INEXPENSIVE MOBILE TECHNOLOGIES TO EMPOWER RURAL FARMERS WITH M-AGRICULTURE

by

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Abstract

Market information and established communication between seller and buyer play an important role in business activities. This thesis investigates the Transkei area in the Eastern Cape Province, South Africa to find out how to empower rural farmers by providing them with less-expensive mobile technology enabling them to post and advertise their produce, access market information on a common database, and find and communicate with potential customers. The farmers' requirements were identified using quantitative and qualitative methods and a prototype consisting of USSD and web applications was developed. It allows the farmer to follow a sequence of menu commands to send a request to the database and access market information, such as commodity prices, and post information about their own produce so as to attract more customers. The low cost of USSD and the ubiquity of mobile phones enable the system to be usable, affordable and effective. During the final stage of development, the system was tested successfully and addressed a major problem faced by farmers, i.e. lack of access to market information.

Keywords: Unstructured supplementary services data (USSD), hypertext preprocessor (PHP), Global System for Mobile communications (GSM), mobile phone, short message service (SMS), marketing, m-agriculture, rural area, farmer, smallholder, Internet.

DECLARATION

I, Marie Louise Iraba, declare that "*Inexpensive mobile technologies to empower rural farmers with m-agriculture"* is my own work, that it has not been submitted for any degree or examination at any other university, and that all the sources I have used or quoted have been indicated and acknowledged by complete references.

Full name: Marie Louise Iraba

Signed .....

Date: .....

EDITOR'S CERTIFICATE

1 November 2011

To Whom It May Concern

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

GLOSSARY

APACHE Freely available web server that is distributed under an open-source licence (Byte Orbit, 2011).

FARMER A person who works on/owns a farm and keeps livestock or cultivates the land.

GSM **Global Systems for Mobile communications**: A worldwide standard for mobile telephones; its ubiquity allows mobile phone operators to make international roaming calls. It is considered a second-generation mobile phone system because signalling and speech are digital compared to the previous generation (funSMS, 2010).

HTML **Hypertext Markup Language:** A markup language with many functionalities used in the design of webpages containing documents, hypertext, images, links, etc. (Web Developer notes, 2010).

HTTP **Hypertext transfer protocol**: A method used to send and receive webpages over the Internet using standardised request and response messages (Bradley & Millspaugh, 2005).

ICT **Information and communication technology:** A term used for computer and communication devices, software applications, and the technology involved.

ICT4D **Information and communication technology for development:** Information and communications technology projects designed for development, especially for rural areas.

INTERNET The world's largest computer network, consisting of thousands of interconnected networks all freely exchanging information (Stain et al., 2008).

JAVASCRIPT A scripting language used to enable access to objects within other applications. It is primarily used for the development of dynamic websites (Science Articles, 2011).

J2ME **Java 2 Platform, Micro Edition**: A platform that uses the Java programming language and related tools to design mobile phone applications.

MARKET A place where sellers and buyers meet.

MOBILE PHONE

A portable electronic device used to communicate. Mobile phones use a network of specialised base stations (Jerry, 2010). Also called a cell phone.

MySQL **My Structured Query Language**: An open-source relational database management system based on structured query language (Sun Microsystems, 2009).

PC **Personal computer:** A data-processing device that utilises a microprocessor. It is designed to be used by one person at a time (Network Dictionary, 2010).

PHP **Hypertext Pre-processor:** This allows web developers to create dynamic content that interacts with databases (Achour, 2009). It is a server-side scripting language.

PHPMYADMIN

The interface freely and convivially realised in program language (PHP) that makes it easy to manage the MySQL database on the server (Sun Microsystems, 2009).

RURAL AREA An isolated area of the country with a low population density (Tolidis, 2010).

SMALLHOLDER

A person who owns a small piece of land (less than a hectare) and whose income is mostly dependent on farming.

SMS **Short message service**: A mobile phone technology for the delivery and reception of messages between subscribers (Kevin Patrick, 2009) and a communication service component of the GSM communication system that uses standardised communication protocols to allow the exchange of short text messages between mobile phone devices (Escape From America, 2011).

SSM **Soft system methodology**: a methodology developed to deal with soft problems involving psychological, social and cultural elements. It is designed to tackle problematics situations encountered in management, organisational and policy contexts, where ther are oftern no straightformward problems or easy solutions (Lester, 2008).

SYMBIAN PLATFORM

An operating system for mobile phones.

UML **Unified Modelling Language:** Helps to analyse and design different object-oriented systems (Stumpf & Teague, 2004).

USSD **Unstructured supplementary services data:** A menu-driven form of SMS used between a mobile phone subscriber and a service application. During the communication, the user receives text consisting of a set of menus as opposed to string of words, as in the case of an SMS (Krugel, 2007).

WWW **World Wide Web:** A system of interlinked hypertext documents between a web client and server (IEEE Computer Society, 2010).

C h a p t e r 1

PROBLEM STATEMENT AND ANALYSIS

INTRODUCTION

In this chapter the background information that contextualises the study is given, as well as the motivation for embarking on this programme of research. The research problem is clarified and refined with reference to related literature. Finally, the research hypothesis is stated and unpacked as three research questions. The chapter concludes with an outline of the rest of the thesis.

SKETCHING THE BACKGROUND

Many of the rural people in this region are subsistence farmers who do not get an income from any other source. Generally, rural area smallholding farmers work hard and invest considerable time and money in agriculture, but their income is low compared to the income of buyers and brokers (intermediary sellers) who serve as a means of access to the market (Science in Africa, 2006; Kirkman et al., 2002; Harwood et al., 2009).

Accorrding to Perret (2002) many farmers in the Eastern Cape, besides their income from farming activities, receive funding from sources such as pensions, government social grants or relatives who have migrated and now work in the cities. Some rural farmers are not only subsistence farmers, but also generate their income from other farming activities such as wool production (Perret, 2002).

Even though economic farming activities do take place to a lesser extent in this region, a well-established market does not exist. Phiri (2009) asserts that rural farmers generally receive less than market-related prices for their commodities and this can mainly be attributed to the fact that they lack

adequate means to market their produce. When their produce is not sold on the market, they choose to sell it at very low prices or use it for domestic consumption rather than letting it go to waste. Another reason prices may be low is that farmers in the same village often grow and harvest the same product at the same time, due to agricultural conditions such as the soil, weather and season. This increase supply, therefore, and pushes down prices (Community Guide to Environmental Health, 2008). Commodity exchanges are mostly between people that are socially connected. Thus the price of a commodity is determined by the social relationship of the seller and buyer, e.g. how close the buyer is to the seller (Phiri, 2009).

RELATED LITERATURE

To be competitive, farmers need to buy agricultural goods for their farming concern when the price is low and sell their commodities when their price is favourable. They furthermore need to find clients on time to maximise their income. Therefore, it is crucial for farmers to know the prices of their commodities and what opportunities there are in the market without necessarily physically going to the market. This will allow them to make informed decisions regarding their business. Kirkman et al. (2002) state that the vast majority of the poor in rural areas (of low-income countries) are either farmers or surplus labourers and depend heavily on markets; they thus argue that integrated markets can be of significant help to the poor.

Could information and communication technologies (ICTs) establish a more dynamic market that will link farmers to a much wider range of clients and business opportunities? If less-expensive technologies could be used for this purpose, would its price not become a financial constraint to rural farmers?

The focus of this thesis is to establish whether mobile phone technology and its availability in the rural region of the Transkei (situated in the Eastern Cape Province of South Africa) could improve the lives of the area's inhabitants financially. A prototype to assist farmers with the selling and buying of

commodities was thus designed and implemented on a mobile phone. The intention was for this system to be economical and available on entry-level phones. The idea was that the system would give farmers access to market-related information that could provide them with more opportunities to market their goods. The mobile phone was chosen as the enabling technology because of its availability in most rural communities; furthermore, it is affordable and does not require a high level of literacy to operate. Mobile phone applications have been utilised in many rural development projects (Routen et al., 2010). According to the World Bank (2008), the mobile phone has the potential to help people in poor countries to escape the cycle of poverty. If it is used creatively it could help to stimulate development, particularly in remote rural areas.

The technologies used in the development of the prototype were websites, unstructured supplementary services data (USSD) and short message service (SMS); the latter two are mobile-based technologies that are less expensive than voice calls (Bhavnani, 2008). Websites require a smart phone that has an Internet option; however, USSD and SMS are available on all mobile phones at a minimal cost. If farmers use this proposed system it would not be necessary to spend large amounts on travelling to the market or phoning several people to access information about their produce.

The decision to use USSD was prompted by the fact that USSD is a fast, cost-effective technology operating at a speed seven times faster than SMS technology. USSD facilitates more interactions and allows instant responses; hence faster communication between user and the network applications is possible (Sanganagouda, 2011).

Maritz et al. (2010) determined that USSD is very inexpensive and chose to use it in their research. They estimated the rate of SMS at 30 cents during off-peak hours and 75 cents during peak hours, while USSD is rated at around 5 cents per session. Another reason for using USSD is that it requires a very

basic phone and is an established technology that is provided by most local service providers.

Sanganagouda (2011) considers the operating costs of USSD as experienced by the operator/service provider and finds that this service could be offered at almost no cost to users.

South Africa has a well-developed telecommunications infrastructure. In 2012 the expected bandwidth in Africa will increase considerably due to new undersea cables (see Figure 1) that are currently being laid around Africa. Two cable systems, ACE (Africa Coast to Europe) and WACS (West Africa Cable System), each with a capacity of 5126 gigabytes, will be available for Africa's use by the end of 2012 (Song, 2010).

