was raised during the Pakistan ICT 2015 development was the lack of infrastructure and inadequate government policies. There was also a lot of duplication of efforts and multiple redundancies by government departments and ICT stakeholders (Jaffri, 2008). There were no ICT training programmes to manage the sustainability of ICTs. These challenges

were also noted and accommodated in the present roadmap framework. For instance, the idea of identifying the infrastructure for each service means that in the roadmap framework discussed in the thesis, all three key components, i.e. ICT services, infrastructure and devices, all work hand-in-hand and cannot be separated for sustainable ICT developments. To address the duplication of efforts and developments, the framework encourages the sharing of devices and infrastructure to enable ICT services to reach the rural people. There is no need to repeat the redeployment of infrastructure and services and this could also be encouraged if all stakeholders cooperate, communicate and engage before any ICT project is embarked upon in rural areas. As for ICT training programmes, the roadmap framework emphasizes the need for regular ICT training in rural areas in order to equip rural ICT users with the technical skills required to use ICT services, infrastructure and devices.

The Pakistani roadmap highlights the use of mobile devices to offer services, i.e. that government should utilize the availability of mobile phones in the country. The need to create ICT awareness for every citizen is also raised (Jaffri, 2008). Much of the focus of the roadmap was on the telecentre model of offering services. Meetings were held with the key stakeholders. The mobile device was identified as the main ICT device which could be used to access many ICT services, as indicated earlier in this chapter under the section on the key findings related to the ICT roadmap framework. While the Pakistani roadmap focuses on the telecentre model, this framework emphasizes the use of ICT hubs at rural schools, hospitals, clinics, shops, homes and any place that is convenient for rural people. The idea is to enable the availability and accessibility of services rather than to focus on the telecentre model, which was not successful in many areas.

The Pakistani roadmap recommends sharing and the provision of ICT services to everyone in the country. However, the roadmap does not indicate the exact infrastructure that has to be deployed to enable the service delivery it focuses on. Again, it targets the whole nation and has been more successful in urban areas.

7.4.3 Malaysia roadmap

As indicated by the National Information Technology council of Malaysia (2008), the focus areas identified are divided into three categories: wireless sensor networks, predictive analysis and 3-dimensional internet. This could be summarized as infrastructure for service provision. The focus is on the current technologies which were available within the country at that particular time. The Malaysia roadmap plan did not focus heavily on future considerations (Dato, 2008). The problems raised include the poor quality of ICT training and low numbers of ICT literate individuals.

According to the National Information Technology council of Malaysia (2008), technologies proposed for Malaysia could be applied in different areas such as:

- Environmental monitoring, security management, health applications, weather predictions and traffic control.
- The focus areas of application include the banking sector, the health and environment areas, as well as consumer and retail researchers. For predictive analysis, some of the considered technologies include: bio-medical, weather and disaster prediction, speech recognition and language translations, prediction markets and communication network analysis.
- The 3-D technologies include: virtual worlds, virtual reality, online game architecture, and multimedia simulation. These were proposed for application in areas such as education, industrial training, disaster simulation and entertainment. This addresses the issue of smart farming through the use of location-based technologies. The back-casting technique was used for the roadmap development.

The Malaysian roadmap focuses on the exact infrastructure that should be deployed; this is the same as in the roadmap framework explained in this thesis. An example of this is the need for wireless infrastructure, as shown Chapter 6, where the wireless infrastructure seems to be popular and required for almost all ICT services. The shortage of ICT-literate people in Malaysia was also identified during the studies in this research and the roadmap framework supports the need for regular ICT training for all community members. Some of the ICT services mentioned in the Malaysian roadmap, such as biomedical, weather and disaster predictions, were not offered significant consideration in the roadmap framework. This was because the rural

dwellers did not mention any of these services, but since the framework is flexible, such services could be accommodated.

7.4.4 The Philippines ICT roadmap

The Philippines ICT plan involves laying down government strategies and programmes which focus on ICT accessibility. The main plan was to engage all stakeholders and encourage them to effectively participate in and contribute to the roadmap process (Ramon, 2006). Workshops and presentations on the roadmap plan and progress were held. The focus was on the types of services to be offered, including those that are accessible, available, secure, accountable, transferable and sustainable (Ramon, 2006).

It can be noted that this roadmap concentrates on the characteristics of the services. These were all considered for the ICT roadmap framework. The methodological approach of the Philippine roadmap, including the workshops and presentations, was also used in this research and various stakeholders were engaged in the process. This was to be achieved through a community eCenter offering – internet in schools, access to training programmes to persons with disabilities, local government units are to deliver services and low cost computing (Ramon, 2006).

The main problem with the Philippines roadmap is that it does not outline the exact infrastructure and devices that are required; this was a key component of the proposed roadmap framework. The roadmap framework does not mention services that cater for individuals with disabilities, but there is a strong belief that the given services are also helpful to every person in the community and could benefit anyone without discriminating against or excluding anyone within the society. The framework also emphasizes the delivery of affordable services to all rural people.

7.4.5 Lesotho roadmap

The Lesotho roadmap concentrates on ICT policy development, targeting converged technologies. The mission is to fully integrate ICTs so as to ensure sustainability in various sectors within the country. The ICT policy goals, as indicated by Mostoahae (2005), include:

- promoting low cost and accessible ICT services
- promoting ICT polices
- increasing ICT awareness and literacy programmes.

The main objectives were to create awareness amongst all stakeholders and facilitate the deployment of an ICT infrastructure. The roadmap emphasizes offering low cost, easy to use ICT products and services that will address local needs (Motsoahae, 2005). Marginalized citizens, including women and the youth, as well as the disabled, were targeted and schools, post offices and community centres were explained as the main points of ICT access. Some of the key services to be offered were in education, human resources, eGovernment, eCommerce, health, agriculture, gender and youth empowerment.

The Lesotho roadmap was also a national programme, which worked largely in urban areas. All the characteristics of the Lesotho roadmap were considered in the framework and key stakeholders were clearly mentioned. The need for affordable and accessible services is also mentioned in the roadmap framework as was indicated by Motsoahae (2005) during the Lesotho roadmap development. The different places of ICT access mentioned in the Lesotho roadmap are vital and the same are mentioned in the present roadmap framework. All the services suggested for the Lesotho roadmap are also considered for the roadmap methodological framework.

7.4.6 South Africa's ICT plan

As indicated by the Department of Communications (2010), the South African roadmap plan focuses primarily on rural development through ICTs. The development of digital content, computer refurbishment centers, eCooperatives, broadband infrastructure and community post offices were the key areas of ICT access. The key stakeholders include USAASA, broadband Infa Co, ICASA and various telecommunication companies; these stakeholders were all involved and consulted in the planning process (DOC, 2010). The roadmap is meant to empower rural communities and to enable ICT services within the required infrastructure to reach rural areas. Some of the ICT services include: education, healthcare, small entrepreneurs and agriculture.

The proposed ICT infrastructure should promote societal improvements in different communities. The roadmap highlights the need to use existing ICT devices such as radio and TV and to promote local content development (DOC, 2010). Issues of eGovernment services in rural areas were also discussed for the roadmap. The main stakeholder for this was the government through its Department of Communications and other departments such as Rural Development. The roadmap also mentions the need for a broadband policy to be in place to support the

infrastructural roll-out (DOC, 2010). Some of the proposed places of access were Thusong post offices, telecentres and digital hubs, cyber libraries and community radio stations.

The South African plan is close to the proposed roadmap framework in that the framework is designed for rural communities. The South African ICT plan also focuses only on rural areas. It mentions the need for different stakeholders, but does not include rural users. The roadmap framework emphasises the need for the involvement of all stakeholders, including rural users. The focus of the framework is to equip and empower rural people with necessary ICTs. This is the same idea for the South African plan. The South African plan, despite mentioning different possible places for accessing ICTs, does not state the specific ICT devices to acquire services. Though the broadband policy is mentioned in the South African roadmap, it does not give the exact supporting infrastructure for this. This has been clearly explained in the present framework, as it highlights the infrastructure required for different services.

7.5 Analysis of existing roadmaps

Only the South African roadmap was designed for rural areas. The other roadmaps focused on all citizens. This means that most of the roadmaps were only successful in urban areas. The framework in this thesis targets poor communities which are difficult to reach and have limited resource access. The ideas raised in this framework are critical for successfully implementing ICT projects for rural roadmap development. The roadmap planning approach could be useful in any other area, i.e. urban or developed nations. This chapter compares the developed ICT roadmap framework to the current ICT roadmaps and demonstrates how the gap between the current roadmaps and the idea proposed could be narrowed. Incorporating the ideas raised in the roadmap framework can benefit all ICT stakeholders and policy makers.

7.6 Analysis and assessment of the roadmap framework

The author is aware that an accurate roadmap framework assessment process can take a long time. This entails exposing the framework through the roadmap development process. And unfortunately that was not possible, as is indicated in Section 8.5. The identified weakness of the roadmap framework assessment was to follow the same methodology that was used for the framework development. However, the assessment process was improved with the inclusion of a successful ICT service roadmap from the Finnish eHealth sector and involving supporting theories. The author acknowledges the other means that could be explored to assess the roadmap

framework, but is satisfied with the process that was explained in assessing the framework for this thesis. The proposed framework is solid enough and should be expected to assist ICT roadmap stakeholders in developing roadmaps.

Through the ICT roadmap framework designed in Figure 6:6, selected existing ICT roadmaps were used to show what has been addressed in these roadmaps.

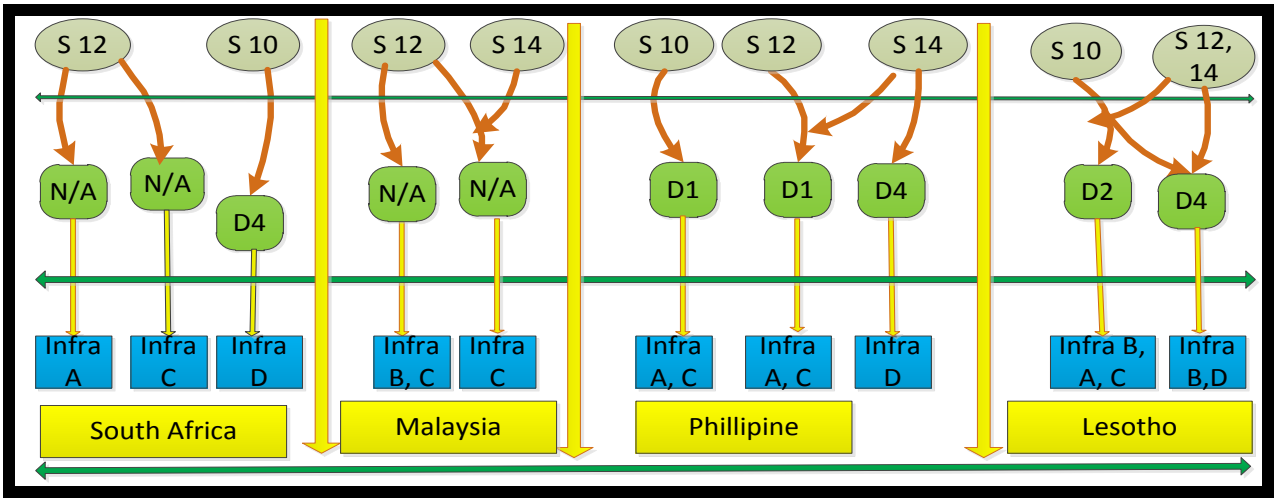

Figure 7:1 ICT roadmap framework assessment – based on existing roadmaps

Figure 7:1 indicates the exact services which were suggested in each country's ICT plan. Where there is "N/A" it means that nothing that was mentioned regarding how the services could be accessed. In the case of South Africa, the ICT plan mentions the need for providing service 12, i.e. electronic-based services and states that this could be offered on Infrastructure A or C, i.e. wired or wireless infrastructure. However, the South African plan fails to indicate the possible ICT devices that could be used to access this service. Four ICT roadmaps from different nations were considered, and all the services planned in all the ICT roadmaps are indicated in the framework.

ICT roadmap framework assessment using successful roadmaps

The differences between the ICT roadmaps in developing and European countries were noted and there was a need to consider some successful roadmaps from European countries.

Finland: eHealth roadmap success

The development of ICTs in Finland, has led to several ICT strengths in Europe. Finland has a well-structured IT infrastructure in healthcare (Livari & Ruotsalainen, 2007). Nurses, doctors and patients all have internet access with updated health information. All medical centres are well connected with the latest information on all patients (Livari & Ruotsalainen, 2007). Appointments with doctors can be made online with consultations also available over the internet (Livari & Ruotsalainen, 2007). The medical staff is equipped with necessary IT skills which are important in maintaining updated patient databases. The Finnish government has also shown great support to the Health department and have proper polices to improve the Finnish health sector (Livari & Ruotsalainen, 2007). Thus, there is strong government support that has encouraged the introduction and steering of IT in the healthcare sector.

The current state of the Finnish health sector is an example that can be shared to other countries and, in this thesis, it is important to note that the wish is to see developments such as these in all other sectors or departments. The health sector is used here only as an example, but the author understands that if the same ideas can be implemented in a separate department or country, chances of success are very high.

Strategic techniques for Finnish eHealth roadmap success

- Provision of updated health information to all the people at any time
- Provision of reliable and accessible health internet services to all the patients all over the country
- Having an online database containing records of patients' medication, consultations and appointments with doctors.

The involvement of the Finnish government and inclusion of key health stakeholders has encouraged other private companies to offer funding to improve the health sector. This has also been important for building better coordination and understanding amongst the citizens and the medical staff, leading to high quality health service delivery. The Finnish eHealth plan is used in this thesis to validate the developed ICT roadmap framework

Finnish roadmap for communication technologies, services and business models

The "Finnish roadmap for communication technologies, services and business models, 2010–2015 & beyond" prepared by the VTT technical research Centre of Finland has been successful due to the availability of funding organizations (Ruuska *et al*., 2010). Financial resources were obtained from various organizations, including the Finnish Funding Agency for Technology and Innovation (TEKES) and other public departments (Ruuska *et al*., 2010).

Engagement of ICT experts and effective communication of individuals was done during the roadmap development. All the people were assigned different roles and feedback as individuals perform their assigned duties (Ruuska *et al*., 2010). A similar process was followed in coming up with the roadmap framework discussed in this thesis; different studies, workshops and ICT experts were engaged in this regard.

In addition, a proper communications network is available with continuous review and feedback to update the roadmap, thus increasing the sustainability of the roadmap. During the roadmap development process, the views of ICT experts collected during interviews in several workshops were used to improve the roadmap (Ruuska *et al*., 2010). The roadmap shows the main ICT trends for 2010, such as digitalization, online services, social networking, cloud computing, globilisation and green ICT. The roadmap explains the different ICT devices such as mobile phones, computers and televisions. This should be supported by different infrastructure and technologies such as radio technologies, wireless infrastructure and broadband connectivity; it also addresses security issues. The Finnish roadmap process was used for the assessment of the present framework.

7.7 Roadmap success

A successful roadmap process provides technical solutions to the current problems experienced in a particular society. These challenges could be in the form of social, economic, technical or any other human factor. For the roadmap to be a success, these factors have to be critically assessed so that the roadmap solution addresses the challenges at hand.

The success of the roadmap is dependent on key characteristics such as trustworthiness and transferable ideas. A well-developed roadmap should be able to be used in other areas and the users should have an understanding of the roadmap. Linking the success stories of roadmaps to the roadmap framework, as initially described in previous chapters, it is important to identify where the Finnish roadmap which is explained above fits into the roadmap snapshot in Figure 7:2.