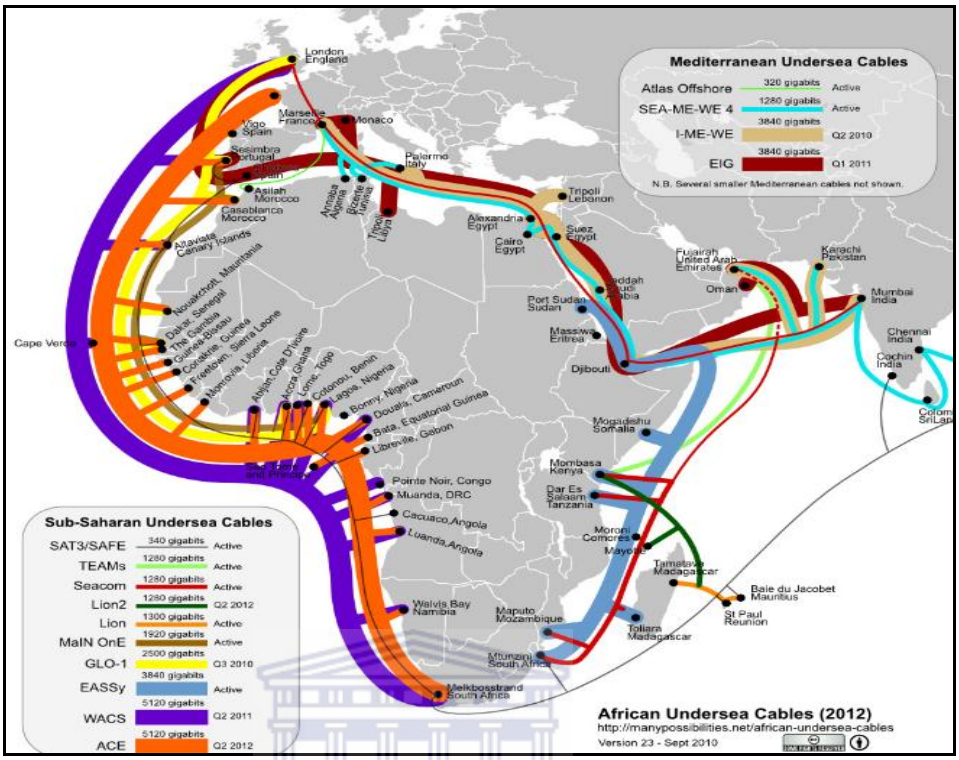


Figure 1: Africa's Internet accessibility by 2012[1] (Song, 2010)

This will improve the penetration and effectiveness of ICTs for all communities in Africa.

The uptake of inexpensive ICTs in rural agriculture could unlock the potential of commercial farming and could be an important key to its success. This availability of ICTs could thus create opportunities for subsistence farmers, but could be also be beneficial for the mobile companies whose communication technologies (SMS and USSD) would be applied in different contexts.

The main problem that drives this investigation is: "*How can mobile technologies create opportunities for rural farmers to promote their agricultural businesses cost effectively?*"

This question can be unpacked into the following sub-research questions:

[1] Steve Song gave permission that this figure may be used in this thesis.

- How should farmers be empowered to advertise their produce and be put into contact with potential clients?
- How should inexpensive mobile technologies be harnessed to provide market-related information to rural farmers?
- How should the uptake of this technology be promoted?

APPROACH AND METHODOLOGY

Different approaches and methodologies were used to investigate the problem. A mixed-method research approach was used to collect qualitative and quantitative data by means of questionnaires and interviews. A preliminary study was conducted to collect user requirements for the system. This initial investigation was aimed at determining how mobile phones were used in this specific rural community, what was spent on mobile phone services in this community, the accessibility of the Internet and which crops were grown in this area for marketing and which for own use. Preliminary research included a survey completed by farmers. The major focus of the survey conducted in the Eastern Cape was to collect information about the farmers' mobile phone usage. Document analysis was used to obtain supplementary information. The analysis and interpretation of this data guided the design of a prototype. The prototype was designed using Unified Modelling Language (UML) and developed using open-source programming languages. Feedback and testing of the prototype were used to improve the prototype.

The finding of the research showed that the majority of rural farmers own mobile phones, but the major use of such phones is communication between family and friends; i.e. mobile phones are not used to help boost their businesses. The major needs of farmers are to have the means to access business information related to farming and the opportunity to advertise their products. Mobile phone applications that can help farmers in their businesses

should be cognisant of rural farmers' requirements and the constraints they face in terms of the use of technology. Mobile applications need to be developed so that technology can be used in an efficient, effective and inexpensive way.

The researcher developed a prototype that could help farmers to post commodities and to contact sellers using SMSs or email. The prototype has two parts: a USSD and web application. The testing of the prototype revealed that the system is understandable and easy to use and potentially very useful to the intended users.

CONCLUSION

This chapter discussed the background of the research, stated the motivation for choosing the topic, outlined the research questions and provided a brief discussion on the approaches and methodologies used during the research. In Chapter 2, the literature is reviewed in relation to the research questions, as well as the key concepts of the mobile technology defined in Chapter 1. The literature review includes information relating to USSD, SMS and the Internet, and the usage of ICTs in developing countries, especially in South Africa. In Chapter 3 the research design and methodology are discussed. This includes methods adopted to collect information from farmers and all the programming tools used to build and test the system.

Chapter 4 contains the results, including system testing results. Chapter 5 provides an analysis of the results and demonstrates the extent to which the resulting system answers the research questions posed; it concludes with recommendations based on the results. Two papers that were published on this thesis can be found on pages 121 and 123.

C h a p t e r 2

LITERATURE REVIEW

INTRODUCTION

In this chapter, the basic terms and concepts on which the study is built are defined. This is followed by a detailed literature review. The review focuses on the ICTs that utilise the Internet and mobile phone technologies for development. It includes literature on how USSD and SMS technologies have been used to improve the lives of rural communities.

CLARIFICATION OF BASIC TERMS AND CONCEPTS

The following are a clarification of how the basic terms and concepts that will be used in the discussion are interpreted in this thesis:

Rural area: South African rural communities are poor and the activities that help the communities to survive are casual agriculture and domestic work (Gopaul, 2006).

Agriculture: South Africa has a dual agricultural economy: subsistence and commercial farming (SouthAfricaInfo, 2008).

ICT in South Africa: South Africa has more access to ICTs than other sub-Saharan African (SSA) countries. It also has more fixed telephone lines, Internet users and mobile subscribers (including broadband subscribers) than other SSA countries (Brown et al., 2007).

Smallholder: Someone with farmland less than one hectare. The project mainly targets smallholder farmers.

Mobile penetration: South Africa has a very high penetration of mobile phones when compared to other SSA countries (Brown et al., 2007). According to txtNation, South Africa has 45 million subscribers, with a 92.15% penetration rate (txtNation, 2011).

Mobile phone coverage in South Africa: Mandioma (2007) states that in 2007 South Africa had approximately 90% mobile phone network coverage (the MTN and Vodacom mobile networks combined). In the rural areas of South Africa, it is the most commonly used technology with which people communicate.

Bandwidth projection: Projected bandwidth of undersea cables in South Africa is shown in Figure 1; the two cable system of 5,129 gigabytes each will improve bandwidth availability in SSA.

Short message service (SMS): This service is used to exchange messages between mobile phone network subscribers. Locally, the cost of SMS is low or even free when using the websites of local mobile network operators.

Unstructured supplementary services data (USSD): This allows a mobile phone subscriber to interact with an application across a GSM network. USSD is cheap and in the South African mobile phone environment is used to send "please call me" messages, do banking transactions, etc.

OVERVIEW OF ICTS IN RURAL AREAS

Background

The mobile phone has become the most used ICT device locally and globally. There is a high mobile phone connectivity in South Africa, with over 50 million subscribers (Hash, 2009). Best & Kenny (2009) note that this growing trend of ICT adoption in the developing world (especially in South Africa) will have a major impact on the development of the region.

With the growth of ICT usage, particularly in terms of mobile phone technology, people from all communities – even poor communities – are more connected. This connectivity allows people to exchange ideas, information and even goods. In developing countries, many smallholder

farmers have no expertise or resources to implement an affordable mechanism that could support them in advertising to and getting into contact with potential clients. As a result, farmers still fail to exploit the available technology to enhance their earnings.

Importance of ICTs in rural areas

With the advancement of ICTs, it becomes more and more difficult to compete in any form of business undertaking without using up-to-date technology. There is thus potential economic benefit for rural farmers to implement affordable ICTs. ICTs will empower farmers by allowing them to advertise their commodities and communicate with prospective customers. It seems as if a lack of information is one of the major constraints in rural famers' business encounters. According to Ruhangayebare (2011), "small-scale farmer have little ability to effectively or favourably compete in agriculture input or output due mainly to insufficient information about the markets, lack of business skills and high transaction costs".

ICTs have become tools for development for all communities, both urban and rural. Unwin (2009) notes that ICTs are a force of economic and social development and a platform for competitiveness. He furthermore observes that people who have access to information and telecommunication services are likely to get better prices for their goods (Unwin, 2009).

Rural areas are lagging behind urban areas in using and benefiting from ICTs. This is mostly due to a lack of resources (such as telecommunications infrastructure etc.) and the low literacy levels of rural communities. Unwin (2009) suggests that by improving information flows to the rural poor it is possible to extend their access to markets, improve their governance, and improve the delivery of public services and education (see also Pringle & David, 2002).

ICTs have the potential to promote rural development through agriculture, as they address agricultural information gaps and blockage. Ruhangayebare (2011) suggests that the presence of ICTs could open more opportunities to link famers or agricultural cooperatives to larger markets and could allow the standardisation of prices.

Challenges of ICT implementation in rural areas

ICT providers and developers are often more profit-oriented than customer-oriented. Most ICT applications do not focus on rural communities, because they can seldom afford the required technologies to use new applications. And systems developed for rural communities often do not succeed due to a lack of community consultation and participation. Maritz & Maponya (2010) suggest that in order to develop a successful ICT system, the developer needs to take into consideration the sustainability of the system.

Medhi et al. (2011) state that while mobile phone applications are being developed for developing communities in many sectors such as the health sector, the financial sector and other areas, usability still remains a major problem for the intended users. These are mostly novice users with low literacy levels.

Smith (2003) suggests that in Africa there is lack of collaboration and coordination to promote ICT initiatives. A large proportion of the South African population is disadvantaged and ICT policy concentrates on ICT ownership rather than focusing on human development (Brown & Brown, 2008).

To promote the use of ICTs among farmers, Mwakaje (2010) suggests strengthening farmers' market groups and establishing market information centres and telecentres in rural areas. May et al. (2007) propose that government should invest in ICTs to support agriculture and provide the

necessary resources, because ICT affects agricultural productivity positively and can reduce poverty.

Another way to promote ICT applications is with the help of local mobile service providers; Sanganagouda (2011) says that value-added services are currently an indispensable part of the range of products offered by mobile service providers. He predicts that service operators will have to shift from being mobile line providers to becoming the providers of innovative services and applications.

THE MOBILE PHONE AND THE INTERNET AS ICT TOOLS FOR DEVELOPMENT

The mobile phone as a tool for development

In many developing countries, ICTs are not very accessible, with one exception – the mobile phone, which provides one of the cheapest forms of available digital technology (Marsden, 2008). According to an ITU report (2009), Africa's mobile cellular growth rate has been the highest of any region over the past five years, averaging close to 60% year on year (Botha et al., 2010). The mobile phone is an accessible ICT tool for many rural low-income communities (in South Africa); it is easy to use and relatively cheap to maintain.

The continual improvement of mobile phone services and the popularity of the mobile phone could have a very positive impact on the economies of developing countries. Over the past few years mobile phone prices have decreased remarkably, while their functionality has increased substantially. All classes of people can afford to use mobile phones, which creates many possibilities for using them as tools for economic empowerment and development (Rashid & Elder, 2009; Santos, 2010; Bhavnani et al., 2008).