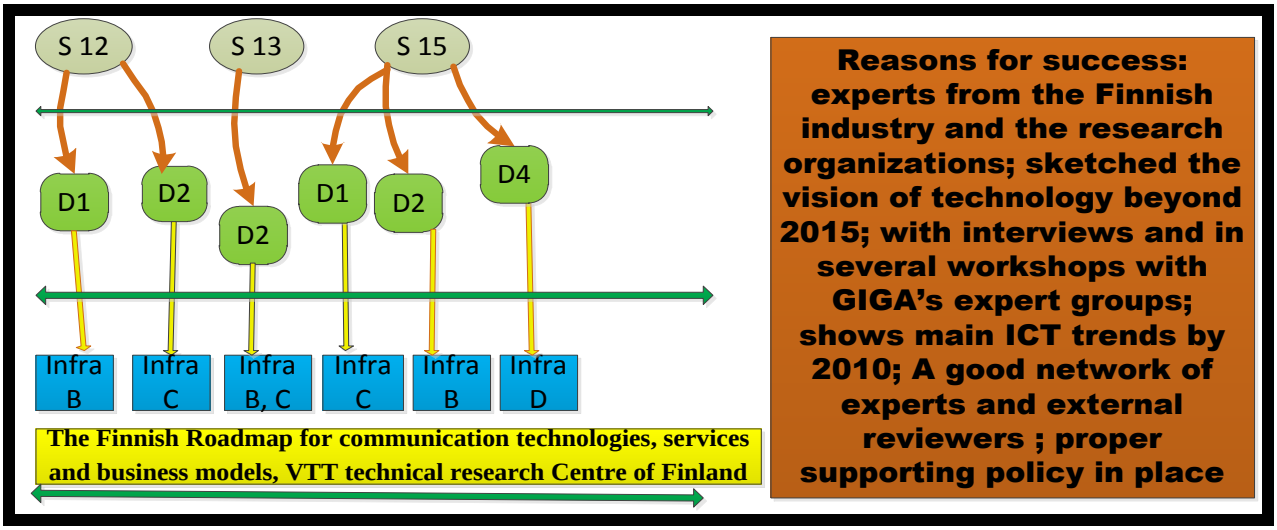

Figure 7:2 Assessing the roadmap framework – using the Finnish roadmap

Unlike the roadmaps for developing countries, as shown in Figure 7:1, the Finnish roadmap plans for future ICT services such as service 15, which is hybrid broadband services such as cloud computing, digitalization, globalization and social networking. Possible devices and the required infrastructure are given for each service. The use of a business models and the involvement of different ICT experts have increased the success of the Finnish roadmap. An interesting finding, which is a similarity to the developed roadmap framework, is that the mobile

and wireless infrastructure remains popular with the use of mobile devices, computers, radios and TVs.

Assessing of roadmaps using the methodological framework

The methodological framework shown in Figure 4:5 is used to assess the existing roadmaps. The aspects identified in Figure 4:5 are considered for each roadmap. Using the Pakistan roadmap, the economic aspect is addressed by encouraging agricultural services. Health and education cover the social aspects of the Pakistan roadmap. The localization of content is meant to ensure the social aspects within Pakistan. The Pakistan roadmap encourages services which create economic opportunities, but the country's lack of proper ICT policies has meant that the governmental aspect is not fully accommodated.

The Malaysian roadmap focused on technical aspects. Environmentally friendly applications are recommended once the wireless infrastructure is provided. The Malaysian roadmap suggests services that improve the educational system and health standards, thus fulfilling social needs. The developments of the banking sector improve the economic prospects of the country.

The Lesotho roadmap encouraged services that uplift the socio-economic aspects of the people. This is enabled by government commitment, which is important in ICT policy making. The Lesotho roadmap focused on eGovernment, eCommerce and eHealth services (Motsoahae, 2005). These services improve the social and economic issues of Lesotho. The roadmap also aims to offer ICT services that cater for disabled people. This eliminates discrimination and improves the social standards of the country.

The South African roadmap mentions health and educational services to improve its service delivery to rural areas. The encouragement of small entrepreneurs and agriculture is important in promoting economic development. The role of policy making is also supported in the South African roadmap and this encourages government support. The existing roadmaps address social, economic, and political areas. The technical aspect is not clearly addressed in the existing roadmaps.

It was observed that, in order to ensure development, ICT should add value and improve the standards in the respective areas that are being targeted (Avgerou & Walsham, 2000). Five variables relevant to address the context, which are almost identical to the already mentioned

variables in Chapter 4, Figure 4:5 were considered. The ICT roadmap framework considers the following aspects:

Culture: Societies or groups in a society vary in their sets of shared attitudes, values, goals, and practices. Culture deserves careful attention when ICTs are introduced in the development context (Westrup *et al*., 2003). In this case culture is considered a central variable.

Environment: Physical conditions (heat, cold, dust, humidity, etc.) need to be considered in order to establish a suitable ICT solution design. The development of green ICT services in rural areas could increase environmental safety.

Organization: The structure of any organization (in the broadest sense of the word) determines the implementation strategy of systems, both in the developed and developing world.

Economy: The current and future economic situation of a country, sector or organization should serve as a determinant in its ICT investment decisions.

Political climate: Some governments are more restrictive in their ICT guidelines than others. Openness is not always appreciated and some governments have 'partnerships' with hardware and software suppliers.

Other variables, such as the technical and societal aspects, are also important; this is indicated in Chapter 4, in Figure 4:5. Government plays a significant role in ensuring that the public has access to services at a low cost. According to Fourier (2008), proper ICT infrastructure and community involvement are some of the key requirements for ICT development.

The discussed ICT roadmap framework plays a great role in accommodating the five variables mentioned by Avgerou and Walsham (2000). Using these variables, the roadmap framework through the ICT devices, services and discussed infrastructure, addresses these aspects. This is supported by Figure 4:5, as explained in Chapter 4. Any of the services identified for rural areas improve the rural livelihoods in different ways, i.e. socially, economically and politically, and provide rural ICT users with up-to-date information.

7.8 ICT roadmap framework weaknesses

Evaluations of ICT projects often reveal an underutilization of resources because the newly introduced ICT has not been well integrated within the local context (Kozma, 2005), and in the worst cases, as a result of 'dump-and-run' approaches (Vosloo, 2006; Reijswoud, van Weide & van der Pscheidt, 2005), as well as a lack of local ownership in the receiving communities (Vaughan, 2006). Also, technical (hardware and software) problems resulting from the 'hostile' conditions in which the ICT was introduced put a strain on the actual impact (Gichoya, 2005). The high rates of hardware breakdown combined with minimal locally available technical problem-solving skills have led to underutilized and even abandoned projects. Finally, high recurring maintenance costs for hardware, software and internet connectivity put a financial burden on the projects, rendering them financially non-sustainable. The other weakness in planning for rural areas lies in the differences in ICT needs for rural users. This requires a lot of planning, stakeholder cooperation, government policies and working together with rural ICT users. This is not always easy and cannot be addressed effectively on the ICT roadmap framework discussed, but can only be explained separately as additional points or recommendations to the roadmap framework.

It is apparent that ICT projects cannot be adequately understood and addressed as technical initiatives (Avgerou, 2003) and therefore, like other technical solutions, the design and implementation of ICT solutions must be carried out in relation to the culture (Westrup *et al*., 2003), the environment, the organization, the available resources, the economic and political circumstances, as well as the desired impact (Avgerou, 2003). According to Avegrou (2003:57–58), there is a need for a situated approach where IT innovation is understood in its complex context (Reijswoud *et al.*, 2009).

7.9 Justification of the ICT roadmap framework

The concept of appropriate ICT technology was used to enable the development of a sustainable and applicable ICT roadmap framework. As a general definition, the idea was adopted that appropriate technology (AT) is "technology that is suitable for the environmental, cultural and economic conditions in which the technology is intended to be used" (Reijswoud *et al.*, 2009).

This is linked to the different aspects explained earlier in Figure 4:5. The author came up with an ICT roadmap framework that is generic enough to accommodate any rural community and is suitable for any ICT stakeholders who are developing an ICT roadmap.

For the ICT roadmap framework to benefit low-resource communities, the author has borrowed the ideas raised by Reijswoud *et al.* (2009) as initially raised by Darrow and Saxenian (1986). These ideas focused on highlighting guidelines for ensuring that the proposed ICT idea provides appropriate technology for the targeted community. These guidelines are necessary in determining whether the solution is viable for developing countries. Some of the guidelines which were borrowed for this thesis as proposed by Darrow and Saxenian (1986) are:

1. "Technology solution easily implemented with few resources at low cost resources, i.e. low cost ICT services, devices and infrastructure"
2. "Technology is developed on the ICT resources that are already available in a community supply of resources, e.g. ICT devices and infrastructure"
3. "The targeted community should clearly understand the proposed ICT solution and be able to use the solution, i.e. simplicity of ICT services"
4. "The targeted community should be in a position to update, review and maintain the proposed solution"
5. "The implemented ICT solution should allow future modifications and be easily adapted to changing circumstances".

These ideas were borrowed and used in the ICT roadmap framework. The ideas were borrowed to emphasise the important areas that can be addressed by the use of technology in rural areas. The aim is to have ICT solutions that are self-sustaining and could benefit rural communities without much involvement of the ICT service providers. The communities could be assisted with ICT education and developmental plans to improve their skills and enable sustainable solutions. Reijswoud *et al.* (2009) mentioned that new technology needs to address the local community in order to witness ICT self-sustainability and gaining expertise in rural communities; the same idea has been supported by Tharakan (2006).

The author found that the implementation of the roadmap framework has to involve all the stakeholders and has to be done clearly with contributions from all the parties involved. The implementation should be done with reference to the services expected in the community, using the devices already in that community and the existing technologies in that particular community. This should be in line with the specified goals of the roadmap and involve all the stakeholders. The author is positive that with the proper engagement of all the key partners addressing the required needs, the implementation process will succeed. The success of the AT idea is based on engaging the right stakeholders, offering services at low costs and addressing the needs of the targeted communities. These have been the main points of the findings of the studies carried out in this research, as explained in the previous chapters. The need for engaging with different ICT players to improve ICT sustainability was reinforced by the use of the stakeholder theory.

Stakeholder theory: Stakeholder theory was used in this thesis to justify the importance of engaging different parties in ICT roadmap development. Preston (1990) mentions the role of stakeholders from long ago in America (1929–1941), when General Electric defined "four major stakeholder groups –shareholders, workers, customers, and the general public". This means that the stakeholders include all different parties. Freeman (1984), in contrast, also mentions the term "stakeholders" with its history and defines it as it was considered in 1963: "those groups with the necessary support to ensure organizational growth" (cited in Freeman 1984, 31). This was also the definition offered by Bailur (2006).

Clarkson (1995) defines primary stakeholders as those "parties involved in the corporation's activities for smooth running". The pullout of key stakeholders in any company can cause the

closure of a company (Clarkson, 1995). In this research project, the stakeholders include ICT service providers, government departments, rural ICT users, rural schools, clinics and community halls. Understanding the role of stakeholders and their definition is critical for ICT development and all parties involved in ICT developments should work together in this regard.

The final stage for the analysis and assessment of the ICT roadmap framework was done through a mini-presentation at the University of Fort Hare Computer Science Department with different SLL ICT researchers. The idea was to gain feedback for other ICT researchers and their projects. The comments made during the mini-presentation were incorporated into the study and modifications were made before finalizing this thesis.

7.10 Conclusion

Various existing ideas which explain how technological sustainability could be achieved were considered. These were critical in explaining the ICT roadmap framework. The chapter begins by highlighting the key findings of the ICT roadmap framework. The focus of this chapter was to share with the readers some of the criteria and theories that were used to support the framework. The role of stakeholder involvement in ICT development is explained with the support of the stakeholder theory. This chapter explains the roadmap framework assessment. It outlines the arguments that were positioned either for or against the sustainability of the ICT roadmap framework.

Chapter 8:
RESEARCH SUMMARY, RECOMMENDATIONS AND CONCLUSION

The roadmap framework is generic enough to be used in any rural area and all ICT stakeholders should be engaged.[13]

8.1 Introduction

This is the final chapter of this thesis. It summarizes the overall research, focusing on giving recommendations and achievements achieved during the research period. The chapter provides the answers to the previous research questions stated in Chapter 1. There are several recommendations which were made after developing the ICT roadmap framework. Some of the roadmap framework's indirect components, which could not be included in earlier chapters but which are important, are:

- Equip rural ICT users with technical skills and educate on ICT usage
- Provide ICT solutions accessible and reaching everyone within a community
- Promote ICT awareness campaigns that could encourage users to enjoy using ICTs
- Come up with proper technical business models to support ICT developments.

The thesis highlights the proposed idea to improve the sustainability of rural ICTs by preparing for the future through an ICT roadmap framework. ICT education and training involving rural community members, stakeholders' involvement and addressing the rural needs are some of the main activities for a successful roadmap planning process.

8.2 Research achievements

The thesis has provided answers to questions that were initially given in Chapter 1. These achievements provide the key contributions made by the author in this thesis. These are:

Main research question: *How can ICT roadmapping be used to plan for future ICT services in rural areas?*

[13]Author's perspective as concluding remarks on the overall research.

To answer this question, ICT studies were done. As indicated earlier, the research question needed some sub-questions to be fully answered. After carrying out studies and developing the roadmap methodological framework, the author answered this question as follows: if proper planning with different ICT stakeholders including rural ICT users is done, then roadmaps could help planning for future ICT services in rural areas. To come up with these solutions, the following sub-questions were used:

Question 1: *Current state of ICTs – What are the ICT trends, developments and challenges in rural areas?*

This question was addressed through the roadmap framework which clearly shows a list of required ICT services and the characteristics of the services were explained (refer to various sections). The classification of ICT services, devices and infrastructure is shown in Figure 6:1, Chapter 6. Several ICT devices such as mobile phones, computers, radios and televisions were listed in the roadmap framework. The idea is to start by using the available ICT devices in different communities. The main ICT challenge which was found after analysis of current ICT challenges and studies carried out in this research, was poor ICT infrastructure in rural areas. This is as a result of poverty and low income earners in rural areas. The author suggests that it could be beneficial to offer services using the ICT devices which rural people have access to or can afford. ICT access points in rural areas were also discussed. These include schools, clinics and community centres. This was to address *objectives 1 and 2*, which were to understand the current ICT environment and identify critical rural technologies respectively.

Question 2: *Future technological projections – Which future technological projections are applicable in rural areas?*

During the study conducted in preparation of Paper 2, for the future of ICTs, a lot of ideas were proposed. It was not easy to clearly identify the actual projections which could be applicable in rural areas. This was because of the current ICT challenges which most rural areas face. The author noticed that most of the future projections such as social networks, mobile growth, cloud computing and electronic service usage have already reached some rural areas. This addressed *objective 3*, which was to analyse future ICT projections and indicate whether these projections are applicable in rural areas. The main issue is to have proper ICT infrastructure, which is still unavailable in these areas, causing delays in future ICT developments. The other issue is that the

current ICT roadmaps for developing countries do not focus much on offering future projected services; this could delay the deployment of the future ICT services in rural areas. Therefore, most of the future technological projections could be applicable in many rural areas, once required ICT infrastructure is provided. This involves the working together of all ICT stakeholders.