In developing communities, the use of mobile phones is largely limited to social communication. This may be due to a lack of applications that are

suited to their business needs. Souter et al. (2005) affirm this, arguing that in India, Tanzania and Mozambique the mobile phone is used mainly for communication within families, replacing some social visits and face-to-face communication.

However, according to Bhavnani (2008), saving time and cost is part of the mobile phone's advantages, and it can also eliminate market inefficiencies in rural areas. Discussing the role of mobile telephony in rural poverty reduction in developing countries, Bhavnani (2008) argues that an improvement of the information flows between buyers and sellers allows an efficient trading of information without obligation to travel to urban areas. A person can just check for demand and negotiate a price on a mobile phone.

As mobile phones become more common in rural areas, several farming communities and other individuals are expected to benefit from the implementation of less-expensive technologies on mobile phones (Bhavnani, 2008). This access to mobile phones has a positive impact on poverty reduction, and it is thus important to ensure that mobile phones and services are affordable. Bhavnani (2008) suggests that relevant applications and business models that would maximise the economic and social benefits while minimising costs should be identified.

Mobile-phone maker Nokia has hailed the importance of mobile phones in developing nations, as they improve the standard of living and quality of life in areas where people are poor (Beaumont, 2010). In 2010 Nokia proposed a project called "Nokia Economic Growth Venture Challenge" with the objective of encouraging mobile phone developers to create applications or tools to sustain local businesses (Beaumont, 2010). Muto & Yamano (2009) find that an increase in the usage of mobile phones by farmers in Uganda prompted rural farmers in remote areas to participate in marketing. Furthermore, they found that the cost of advertising crops in these areas decreased due to the information flow brought about by mobile phone

penetration within the rural community. In another research project, Donner (2008) found that fishermen who purchased mobile phones were armed with better information and could land at a port with buyers willing to purchase their catch. It is thus beneficial to use mobile phones for small businesses, but the cost is still prohibitive.

In a study by Rashid & Elder (2009), it was found that mobile phones contribute to greater efficiencies for farmers and small entrepreneurs.

With the ever-increasing number of new mobile users in the developing world, there is a need to determine how the use of the technology can contribute to development.

USSD services

USSD is a mobile phone technology that has been used in various applications such as banking services, buying airtime credit, etc. It is useful, quick and less expensive than other mobile phone-based applications (Mobile Telephone Networks, 2008). The limitation of USSD is that it limits the user to predefined input; for example, to buy airtime, the user can only choose among provided options, e.g. five rand (R5) or ten rand (R10) worth, and cannot input a different amount. However, USSD has the advantage that a user can access a service through a simple menu selection at low cost.

As Sanganagouda (2011) explains, USSD-based applications are being promoted by mobile service providers because they require minimal investment on the network and use existing Signalling System #7 (SS7) protocols. Furthermore the USSD Gateway uses the same application programming interface as the Short Message Service Centre (SMSC). (Sanganagouda, 2011).

SMS services

The short message service allows the delivery and reception of text messages between mobile phone subscribers of different operator networks (Netfors,

2010). This service provides quick communication between mobile phone subscribers. SMS costs are relatively high when compared to USSD, however. An SMS shortcoming is that a message only allows a limited number of characters to be sent.

Every mobile phone supports technologies such as SMS and USSD, and both can be applied in different contexts (Krugel, 2007). For example, Pramsane & Sanjaya (2006) provide an SMS-based application for students to request information such as checking of grades, enrollment information, universtity announcements, etc. via SMS. The information is in a database connected to an SMS server. The SMS server has a software application that helps manage the SMS request and query the database.

The Internet as a tool for development

Even though the Internet is a valuable tool, it has not been appreciated and used when it was deployed in rural areas of developing countries (Best & Kenny, 2009). For example, the telecentre projects deployed by governments as an initiative to help communities in rural areas were not used and were eventually abandoned.

Marsden (2008) says that the South African government tried to intervene on several occasions to give the wider population access to ICTs, but that most of these interventions were met with limited success. Kenny (2008) finds that the cost and complexity of access to the Internet were not necessarily the most significant barriers to high utility of the technology by the rural poor. For many rural people, the Internet still appeared to be an unnecessary luxury. The situation is somewhat different among the majority of rural businesses, where email is seen as a valuable tool (Kenny, 2008).

The Internet could be a vehicle for rural people to develop themselves. It is currently accessible via mobile phones, but it is still too expensive for most

rural people. Hopefully, in the future it will become cost-effective and its usage more common in rural communities.

ICT USAGE FOR RURAL FARMERS

The integration of ICTs into rural agricultural systems could provide new communication pathways and reduce transaction costs, such as those of travelling to nearby towns to access agricultural information. Findings of Alao's (2010) study of "The impact of ICTs for agricultural development in the rural community: A case study of Alice, Eastern Cape, South Africa" confirms that the majority of farmers need ICTs to enable them to easily access information about market surveys, pricing, farming techniques and farm products. This confirms the importance of providing agricultural information to farmers and justifies utilising ICTs in promoting rural agricultural development.

Usage of ICT by farmers is beneficial, as research by Mwakaje (2010) finds. He finds that farmers who use ICTs to access market information are able to sell more produce at better prices compared to those who do not.

Since the cost of ICT usage is a crucial hindrance to development among rural people, the use of mobile phones could be a more viable solution. It is thus important to focus on less-expensive applications that would allow information exchange between rural users and would boost their businesses and the economy in their areas.

SOME SUCCESSFUL PROJECTS

In recent years there have been several initiatives to introduce ICTs to rural communities in order to address pertinent socio-economic problems related to health, education, agriculture, etc. For example, in "The deployment of an e-commerce platform and related projects in a rural area in South Africa", (Dalvit, et al., 2007) designed an e-commerce platform to promote tourism and advertise local arts, crafts and music, and it also involved providing

infrastructure, technical support, promotions and the teaching of computer literacy in the community. This e-commerce platform was developed as a web application maintained by an administrator. The system consists of an e-mall containing many stores managed by store owners. Stores owners are local entrepreneurs and the system allows them to customise their store according to their specific needs, while customers can access the platform to buy goods and services.

Wouters et al. (2009) worked on a USSD-based application designed to support home-based health care in South African rural communities. This is a patient monitoring system that uses USSD technology to provide health information and enables clinical sisters to have instant access to the patient's vital signs via a desktop computer. This system was easy to use by simply dialling a number and using a menu structure (Wouters et al., 2009).

M-Pesa provides financial services and was launched in March 2007 in Kenya. It has been introduced in South Africa in May 2010 by Nedbank in conjunction with Vodacom. M-Pesa provides banking services, enabling people to deposit and withdraw money from agents using a mobile phone. It has had positive impact on local communities, especially rural communities with limited means of communication who reside far from financial institutions branches (Bester, 2010). Another example is provided by Mukhebi et al. (2007) in their study "Linking farmers to markets through modern information and communication technology in Kenya", who came up with an idea of creating rural-based market information points and district-level market information to link local entrepreneurs and traders. This involved mobile phone SMS communication in partnership with a leading mobile operator, Safaricom Ltd, to deliver information to farmers. An interactive voice response service was used for information delivery through simple menu steps and an Internet-based database system was created and used to disseminate information through a website.

The projects discussed above were successful because the developers took recipients' requirements into consideration and did a proper analysis before implementing the system, and also trained and empowered communities to use the system.

HOW TO ENSURE THAT ICTS WILL WORK FOR DEVELOPMENT

The development of appropriate ICTs for development (ICT4D) requires paying constant attention to the real challenges that poor communities face. Toyama & Dias (2008) found that the number of active mobile phones in the world exceeds more than half of the world's population and these users need mobile technology to be personalised and customised to serve their needs.

Furthermore, there is an advantage in fitting technology into the existing social fabric rather than creating new institutions to house the technology. New institutions are difficult to set up, and if a technology can work within existing social structures, the community will be more likely to embrace it (Toyama & Dias, 2008).

Odero et al. (2010) focus on creating an inexpensive group communication tool through SMS for low-income users. Their system – called Tangaza – is a social networking service that makes use of SMS and voice to enable low-cost group communications; it can be used with basic mobile phones with no installed software. Their design was limited to standard GSM features available on every mobile phone with the intention of limiting user and provider costs wherever possible (Odero et al., 2010). They explain their application as being "designed to enable cheap, primarily spoken communication among groups of users".

Similar to Tangaza, Semeni is a value-added service developed by Safaricom-Kenya that helps to link group of users, enabling them to exchange information at low cost. It is an example of how mobile applications can be

promoted with participation or assistance from mobile service providers (Safaricom, 2010).

Jensen (2007) discusses the idea that ICTs may help poorly functioning markets work better and thereby increase incomes and/or lower consumer prices. Jensen (2007) explains the fact that "it has become increasingly common to find farmers, fishermen, and other producers throughout the developing world using mobile phones, text messaging, pagers, and the Internet for marketing output".

ICTs can make the difference for less-privileged communities, but to help such communities, it is important first to understand their needs in terms of accessing ICTs. Unwin (2009) sees a problem where innovations in ICT are driven by different competing interests, which make these innovations incompatible and they thus fail to work for rural communities. ICT services thus fail when they are developed without considering the needs of beneficiaries.

Unwin (2009) suggests that while there are many different interests in ICTs, developers have to use available help to ensure that poor communities are able to benefit. All those involved in ICT innovation have to identify appropriate technologies that can be used to serve the ICT needs of potential beneficiaries. Developers have to understand the content requirements for information communication if they want to help rural and developing people to use ICTs in a way that will enable them to develop themselves. They thus need to identify the best and most cost-effective ways of using ICT4D to empower marginalised communities (Unwin, 2009). According to Mathur & Ambani (2005), there is still opportunity to apply ICTs as solutions to the development of rural communities in developing countries. New technologies can be realised to ensure information dissemination at low cost and develop feasible and profitable applications.

Marsden (2008) is of the opinion that if there is a serious interest in using ICTs to improve the lives of people in developing communities, people working in this field need to create solutions to empower end users to modify systems to suit their own needs.

CONCLUSION

This chapter presented the literature on the usage of ICTs in developing countries, especially in South Africa. Literature related to the use of the Internet, USSD, SMS and mobile phones in general was discussed, as were ICT-based development projects for South African rural communities. The following chapter covers the research design and methodology.

C h a p t e r 3

METHODOLOGY AND RESEARCH DESIGN

INTRODUCTION

This chapter presents the methodology and methods used to attain the prescribed objectives of the research. It focuses on the research design, methodologies, methods adopted, data collection methods and data analysis tools. The programming tools used to build the system and the testing techniques that were adopted are also presented.

RESEARCH PROBLEM

The main problem of this research is "*How should mobile technology create opportunities for rural farmers to promote their agricultural businesses cost effectively?*" This translates into the following research questions (see page 6):

How should farmers be empowered to advertise their produce and be put into contact with potential clients?

How should inexpensive mobile technologies be harnessed to provide market related information to rural farmers?

How should the uptake of this technology be promoted?

RESEARCH APPROACH

Crotty (1998) outlines key questions that a researcher should ask him-/herself. These questions constitute the basic framework of any research process: What methods should I use? What methodology governs the choice and use of these methods? What theoretical perspective lies behind the methodology in question? And, finally, what epistemology informs this theoretical perspective? Aligned with these questions, Crotty (1998) defines four elements involved in the research process: methods, methodology, theoretical perspective and epistemology. He regards the methods as techniques used to

gather and analyse data related to the research question or hypothesis. The methodology is the strategy, plan of action, process or design of choosing and using particular methods and linking the choice and use of methods to the desired outcome. The theoretical perspective is the philosophical stance informing the methodology and thus providing a context for the process and grounding its logic and criteria. And, finally, Crotty (1998) defines epistemology as the theory of knowledge embedded in the theoretical perspective and thereby in the methodology. Figure 2 shows how the four elements inform one another.

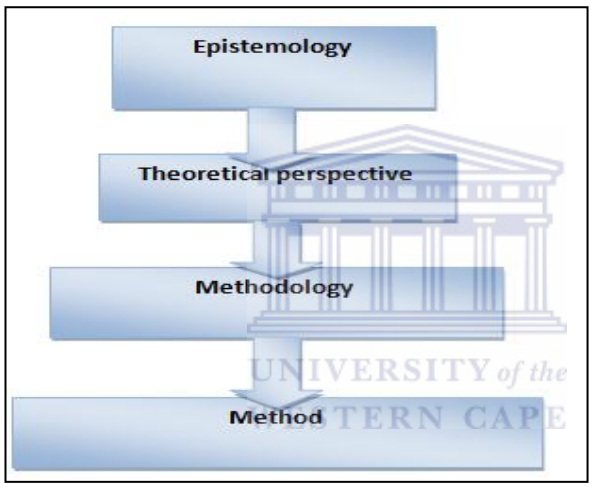


Figure 2: The four basic elements of research (Crotty, 1998: 4)

Thus, different strategies were followed to help the researcher to learn more about the people, business practices and ICTs used in the areas where data was collected. In order to understand better how to interview participants and obtain the required information from them, the research process adopted the approaches discussed below.

Epistemology

Epistemology can be defined as a way of understanding and explaining how we know what we know. *Objectivism* and *constructionism* are the epistemological stances adopoted by this research. Objectivism implies that meaning exists

independently of individual consciousness. Constructionism asserts that meaning is constructed.

Theoretical perspective

The theoretical perspective provides a context for the process and grounds its logic and criteria on how we see the world (Crotty, 1998). The theoretical perspective functions in terms of *post-positivism*, which is an amended form of positivism that recognises human conjectures, but retains the idea of objective truth and *interactionism*. *Interactionism* is a theoretical perspective that derives the characteristics of the society from human interactions.

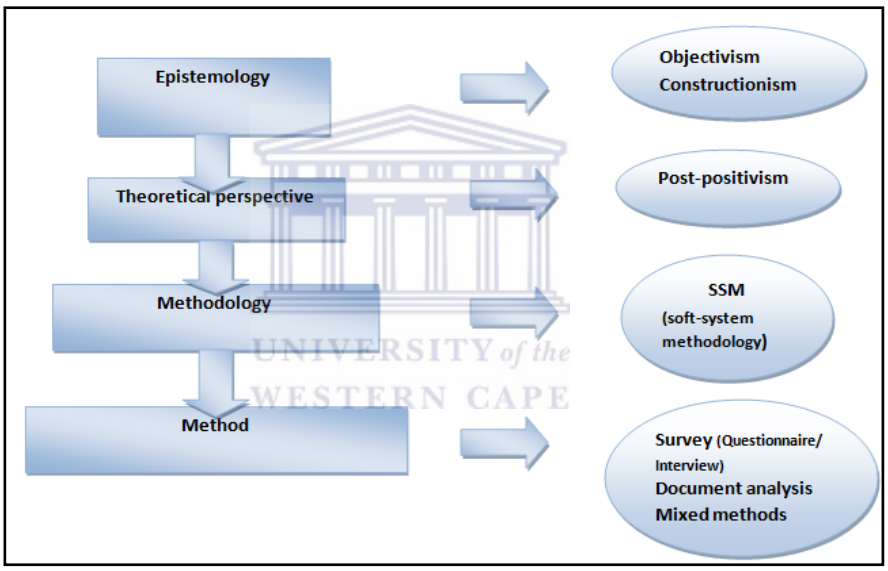


Figure 3: Methodology approach, based on Crotty (1998)

Methodology

This is referred to as a strategy or an action plan to choose the methods to be used. Soft-system methodology (SSM) was used to manage the research process.

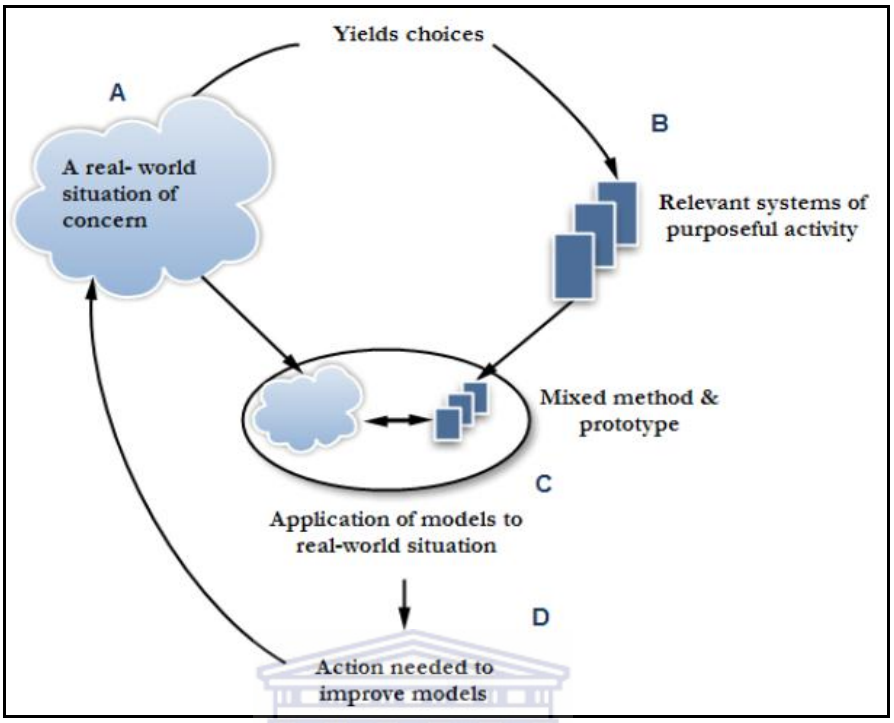


Figure 4: The basic shape of SSM (Checkland & Scholes, 1990: 7)

SSM, conceived by Peter Checkland of Lancaster University, is a problem-solving approach to systems development (Checkland & Scholes, 1990). The methodology is suitable for research problems with no obvious or clearly defined solution reference. The SSM framework (see Figure 4) is appropriate for this research as it tries to solve a particular problem with no well-defined solution and it forms a cycle that is repeated until an appropriate solution to the problem is identified. The problem that needs to be solved is to find out how mobile technologies can create opportunities for rural farmers to promote their agricultural business cost-effectively.

To analyse the problem, SSM is used as follows (see Figure 4):

- ***Perceived real-world situation of concern* (see A *in* Figure 4)*:*** Rural small holder farmers are not able to sell their produce at market-related prices.

- ***Building relevant systems of purposeful activities based on the researcher's explicit world view*** **(see B in Figure 4):** A prototype is built that can be accessed via a PC or mobile phone.

- ***Comparison of models with perceived real world situation*** **(see *C in* Figure 4):** The prototype is compared to the problem by means of the mixed-method approach, which involves using more than one method in the research. Both qualitative and quantitative research methods were used and the information retrieved from the data allowed an assessment of whether it provides the desired solution to the problem.

- ***Action needed to improve the situation*** **(see D in Figure 4):** This involved engaging in structured debate about desirable and feasible changes to improve the prototype, and carrying out testing of the prototype that led to the identification of further improvements.

Methods

Methods are the different tools (such as *interviews, questionnaires* and *document analysis*) used in the process of sourcing information related to farmers and other information relevant to the research.

A *mixed-method approach*, i.e. a combination of quantitative and qualitative approaches, was chosen for this research. It provides a better understanding of the research problem than using the two methods separately would have done (Creswell, 2011). Johnson and Onwuegbuzie (2004: 15) are of the opinion that this method "can help bridge the schism between quantitative and qualitative research".

There are two major types of mixed-methods research, namely *mixed-model* and *mixed-method* research. With the mixed-model design, qualitative and quantitative approaches are mixed "within or across the stages of the research process". The mixed-method approach entails a *quantitative phase* and a

qualitative phase, which is implemented over the whole period of the research study.

The specific mixed research design adopted for this research was the *mixed-model*. For example, the researcher used random sampling and different tools to collect and analyse both numeric and qualitative data obtained from participants. One method was used to retrieve the data and the other to confirm and explore the answer.