Question 3: *ICT roadmaps – To what extent can ICT roadmaps help in ICT planning and development within rural areas?*

Current literature and online searches have indicated that there are numerous roadmaps in different areas. Many of these roadmaps are available in developed nations and are mainly drawn up by companies. Details of the roadmaps were explained in Chapter 3. Through a roadmap literature review, the author found that developing nations such as Bangladesh, Malaysia, Pakistan, Lesotho and South Africa have ICT roadmaps. It was observed that almost all the ICT roadmaps focus on ICTs nationwide. The South African ICT roadmap plan is one national roadmap that focuses on ICTs developments for rural areas. After going through the existing roadmaps and developing the ICT roadmap framework, it is clear that if proper planning of ICT roadmaps is done, engaging all the parties involved in addressing the desired services, roadmaps could surely benefit rural communities. The ICT roadmap framework focused on addressing the technological aspect, besides earlier mentioning other aspects in Chapter 4, in Figure 4:5. But, it should be noted that addressing the technical aspect can improve the other areas such as social, economic or political aspects, thus leading to the sustainability of the roadmap. Again, once all the stakeholders are involved, the roadmap can indicate which services which are vital for community development. This was important in achieving *objective 4***,** which was to provide and develop an ICT roadmap framework.

Question 4: *ICT stakeholders – What is the significance of engaging all ICT stakeholders when planning for ICT development in rural areas?*

Various sections of this thesis explained the need for ICT stakeholders' involvement. There is no doubt that for successful ICT developments, government departments, rural community members, private and public companies, academic institutions, foreign ICT experts and NGOs need to be fully involved. All the current ICT roadmaps involve different ICT stakeholders. It was observed that at times ICT rural users are not engaged throughout the whole roadmap

development process. ICT stakeholders also play a vital role and if they all work together and plan effectively, ICT roadmaps could sustain rural service delivery.

Question 5: *What ICT services, devices and infrastructure mix is applicable in rural areas?*
This question was answered in Chapter 6, Figure 6:1, Figure 6:6, and in the assessment of the framework in Chapter 7. Different ICT services can be provided and share infrastructure or devices. This question has been answered and supported by *recommendation 5* given in this chapter. This recommends the need to have convergence of ICT infrastructure, services and devices. Having provided answers to the above questions the author has managed to achieve the following research objective, which was set out in Chapter 1: this was important in assessing the ICT roadmap methodological framework, which was *objective 6.*

Main research objective: The research's main objective was to: analyse current ICT trends and technological changes by projecting the future of ICTs and existing ICT roadmaps and then consider the ICT roadmap framework to enhance roadmap success. The framework should enable successful and sustainable ICT roadmap development. This was achieved through various research studies explained in Chapter 4 and the developed ICT roadmap framework described in Chapter 5 and Chapter 6. The sections which provide answers to how the objectives were met are shown in Section 1.12.

8.3 Recommendations

This section gives some of the recommendations which are necessary for ICT developments. These recommendations were based on the different studies conducted for this research and the findings after the roadmap framework development. Some of the recommendations are:

Recommendation 1**:** *Align ICT policies and strategies to take advantage of mobile and broadband development and, in particular, updating telecommunications regulations* – Coming up with ICT policies that support mobile and wireless infrastructural developments is vital in reaching poor communities. Again, proper ICT policies will boost mobile applications and service delivery with internet access and an increase of broadband penetration (Kloch *et al*., 2011). On the African continent, only mobile technology has seen significant growth thus far.

Recommendation 2**:** *Developing nations need to come up with well-planned ICT infrastructure roll out plans* **–** All future ICT services rely on the well-connected networks. This is possible if rural areas in Africa are considered and provided with ICT infrastructure. The planning process requires commitment of all key ICT stakeholders. This recommendation is backed by various ICT stakeholders including the European Union.

Recommendation 3: *Provision of computer peripherals and internet to low-resource communities* – Having noticed that although most ICT devices are getting cheaper and cheaper, this does not guarantee that all rural people are able to own such devices. The poverty in many communities is so high that a lot of people are not going to afford ICT devices. According to Levin (2005), almost half of South Africans had never used the internet. This means that poor communities are in need of ICT devices. The eReadiness study explained in Paper 6, shows that rural ICT users are ready and eager to learn. The main issue that delays ICT developments is lack of ICT devices. Donors, the international community, the private sector and NGOs could help by providing ICT devices such as computers to poor communities.

Recommendation 4: *Use of already existing ICT devices* – In the absence of computer donations, this recommendation requests ICT service providers to use existing ICT devices foe service delivery. Some of these devices are: radios, TVs and mobile phones.

Recommendation 5: *Stakeholders' engagement and appropriate technical business model* – The need for all ICT stakeholders to work together and develop ICTs is one of the main proposal in

this thesis. The stakeholders should include the rural ICT users and communication should be effective from the beginning of the project to the end. Duplication of infrastructure, services and ICT developments in a particular community can only be reduced if stakeholders work together. There is a need for proper technical business models that clearly identify the different targeted customers: in the case of rural areas, these are farmers, teachers, learners, the old, rural entrepreneurs, jobless youth and women at home. A sample of a technical business model is shown in Appendix C. The model explains the values which an ICT product or service should have, such as being affordable, easy to use, single service, low power consumption or solar enabled. The ICT business model emphasizes having long-term customer relationships with rural customers. It is important to highlight how revenue is to be generated and the different costs associated with the ICT projects have to be clear. All stakeholders involved should be identified, and community engagement is essential to enable a sustainable ICT solution and satisfy rural customers' needs.

Recommendation 6: *ICT training and education programmes in rural areas* – The literature clearly show that many ICT users in rural areas are illiterate. This means that ICT service providers should continuously offer training to users in rural areas.

The recommendations show that ICT policies should be available first. Then, proper ICT infrastructure can be provided. The necessary ICT devices should follow. After these, ICT stakeholders should keep on working together and provide appropriate technical business models to support the services. The ICTs should be provided at low cost, in local languages to improve understanding and minimize costs. The last step of the recommendations is to provide continuous ICT training in rural areas. This would encourage the sustainability of ICT project development.

8.4 Successful ICT stories– applicability of ICT roadmap framework

The roadmap framework encourages the use of mobile phone as a common ICT device. In this section some statistics to support the applicability and sustainability of mobile applications are explained. The common example is the popularity of M-PESA, which was launched in 2007. Several millions of users now rely on this application to send money, mainly because of its simplicity and good business model (Mobile Africa Report, 2011). The M-PESA idea has expanded to other African countries where people are able to send money over their mobile phones. In support of mobile usage, during the year 2011, Africa reached a rate of 1 mobile

phone per every individual (Mobile Africa Report, 2011). It is also predicted that by 2014 more than 55% of the African population will be using mobile phones (Mobile Africa Report, 2011).

The collaboration of Mxit and WiWallet is an example of relationships which indicate how ICT services could be merged and improve service delivery (Mobile Africa Report, 2011). The mobile penetration growth in rural areas has been supported by over 25% of rural dwellers and a further 37% of all urban South Africans using mobile phones to access the internet (Mobile Africa Report, 2011). Furthermore, close to 20% of mobile phone users in South Africa are using SmartPhones (Mobile Africa Report, 2011). These statistics support the idea which came up from the roadmap framework, where the mobile infrastructure and the mobile device are common for ICT service delivery in rural areas. One can see that if the mobile phone can change life as seen in the case of M-PESA, then if other services are also planned with proper technical business models, this could still further benefit rural ICT users and improve ICT sustainability.

8.5 Further research

For further research, the author discovered that there are some ideas which can help to improve the ICT roadmap development and assessment. The developed ICT roadmap framework can be improved by engaging expert developers to apply some intelligence to the framework so that it can accept different components useful in decision making. Some key points that might improve such a study would be by making changes to the following:

- Selection of case study countries
- Selection of ICT experts
- Selection of rural areas, i.e, avoid studying only one country and one province
- Assessment of the ICT roadmap framework should be done by various ICT experts from different countries.

Expanding the number of case studies, ICT experts, rural communities and stakeholders consulted can add more ideas to the framework. In this research, the author mainly looked at ICT developments in Finland, focusing mainly in Espoo and Helsinki. The research in South Africa was done mainly in the Eastern Cape Province in three rural areas, with the SLL being the main case. Interviews and meetings were held with several ICT experts who were available and willing to share their views. For the framework assessment, it would have been important to

engage other different ICT stakeholders besides the SLL researchers to get more views. Due to these limitations, the author for future research advises more workshops with various ICT stakeholders including policy makers, and looking at more case studies from other countries. Besides, these suggestions for future research, the current state of the developed ICT roadmap framework is significant and vital for ICT stakeholders to use in roadmap development.