RESEARCH DESIGN

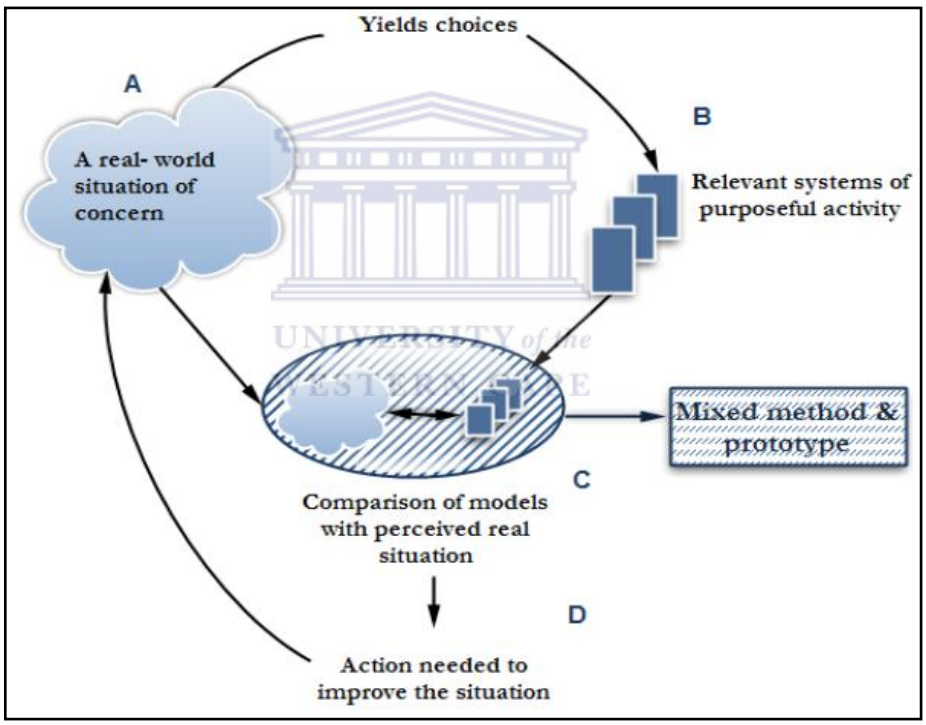


Figure 5: The basic shape of SSM (Checkland & Scholes, 1990)

SSM was used to manage the research process. The mixed-model method and the testing of a prototype were used to compare the suggested systems with the real-world situation (see C in Figure 5).

The research design guided the researcher and it was important for the logical progression of the study and the interpretation of the results.

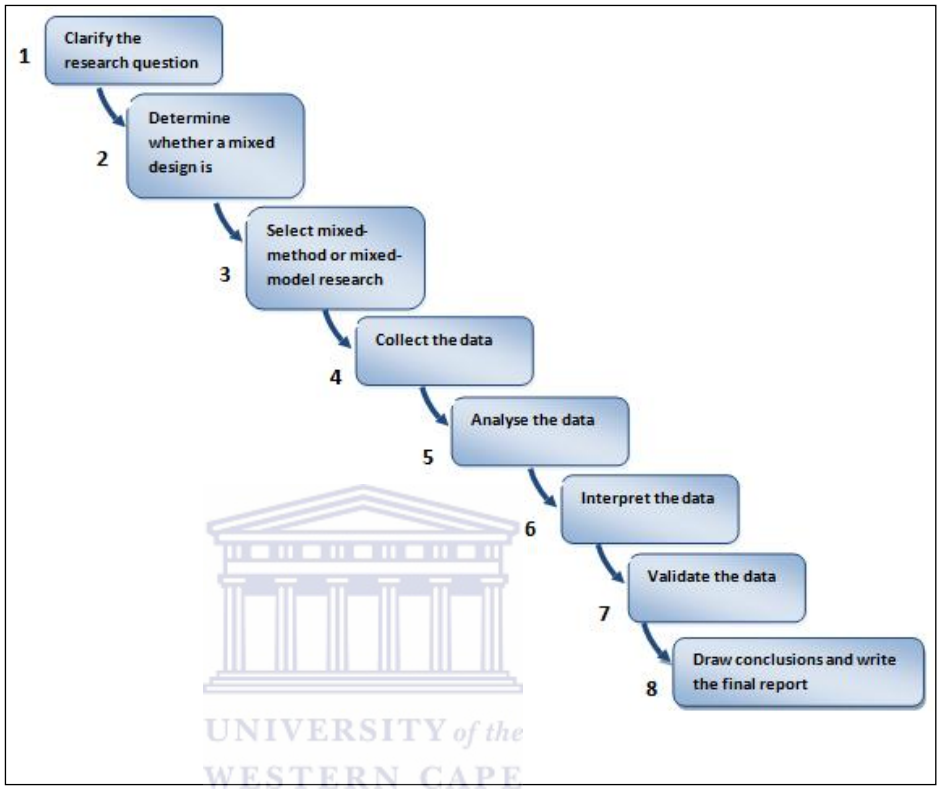


Figure 6: Eight-step research process model (Johnson & Onwuegbuzie, 2004)

The eight-step mixed-model approach was followed:

1. ***Clarify the research question:***

   The research question was set up with the aim of identifying the major challenges members of the farming community face when selling their produce on the open market, and a remedy was proposed. Before clarifying the research problem and formulating the research question, the researcher discussed the problem with people from the area under investigation. Other information about the area was sourced from the literature – the media, newspapers

and journals. All this information helped the researcher to come up with consistent research question.

2. ***Determine if a mixed design***:

   It was decided to adopt a *mixed design*, as it was found to be appropriate for this investigation, because it involved both qualitative and quantitative approaches. To get feedback about the use of the prototype, qualitative and quantitative methods were used. The prototype was shown to computer science students who responded to closed- and open-ended questions posed in the questionnaire. In the open-ended section of the questionnaire, participants could suggest changes and ideas not considered by the researcher. This opened up new avenues of investigation, which were pursued with interviews.

3. ***Select mixed-method or mixed-model research:***

   The specific mixed research design adopted for this research was the "*mixed-model*". This entails random and purposive sampling of participants and the use of different tools to collect and analyse both numeric and qualitative data from participants. One method was used to retrieve the data (questionnaire) and the other (interviews) to confirm and explore the answer.

4. ***Collect the data:***

   Survey:

   A survey is "the best method available to social scientists interested in collecting original data for describing a population too large to observe directly" (Mouton et al., 2007). Johnson and Onwuegbuzie (2004) proposed an eight-step research process model (see Figure 6).

   A survey was carried out among computer sciences students to obtain preliminary information and define the initial user

requirements. Information from this investigation fed into a more detailed questionnaire administered to farmers.

Sampling:

Sampling is a crucial part of the methodology. There are different types of sampling methods, but in this research random sampling and purposive or judgmental sampling were used. Random sampling means that each person has the same probability to be selected, while judgemental sampling means that the person doing the sampling uses his/her knowledge or experience to select the items to be sampled (Westfall, 2009).

This study combined both random sampling and purposive sampling of participants among students and farmers.

Research instruments:

The mixed-model research method was used to interact with and source information from the stakeholders.

The mixed-method included using different methods such as *questionnaires, un-structured interviews* and *document analysis* to source information related to farmers and other information relevant to the research. Document analysis was done during the literature review stage at the beginning of the project. It allowed an understanding of how ICTs were used in South Africa rural areas. It was guided by the research questions and key words, and involved looking at related work and outlining the advantages and limitations that other researchers encountered while carrying out and implementing their projects. Most importantly, it uncovered the current inadequate application of ICTs for rural agricultural development in South Africa.

In September 2010, a pre-test was conducted among 41 students in order to obtain basic information. Data was collected from the students by means of questionnaires (Appendix A (i)) and informal talks (see field notes in Appendix A (ii)). The information obtained helped to design the farmers' questionnaire (Appendix B). An Android mobile-phone-based version of ODK (Open Data Kit) Collect was used by one of the researchers in March 2011 to collect further data from 46 farmers in the Transkei area.

Prototype:

After the user requirements were collected and defined, a model was designed to provide a system that meets these requirements. The model assisted with understanding the system structure, activities and sequences of activities required to build the prototype. Unified Modelling Language (UML) was used to illustrate interactions between the system and the users and also to describe systems classes, their attributes, and the relationships between the classes. Hypertext Preprocessor (PHP) scripting language was used to create a website and serve as a link between Java 2 Platform, Micro Edition (J2ME) and My Structured Query Language (MySQL). PHP was chosen because it is compatible with many operating systems and relational database management systems. It helped to create a dynamic user-friendly website that would allow users to update their information concerning commodities and prices. NetBeans helped in writing the J2ME codes; it was used to develop mobile-device applications that are compatible with all models of mobile phones. In the initial stage the prototype was exposed to users for testing purposes involving functionality, compatibility and usability. DieselTest (see Appendix F) helped to test the web application.

For the prototype evaluation, more data were collected from students using a questionnaire (see Appendix C (i)) and through

informal discussions (see Appendix C (ii)) in April 2011. The information obtained helped to improve the prototype and it was re-tested with students using questionnaire (see Appendix D) in August 2011 and revised until users were satisfied.

5. ***Analyse the data***

After collecting the data, the next step was data cleaning, which is a process of identifying inconsistent and incorrect data, such as outliers, and correcting them. Data were analysed and the results presented as tables and graphs. The data analysis tools used were Microsoft Excel and SPSS (Statistical Package for the Social Sciences).

Data analysis method:

The quantitative and qualitative data obtained from participants were analysed using Microsoft Excel and SPSS. The qualitative data were analysed by comparing findings to the desired outcome. Charts were used to present the results.

The mixed-model design was used for following the different stages, as depicted in Figure 7.

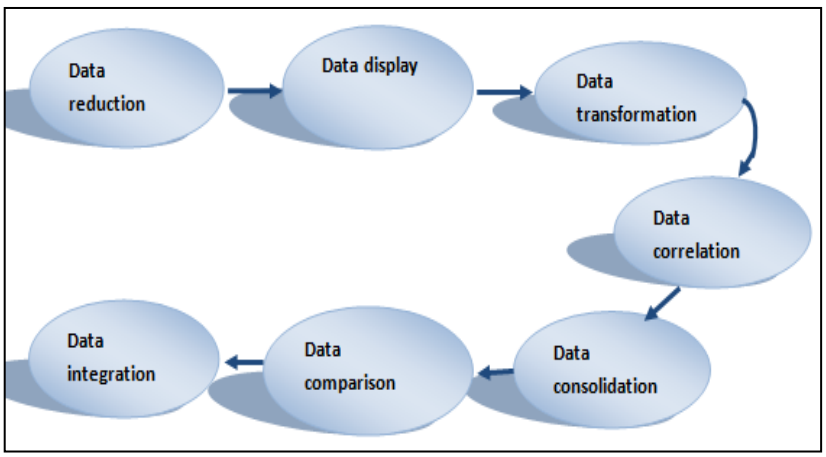


Figure 7: Mixed-model design (Johnson & Onwuegbuzie, 2004)

According to Johnson & Onwuegbuzie (2004), *data reduction* is the process of reducing the dimensionality of the quantitative data using discriptive statistics and exploratory analysis. *Data display* involves the visual represantation of quantitative data by means of matrices, charts, graphs, venn diagrams, etc. In our study, quantitative data were captured using Excel and coded so that categorical values could be analysed (e.g. excellent = 1, good = 2, …, bad = 5) and the results were displayed in tables, graphics and charts.

Data transformation is the procees by which quantitative data are converted into a narative interpretation and qualitative data are coded and converted into numerical values that can be analysed statistically. During this study, both qualitative and quantitative data were collected. The quantitative data was analysed using SPSS features that included cross-tabulation and descriptive statistics. The qualitative data was oragnised into themes for analysis.