8.6 Research conclusion

Rural ICTs face a lot of challenges as technology changes drastically. Most of the deployed ICTs fail to sustain rural communities and as a result most ICT projects fail. It is remarkable to realize how easily rural communities have adopted these innovations. The need for ICT service provision in rural areas has been targeted by different ICT stakeholders. This has been encouraged by ICT services which are available within many areas in the world. Most ICT researchers are targeting rural areas and providing different services ranging from, eCommerce, eHealth, eGovernment, eLearning and mobile services. Examples of some notable ICT contributions include reducing the cost of getting services and enabling accessibility – mainly for information exchange. Furthermore, access to ICT enables exchange of ideas and improves various parts of the society as indicated in Figure 4:5. This has encouraged ICT stakeholders to come up with different ICT strategic plans to improve sustainability of ICTs in rural communities.

Several ICT planning strategies were looked at, including ICT roadmap developments and the conclusion is that if proper ICT planning is done, rural communities could benefit in all sectors of the community, such as in the economic, political, social and technical aspects. The author observed differences and challenges within the existing ICT roadmaps for some countries such as Bangladesh, Malaysia, Pakistan, South Africa and Lesotho. The author identified some of the missing areas in already existing ICT roadmaps and proposes a roadmap framework which could assist ICT stakeholders in improving the roadmap planning process.

The ICT roadmap methodological framework thus recommends the provision of low-cost ICTs on an advanced ICT backbone which users could easily access. It focuses on addressing the three key ICT components, i.e. ICT services, infrastructure and devices. At the same time, the framework explains how the key ICT components could improve rural livelihoods socially, economically, politically and technically, while protecting the rural environment. Roadmaps are

meant to help in planning and decision making. This ICT roadmap framework combines ideas from different ICT experts and general users and is aimed at helping the roadmap generation process to improve ICT developments for rural areas. The ICT roadmap framework is aimed to equip ICT stakeholders with better knowledge that is necessary to build sustainable ICT roadmaps. This could improve ICT developments and benefit rural ICT users.

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APPENDIX

Appendix A - Sample Questionnaires

Questions used during discussions and focus groups with ICT Rural Users

Questions used during discussions and focus groups with ICT Rural Users

1. Tick some examples of ICTs you currently use

- ☐ radio
- ☐ Television
- ☐ Mobile phones
- ☐ ipads
- ☐ laptops
- ☐ Desk top compute

2. How many examples of successful application of ICT in rural areas are you able to indicate?

- ○ 1
- ○ 2 - 5
- ○ 6 - 10
- ○ more than 10

3. Do you know about governmental initiatives in your country that aim at stimulation of rural development through ICT?

- ○ Yes
- ○ No

if YES, what are they?

4. Are there such initiatives funded by private/non-government sector?

- ○ Yes

○ No

if YES, what are they?

5. Which ICT services do you find especially important for stimulation of the rural areas development?

- ☐ eGovernment
- ☐ environment monitoring
- ☐ emergency services
- ☐ food safety
- ☐ precision farming
- ☐ subsidy control
- ☐ support for delivery chain
- ☐ IT support for forestry and wood industry
- ☐ rural tourism
- ☐ eHealth
- ☐ eLearning
- ☐ other...

6. Do you know about any initiative in your country that aim at the collaboration between rural workers (traditional understanding of rural jobs)?

○ Yes

○ No

if YES, what are they?

7. Do you know about any initiative in your country that aim at the collaboration between people working and living outside cities (jobs not perceived as “traditionally rural”)?

- ○ Yes
- ○ No

if YES, what are they?

8. Which of these technological aspects do you find specially important for the rural collaborative settings?

- ☐ context sensitivity and location-based services
- ☐ increased connectivity
- ☐ mobility
- ☐ knowledge technologies
- ☐ natural interfaces
- ☐ simple access
- ☐ spontaneous and dynamic connections
- ☐ other... (what?)

9. What socio-economic aspects need to be considered to ensure that meaningful applications and services development and implementation takes place in rural areas?

- ☐ resistance of those involved in traditional activities to uptake innovations
- ☐ digital divide
- ☐ low profitability of ICT implementation

- ☐ high cost of infrastructure development
- ☐ lack of good practices
- ☐ other... (what?)

10. What ICT infrastructure would you want to be deployed in rural areas? Tick any from the list

- ☐ Fibre Optic cable
- ☐ Satellites
- ☐ Mobile infrastructure
- ☐ Digital Subscriber Line (ADSL)
- ☐ Wireless Local Area Network

11. What are some of the ICT challenges in rural areas? Tick any from the list

- ☐ Poor infrastructure
- ☐ Shortage of ICTs
- ☐ No access to ICTs
- ☐ ICTs are expensive
- ☐ ICT illiteracy
- ☐ No Government ICT support
- ☐ Social, cultural ICT challenges
- ☐ Lack of reliable ICT power supply

Questionnaire for ICT Experts – Workshop Discussion

ICT Roadmap Workshop Discussion Questionnaire

Information Communication Technology for Development (ICTD) Technical Road map for Service Delivery in Rural Areas:

The future of technology is becoming an interesting area for the researchers. Different individuals and organizations have anticipated the future of technology and some of the proposed ideas are: increased adoption of cloud computing, mobile applications, social networking and semantic web technologies. We appreciate that all these future expectations have an effect on ICT platforms and the fact that there is a lot of work being done to improve service delivery through ICTs in developing countries. However, a concern remains on the alignment and applicability of these projections with the realities in rural third world countries. ICTD practitioners need to be aware of the competing future scenarios and orient their work in such a way that their solutions are not obsolete immediately after deployment.

1. Do you accept that technology is changing?

Yes		No		Not sure	

2. Do these technological changes affect ICT applications?

Yes		No		Not sure	

3. From the above list which ones do you think are the top three projections in terms of growth/ expansion?

1……
2……
3……

4. To what extent do the following factors affect the implementation of some of the future technological projections in Rural Areas? (*Whereby 1 denotes strongly disagree, 2-disagree, 3-somewhat disagree, 4-neither disagree nor agree, 5-somewhat agree, 6-agree, and 7-strongly agree).* Please circle the number of your answer.

Shortage of resources	1	2	3	4	5	6	7
Poor infrastructure	1	2	3	4	5	6	7
No interest	1	2	3	4	5	6	7
High technological illiteracy	1	2	3	4	5	6	7
Poor internet connectivity	1	2	3	4	5	6	7
Low income	1	2	3	4	5	6	7

Government policies 1 2 3 4 5 6 7

5. In general, what are some of the factors that affect ICT applications? List them:

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……..……

6. What would you think are some of the possible services which could be provided in areas with such challenges above? List them:

……

……. 7. In your own opinion what would you say is the future of ICT technology?

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8. Do you understand the term ICT Technological Road Map?

Yes		No		Not sure	

9. Do you think it is necessary to have a Technological Road Map for ICT applications in Rural Areas?

Yes		No		Not sure	

10. What do you think would need to be considered in designing the ICT Technological Road Map? Tick any from the list:

Users	
Current state ICTs	
Government polices	
The future changes	

11. What do you think would be the best way to represent the ICT Technological Road Map? Tick any from the list:

An architecture	
A model	
A software	
Detailed Statements	

12. Do you have any comments or suggestions on the services you think could be deployed in Rural communities that could be considered in designing the ICT Technological Road Map.