Data correlation is a process in which qualitative and quantitative data are correlated with quantitised data (Johnson & Onwuegbuzie, 2004). The next stage is *data consolation*, in which quantitative and qualitative data are put together to create a novel consolidated variable. After that, the last stage is *data integration*, which is where quantitative and qualitative data are integrated into two separate sets to form a coherent whole (Johnson & Onwuegbuzie, 2004).

Objectivity, validity and reliability

According to Janetzko (2008), the quality of data can be described in terms of objectivity, reliability and validity, especially when the research may be dealing with noisy data.

Objectivity

Objectivity allows an assessment of whether the data collected were not influenced by the person who carried out the survey or by any tool used to collected data. For example, if thermometers from different vendors give different readings, data collection processes that make use of these will not qualify as objective (Janetzko, 2008). In this research, the questionnaire used to collect data included many quantitative variables such as numbers of mobile phones per family; all these variables provided information that would be relatively the same if the survey had been conducted by another researcher. Because of this, the information obtained from participants was objective.

Reliability

Reliability ensures the consistency of data collected at different points in time. According to Janetzko (2008), reliability defines the extent to which repeated measurements lead to consistent or comparable values. In this research, we used different tools to collect information, such as consulting reputable sources and documentations about farmers and what crops they produced, thus ensuring reliability. One of the problems encountered during data collection was that only 46 farmers were able to fill in the forms and provide significant information.

Validity

The information obtained through the questionnaires was analysed and the information obtained from the interviews was used to

validate what had been obtained through the questionnaires (Janetzko, 2008).

6. ***Interpret the data***

The next step was to find which results were significant and to interpret them. Results were presented as text, tables, diagrams and charts.

7. ***Validate the data***

To determine if the data were legitimate and consistent, more than one method of data capturing was used (allowing triangulation) and the results from these methods were compared to check the data's validity. Both qualitative and quantitative data were collected with questionnaires (closed- and open-ended questions were posed in the questionnaire). The responses to the questionnaires were validated through interviews.

8. ***Draw conclusion***

The final step was to draw conclusions and write a report.

Ethical consideration

The university required the researchers to apply for ethical clearance for the research. Participants were given details about the project such as the benefits expected from it. Also, the information collected did not involve sensitive information or participants' personal information. Farmers consented to give information only after the project was fully explained to them and the information they provided was kept confidential and used only for the purposes of this project.

CONCLUSION

Table 1 presents a summary of the research instruments used, their importance and limitations.

	Methodology	Method	Importance	Limitations
SSM	Mixed-method	Interviews	Enable a higher response rate Useful for participants who are unable to fill in questionnaires	Time consuming Cannot be administered to a large number of participants
		Questionnaires	Help to gather information from a large population Cost-effective	Response rate is relatively low
		Literature review/Document analysis	Helps to learn more about related projects	Time consuming
	Prototype	Model testing	Helps to improve the quality of the prototype	Time consuming

Table 1 Summary of different instruments used during the research

This chapter outlined the research approach and methodology adopted in this project. It described the data-collection tools and the data-analysis methodology. The design of the prototype was illustrated by means of a use-case diagram. The next chapter focuses on the results of requirement identification and the results obtained during prototype testing.

C h a p t e r 4

RESULTS

INTRODUCTION

In this chapter, the survey results, as well as the proof-of-concept prototype testing, is presented.

The research process went through several cycles of analysis, evaluation of findings, changes and interventions until the problem was addressed. Soft-systems methodology (Checkland & Scholes, 1990) was used to manage the research process.

This method has four major steps, which are represented by Figure 8. Step A represents the strategies used to identify the problem; Step B the means used to solve the problem; Step C compares the existing problem with the proposed solution to see if they match; while in the last step, D, if the solution does not solve the existing problem satisfactorily, the cycle will be repeated until a satisfactory solution is found.

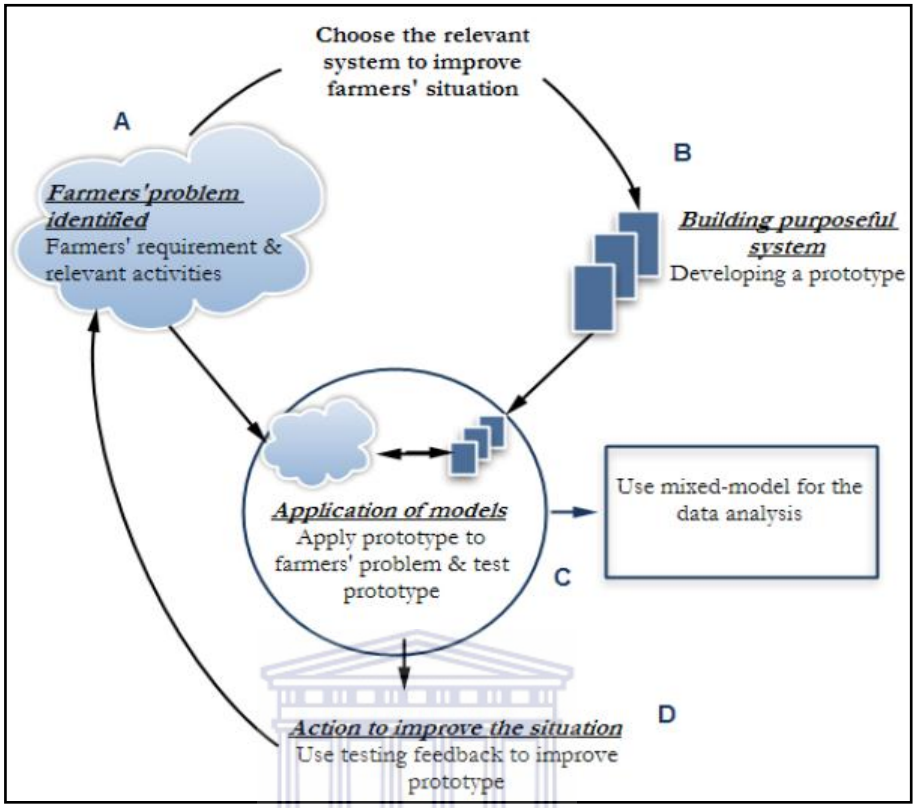


Figure 8: Summary of factor gathering and results presentation

USER REQUIREMENT IDENTIFICATION (STEP A)

User requirements were identified during the first cycle of SSM by means of surveys that included questionnaires (Appendix A (i), B), interviews (Appendix A (ii)) and document analysis. The problem was identified and information collected from farmers and other stakeholders to identify the requirements of a system to address the problem that farmers face when attempting to promote their businesses. The findings of the preliminary investigation were used to refine the questionnaire that was used to collect information from farmers (see farmers' questionnaire in Appendix B). The information that was obtained helped to inform the design of a mobile prototype that could be used to promote rural farmers' businesses cost-effectively.

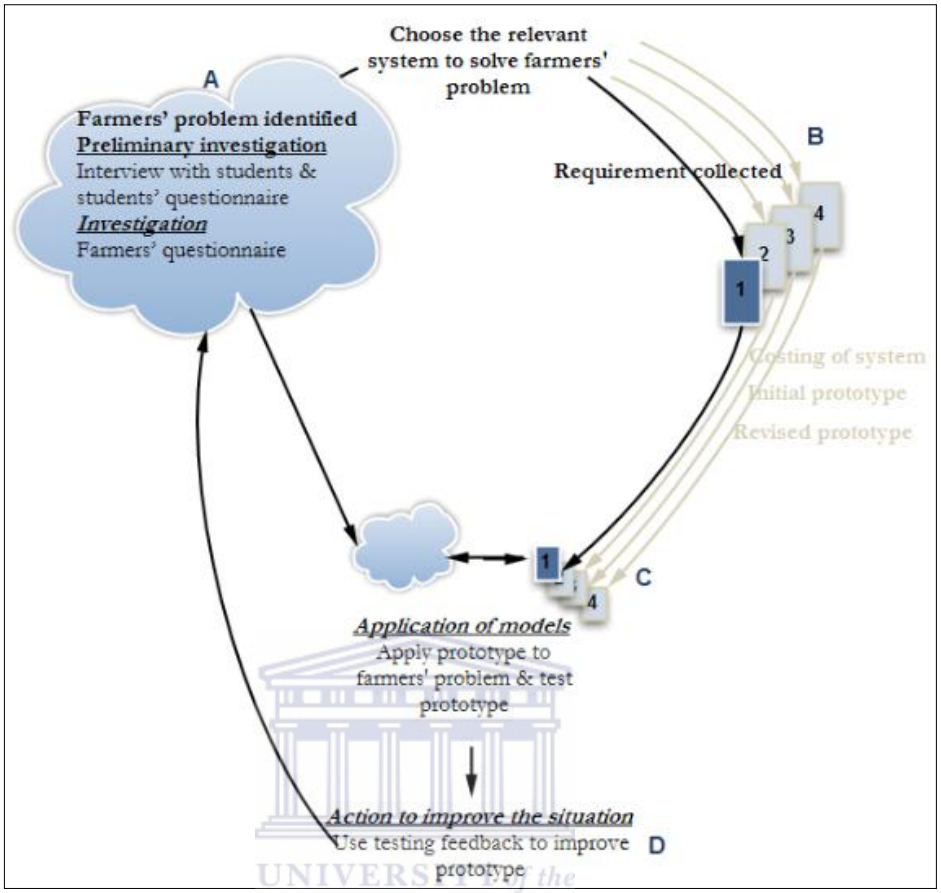


Figure 9: Step A: Identifying the problem

Detailed description of the preliminary investigation

Using the mixed-model method as defined by Johnson & Onwuegbuzie (2004), a preliminary investigation was used to collect information from students about rural farming activities.

Interviews

Interviews were conducted with six randomly selected UWC students from rural areas, five of whom were from the Eastern Cape Province and one from a rural area in Malawi. Students were interviewed (in stead of farmers) since the researcher could not visit the rural areas to interview the farmers. It was felt that with the information gained from these interviews, the response of the farmers could be predicted. During the interviews, students were asked about the type of farming being conducted in their communities, the usage

and cost of mobile phones, and what type of commercial activities existed in their communities. Three students were from villages and the others were from small towns in a rural area.

The interviews showed the following:

- Farmers mostly live in rural villages or small towns.
- Farmers in rural areas cultivate crops such as cabbage, banana, maize, etc.
- The most successful businesses are those that sell maize, cabbage and tomatoes.
- To determine the current price for their commodities, farmers often have to go to the market, which sometimes requires them to travel long distances.
- Farmers in the same area produce the same products for a given farming season, which creates a surplus of products at the market and makes it difficult for farmers to charge competitive prices.