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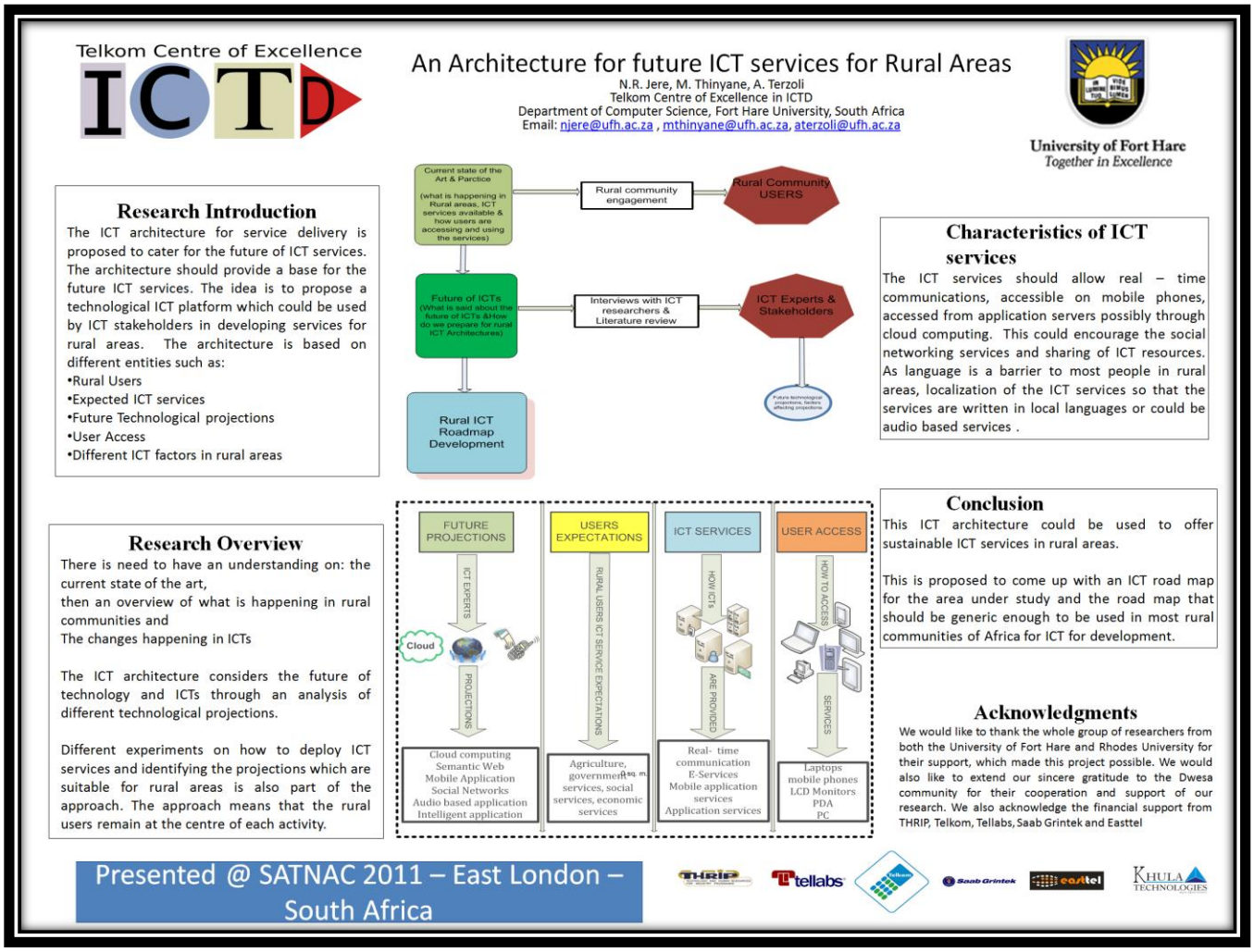
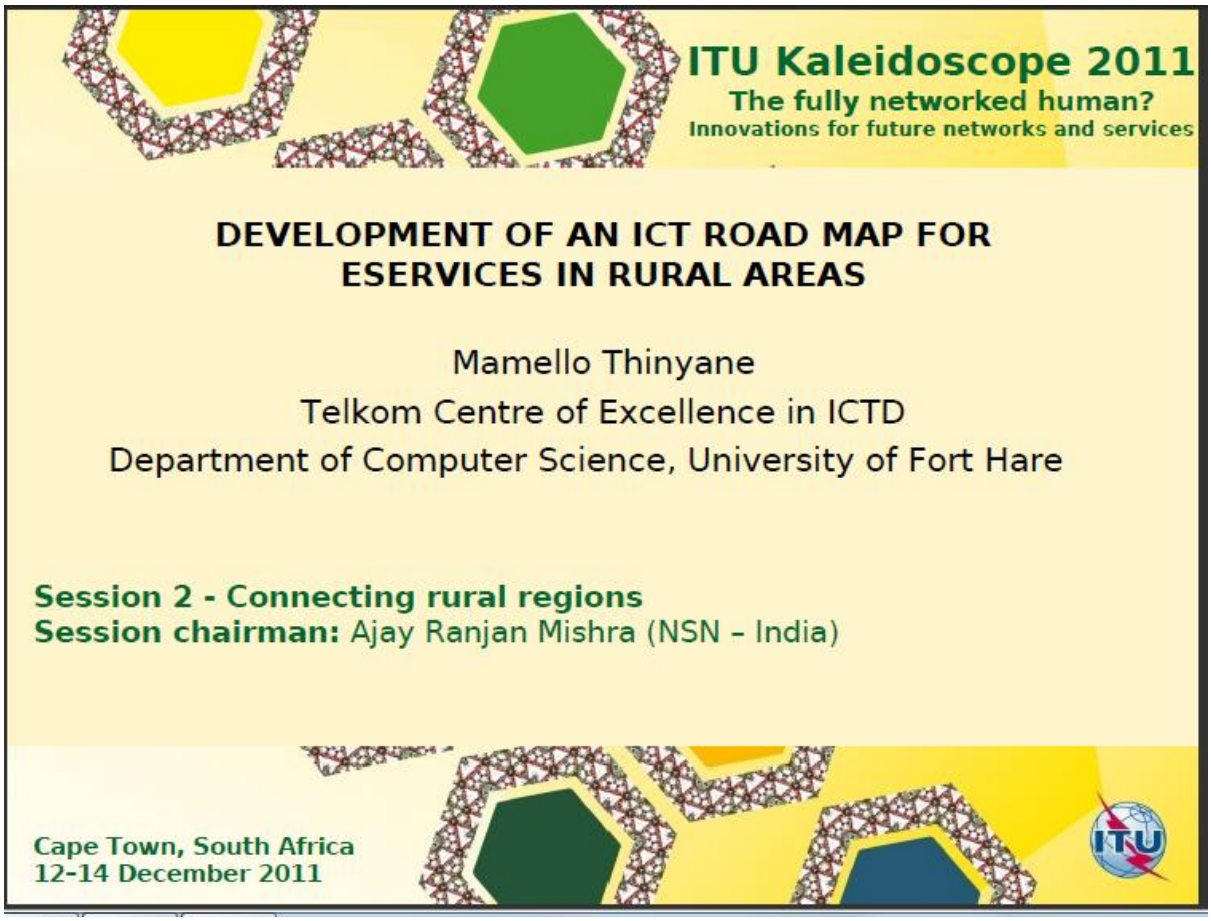
Appendix B – Publications