The interview conducted with the student from Malawi revealed the following:

- Rural farmers sell their produce during market days and learn about crop prices at the market on market day.
- The market is the major or only place for some farmers to trade their crops. Some farmers are disadvantaged because in some areas only one market day is held per week, compared to other areas where several market days are held per week.
- All items not sold during market day are usually wasted or sold at the lowest price. This is true especially of perishable items such as tomatoes, which are often thrown away at the end of market day as farmers cannot take them back home.

- Farmers do not sell directly to major buyers like supermarkets; instead, intermediate contractors buy from farmers at the lowest prices possible and then sell the products to supermarkets or food factories at a higher price.

The rural farming business is affected by, among other things, a lack of market information. Farmers sell their produce at the markets during market days; however, they do not know how to reach alternative buyers. Intermediate buyers benefit by buying produce from farmers at very low prices and selling it at inflated prices.

The information about mobile phone usage in rural areas gathered during the interviews showed the following:

- Most people in rural community are illiterate or have had limited schooling.
- Most people in the community above 15 years of age own a mobile phone. This can probably be ascribed to the wide mobile network coverage.
- While most young people have attractive (expensive) mobile phones, the adult population use basic mobile phones with basic features like voice and SMS functionality.
- The major use of mobile phones in rural areas is to call friends or make emergency calls (e.g. calling the police or an ambulance).

To summarise, it seems as if the majority of people in rural areas (including farmers) are knowledgeable about the available ICT features on mobile phones, but do not use most of them.

Further interview findings regarding farmers' access to Internet services are as follows:

- It is difficult to access the Internet in the rural areas, but in small towns mobile phone is more accessible, as there are a number of cyber cafés.

- While other community members do not often use the Internet, those who do have to go to the cyber cafés that provide Internet services in small towns.
- While in their home villages, students access the Internet through mobile phones.

Access to the Internet in rural areas may not necessarily be impossible. In some cases there are no cyber cafés, but even though people may have phones with advanced features, they do not know how to use these features to access the Internet with their phones. Respondents said cyber cafés were located in small towns, not in rural villages, which may imply that farmers who want to access the Internet through cyber cafés either have to live in a small town or will have to travel to the nearest small town to access the Internet at a cyber café. Rural people, including farmers, do not access the Internet generally because they do not see the need to do so.

The interviews provided important preliminary data that we used to develop a pilot questionnaire addressed to students.

Students' questionnaire information

The following is the response from 41 students collected by means of a questionnaire during the first round of testing.

The majority of respondents were from a city (40%), with the rest coming from rural villages (50%) and rural small towns (10%).

Internet accessibility

Some students (29%) indicated that they do not access the Internet when they are at home. We considered this question to be important and it was posed again in the farmers' questionnaire. Students who were able to access the Internet provided important information. The findings show that the Internet is mostly accessed through Internet cafés (45%) and also by means of mobile phones (27%); only 18% of students were able to browse the Internet from

home by means of an asymmetric digital subscriber line (ADSL) or similar (see Figure 10).

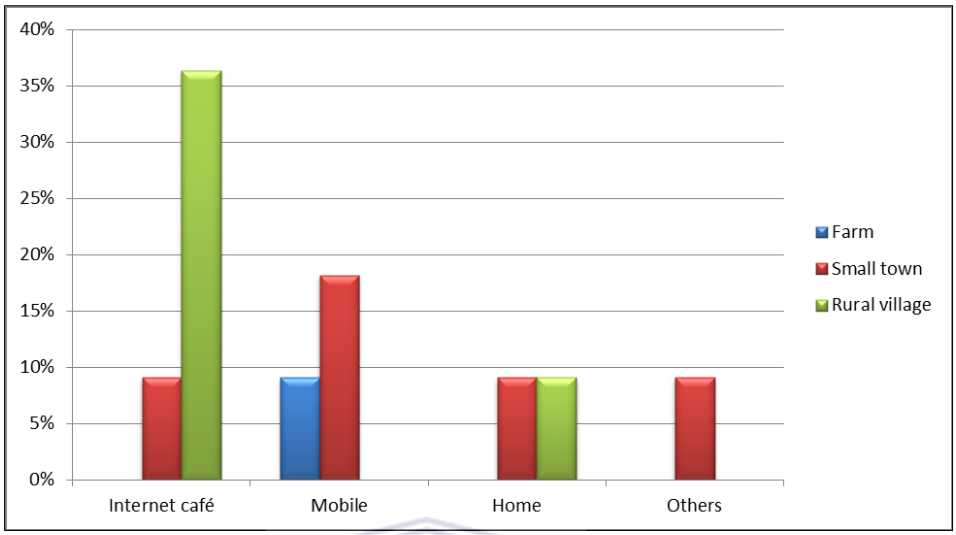


Figure 10: Internet accessibility in rural areas

Expenditure on mobile phones and Internet

The inquiry about students spending was influenced by the assumption that, in general, students do not have an income and that farmers' expenses on mobile phones may be roughly the same. A question was posed to determine the approximate amount of money farmers would spend on mobile technologies and the usage of mobile phones in rural area.

Cost of access to the Internet

In rural areas, access to the Internet is more expensive compared to access in the city. In rural areas – small towns or farms – the majority of people access the Internet through Internet cafés.

Almost 66% spend above R10 per hour to access the Internet, while 33% spend R5 or less. The majority of respondents from rural areas spend R10–R5 per hour to access the Internet, mostly through Internet cafés (56%), followed by 33% of respondents who reside in small towns and access the Internet through mobile phones.

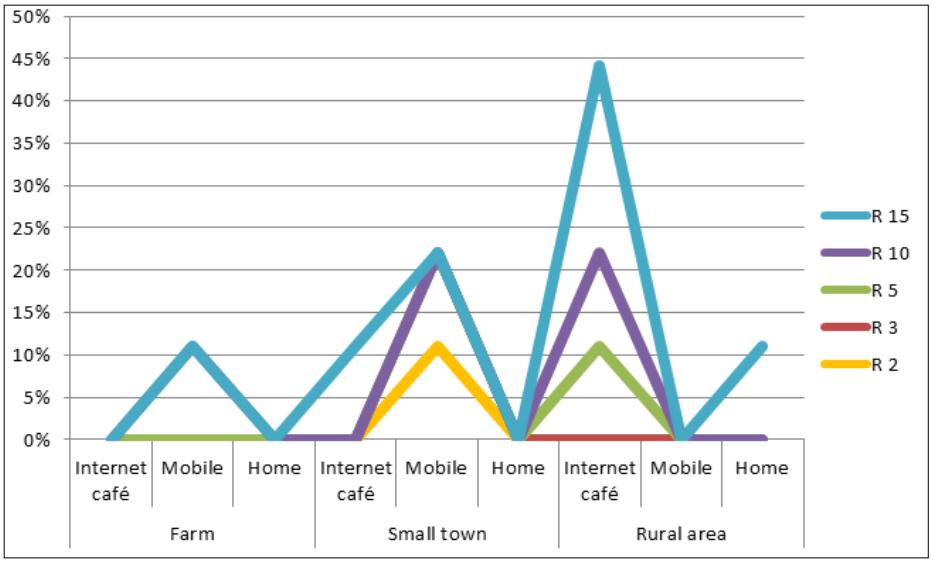


Figure 11: Hourly student Internet spending

Figure 11 shows that students from rural area spend more time and money on the Internet compared to those from farms or small towns. This may be because most rural people have access to the Internet from cyber cafés. As shown, those accessing the Internet through cyber cafés spend more money per hour compared to other groups. Those who access the Internet through mobile phones are likely to spend less. We can deduce from this information that accessing the Internet through cyber cafés tends to be more expensive than using mobile phone or it is more difficult to access the Internet by means of mobile phones, therefore people do not use this method very often. The majority of rural people do not use mobile phones to access the Internet, preferring to use Internet cafés; or it may be that their mobile phones do not support features that enable Internet access. We considered this information and refined the design of the farmers' questionnaire to be able to collect relevant information on Internet access and use.

Mobile phone ownership, usage and expenditure

Mobile phone ownership

In every student family there is a phone and most families (93% of respondents) have at least two phones per family.

The question is: why do they not access the Internet by means of their mobile phones? Is it because they are not knowledgeable about that technolog; or is it that their phones do not support the browsers required to access the Internet; or is it that they do not see the need to access the Internet?

Major usage of mobile phones

All mobile phone services are used by students, especially SMS, mobile services such as "Please call me", and the Internet (88%).

Most students' families use mobile phones for calls (98% make calls) and SMSs (88%), while only 51% use USSD and 49% access the Internet.

Usage of mobile phones by families

Families mainly use mobile phones for voice call (98%) and sending SMSs (88%), while USSD is used in the form of "Please call me" messages. The Internet is accessed via mobile phones by 51% of respondents.

Spending on mobile phone

Most (73%) spend less than R50 a week on mobile calls and services, while 20% are able to spend between R70 and R110 per week. Only 7% can afford to spend more than R200 per week.

Major crops cultivated in rural areas

The information provided by students about the main crops cultivated and sold in their areas was used to refine the farmers' questionnaire. The major crops identified were maize, bananas, cabbages and apples.

Investigation conducted with farmers

The findings of the students' questionnaire and interviews helped the researcher to understand the farmers' situation in rural areas and allowed her to develop an appropriate questionnaire to be addressed to Eastern Cape farmers.

Rural farmers' questionnaire

This questionnaire was used to collect information that could inform the design of a prototype to address rural farmers' agricultural needs. It was administered in the Transkei area in the Eastern Cape Province and was distributed to 46 farmers. During this survey, we enquired about the cost and usage of mobile phone within farming communities, the accessibility and cost of the Internet, the means of accessing market information and information about the most-produced crops.

Description of participants

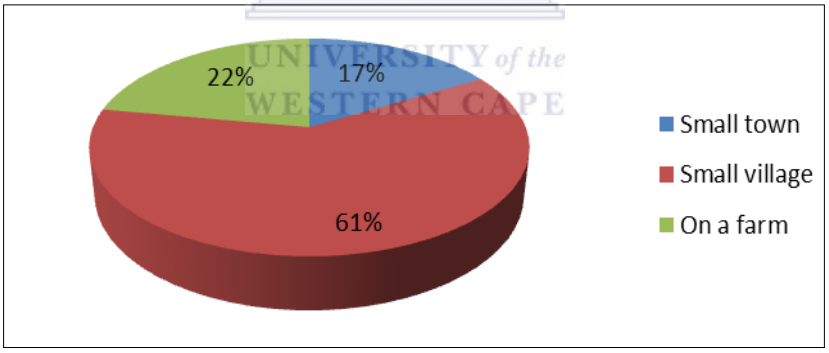


Figure 12: Participants' locations

The majority of the farmers who responded to our questionnaires were male (78%). Most participants resided in small villages or on farms; only a few were located in small towns (see Figure 12).