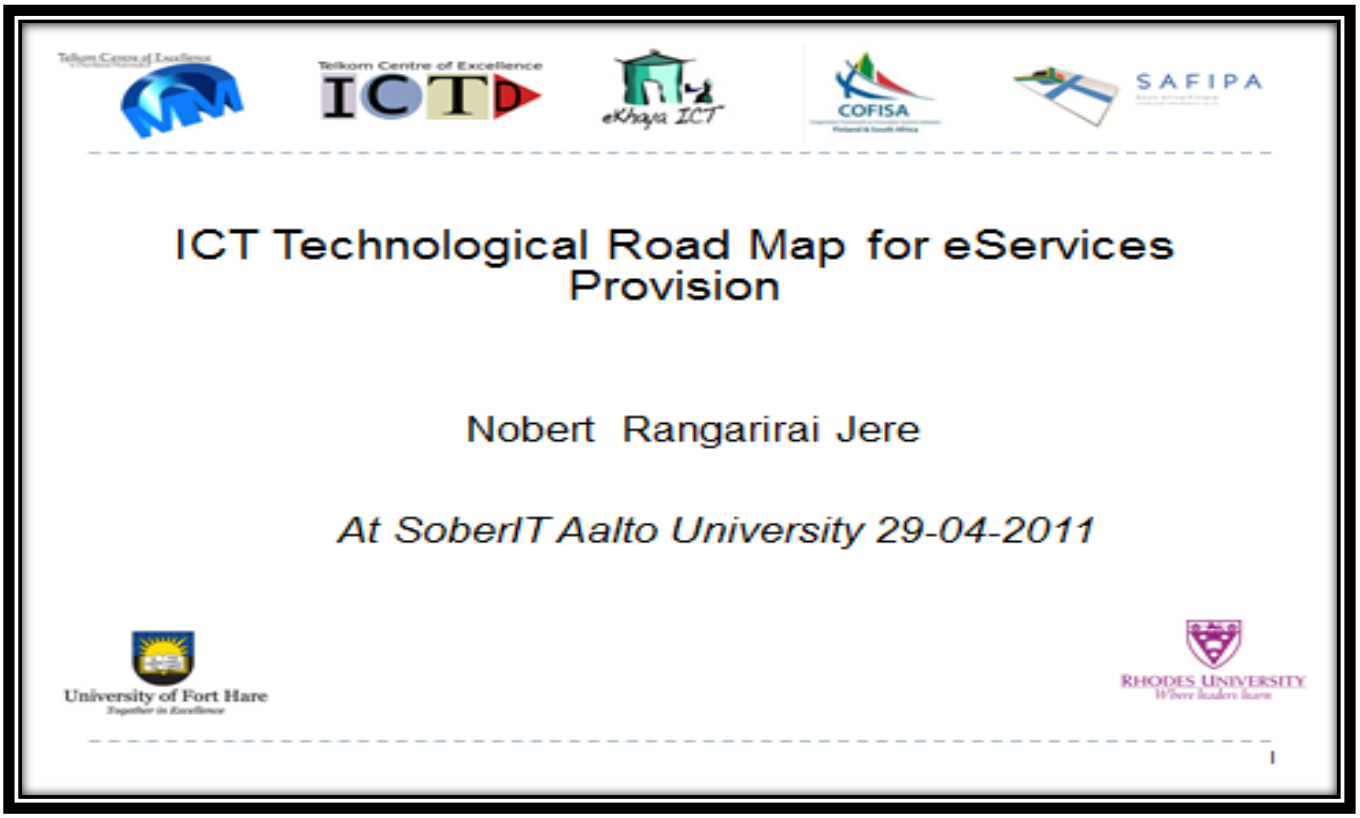




Paper 4 – presented by the research promoter in 2011, South Africa Cape Town:

Attached in this section are samples of published papers:

Appendix C – Workshops



AN ICT ROADMAP PLANNING TOOL FOR ESERVICES IN RURAL AREAS

BY

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Finland Aalto Visits: Meetings, Seminars and workshop Attended

Date	Details	Discussions
08/04/2011	Meeting with Kimmo & Tingan SoberIT	Discused project overviews & shared on the projects involved in: eg OtaSizzle project (Living Lab in Aalto University campus): http://www.sizzlelab.org. ICT related communities in Campus:http://aaltoes.com
08/04/2011	Forum Virium Helsinki (Helsinki Living Lab)	The 5-year anniversary seminar: met a lot of people in ICT living labs including, Annti Korhonen(V.P Digital City Concepts), Jarmo Eskelinen (Toimitusjohtaja- CEO) Peter Green (Finnish Mobile Association), Pekka Koponen (Kehitysjohtaja- Dvpmnt Director)
11/04/2011	Meeting with Miihkali Euro SoberIT	Shared ideas on the future of ICTs and different applications which could be provided for rural communities. From him, cloud computing & Mobile applications are possible solutions
12/04/2011	Aalto's Insight into NFC - workshop	Event organized by Aalto Entrepreneurship Society. Presentations on Near Field Communication (NFC) were done. Nokia sharing on how they plan to approach NFC in Europe. Met Sixten "Sigge" Sandstrom (Director of Ecosystems Markets/ Industry Collaboration- Nokia). He highlighted reaching out the whole world on the benefits of NFC remains the key challenge.

13/04/2011	Otaniemi Open 2011	EIT ICT Labs Event: Demonstrations on different ICT projects were done from different organizations. Presentations on Bringing Europe to a new ICT age by Willem Jonker (CEO EIT ICT Labs), EIT ICT Labs and Helsinki by EIT ICT Labs Helsinki Node Director, Services at hand – ICT inspired smart spaces by Petri Liuha, Nokia& Action Line Leader for Smart Spaces at EIT ICT Labs. ICT services for Health and Wellbeing by Patrick Strating EIT ICT Labs Eindhoven Node Director- Netherlands. Demonstrations were made on ICT applications such as Kassi, AudioImager, Behavioral Observation System (BOB), Usability methods for mobile devices, Qt Remote UI, Mobile HUBI Portal
14/04/2011	Meeting with Marko Professor, D.Sc.(Tech.) Usability SoberIT	Discussed on the ICT technological road map. A lot of ideas were proposed in designing the road map. Main ideas raised: a look at the current state of the Art and state of the Practice --- looking at what is happening in the community now: Doing a usability testing on what ICT applications work and which ones are preferred by the Users. A user centric approach and constructive research suggested as methodologies. How some companies attempt to prepare for the future e.g Nokia wishing to provide Intranet in Mobile services. He also sees the road map as a report description with detailed statements. The main question could be how we make sure that eServices are accessible and usable in rural communities: Guidelines that developers of emerging new eServices would follow, have access & benefit from the services. He also emphasized on the need to offer ICT education as technological illiteracy is still high in many parts of the world.
18/04/2011	Meeting with Timmo SoberIT	Discussed on the ecosystem model or architecture where technological services and the business model meet. The future architecture which should be considered in designing ICTs. The Business model canvas for sustainability of services from the enterprise architecture was explained. Simple Mobile applications proposed as part of future ICTs.

19/04/2011	Meeting with Antti Korhonen	Former employee of Nokia, now the Vice President of DigiEcoCity Ltd. Discussions on ways of providing energy/ power supply to rural areas or areas without power sources. Best ways of providing low cost energy supply where users can pay through services. Working for services, in cases where there is no cash to pay for the services. Referred to amaoulu Helsinki eservice platform. Also of the view that open source application could be best in designing applications for rural communities.
26/04/2011	Meeting with Matti Professor pro tem SoberIT	ICT services delivery & sustainable ICT solutions. Key stakeholders to be involved in ICT projects. ICT living labs Analysis
26/10/2011	Seminar chaired by: Prof: Harry Bouwman (Delft University of Technology:) and Prof Matti Hämäläinen: Marko Nieminen and Mikko Heiskala	Smart Living" seminar at Aalto University, Innopoli 2, 4th floor, Jotuni room - lunch 12:30 - 14 at Innopoli 2. The seminarcovered smart home, the underlying technologies (e.g. platforms, including mobile + IoT/WoT + social media services) and other elements enabling the growth of "ecosystems" in "smart living" that is still at an embryonic stage as an industry.
25/11/2011	Workshop chaired by Prof. Sepaa and Amrita; Christian Aspegren and Aki Koivistoinen	A workshop on the business opportunities through Indian health kiosk. University of Tampere, Kanslerinrinne 1, Building Pinni A. Workshop details: The beginning was a presentation on having Global Business Creation courses to encourage Global business. The idea is proposed to be implemented in Finnish Universities: Then the presentation on the Indian Health Kiosk: The aim of the health kiosks is to improve health awareness in rural communities: It encourages the promotion of rural people who have health knowledge to assist the communities which they are living in.

Technical Business Model sample