We were also interested to know whether the farmers are literate, and especially if they are able to use SMS/USSD, to make contact with the sellers or post/read information concerning their commodities. All participants could read and write well, as indicated by their ability to complete the

questionnaire; quite a few participants had attained secondary level of education, but very few had attained any post-secondary level of education. This was an important point that was considered in the development of a technology that would require basic literacy and numeracy.

Results obtained from the farmers' questionnaire

It was observed that in the Transkei area the majority of people (67%) do not have access to the Internet (see Figure 13).

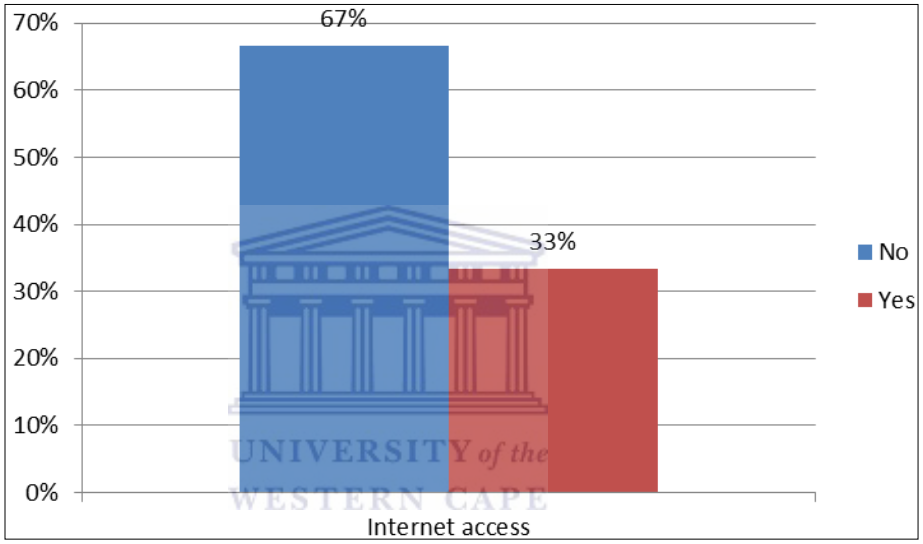


Figure 13: Internet access of respondents

However, the small number of people who indicated that they access the Internet do so very rarely: 50% access it rarely, 38% access it sometimes and only 12% access it regularly (see Figure 14).

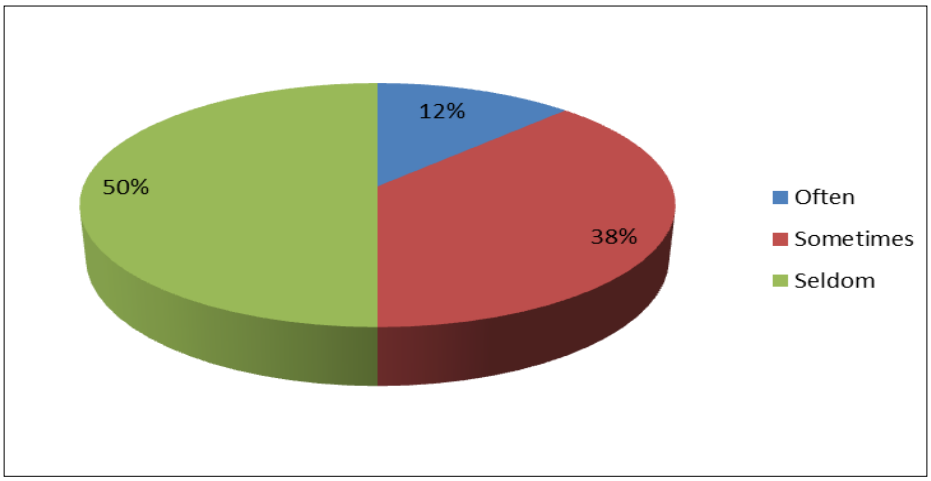


Figure 14: Farmers' usage of the Internet

It was found that all participants own a mobile phone, with each family owning at least two mobile phones.

Most of the mobile phones owned by the farmers do not have the facilities required for Internet usage such as an Internet browser and other tools (see Figure 15).

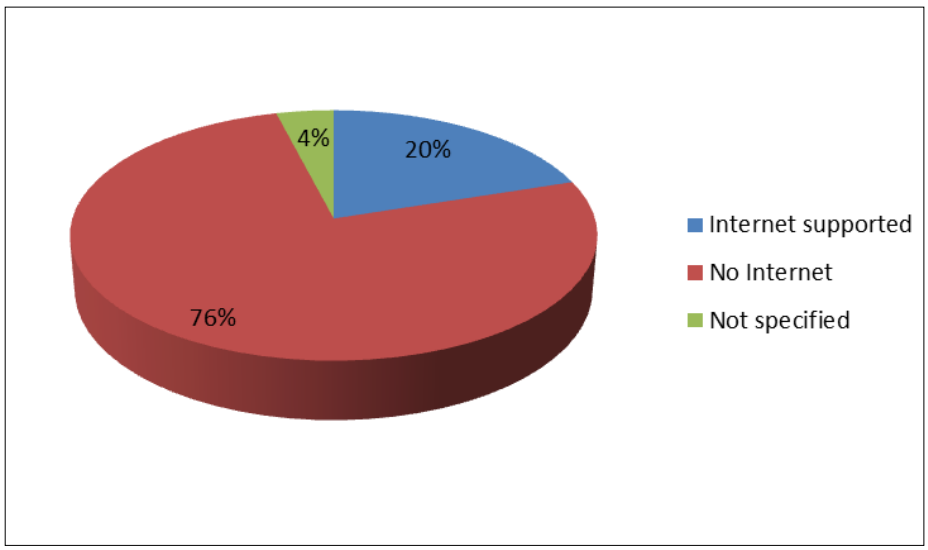


Figure 15: Support for the Internet available on farmers' mobile phones

The most popular type of phone was the Nokia 1200 and Nokia 1600, which are less-expensive mobile phones without Internet features, Bluetooth and multimedia capabilities (see Table 2). These phones allow SMS, USSD and voice calls. Only a few people had phones like a Nokia N30 or Motorola V 360 that have advanced features such as Internet access and multimedia capabilities.

This lack of adequate mobile Internet access in the target population compelled the researcher to not only design a web-based system, but also a USSD-based system for posting and accessing the information. USSD would allow all users to access the system by means of their mobile phones.

SMS, voice calls and USSD usage and cost

Further information was collected about how farmers use services such as SMS, voice calls and USSD, and the costs associated with these services. The majority of people were found to use their phone primarily for making calls and sending SMSs.

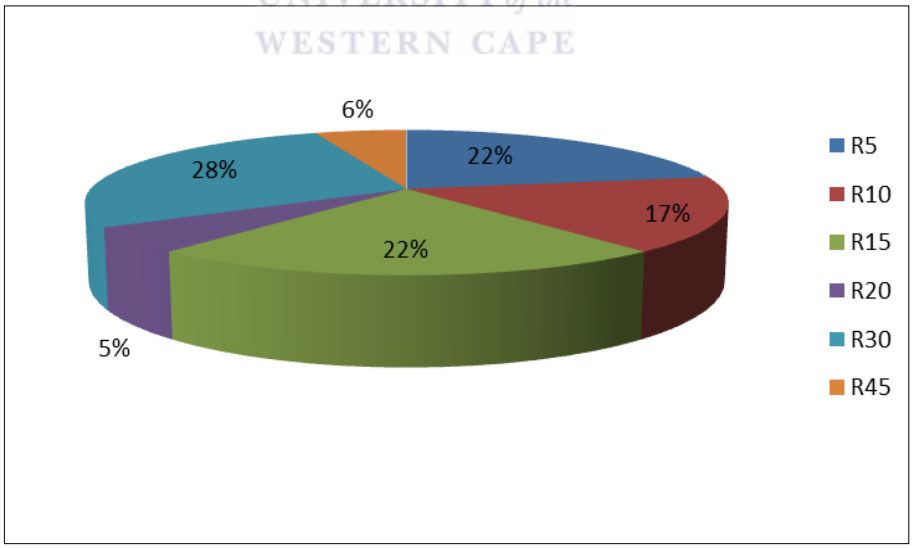


Figure 16: Weekly spending on calls

The highest cost was for voice calls. Only 6% of participants could afford to spend about R45 per week on calls; most (61%) spend less than R20 per week

on phone calls (see Figure 16). Most (65%) participants spend about R2 on SMSs's (see Figure 17).

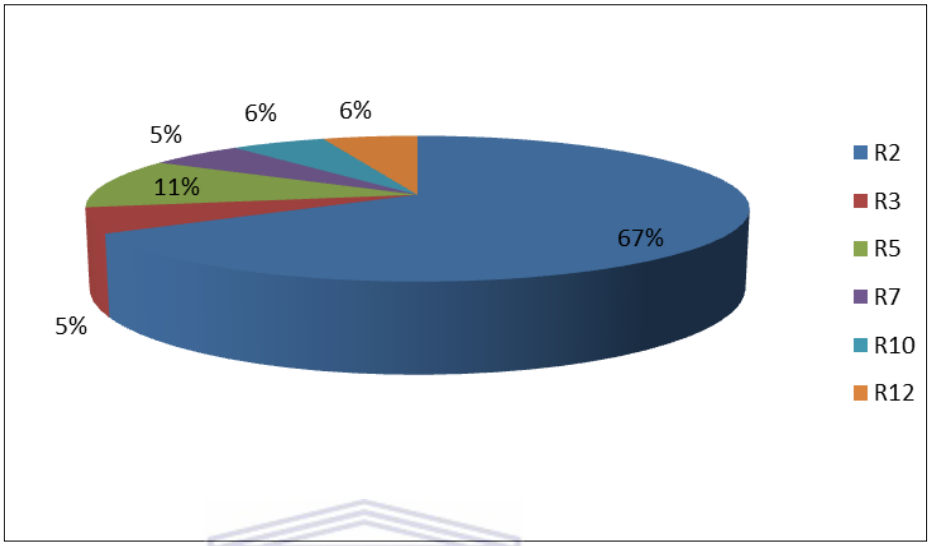


Figure 17: Farmers' weekly spending on SMSs

According to the data collected, the farmers did not know about USSD technology on their phones; however, they use it in checking and recharging their airtime as well as sending "Please call me's". The other discovery was that farmers used the radio and shops/stores to get information about prices of products in their areas, which means that mobile phones are very seldom used to access market information (see Figure 18).

- Respondents who indicated that they use the radio as means of getting information about price of crops price indicated that the information about the prices of a specific crop is often not relevant to them in their specific area.
- Those respondents who indicated that they get information from shops or stores indicated that they often need to travel some distance to reach the shops from which they obtain such information.

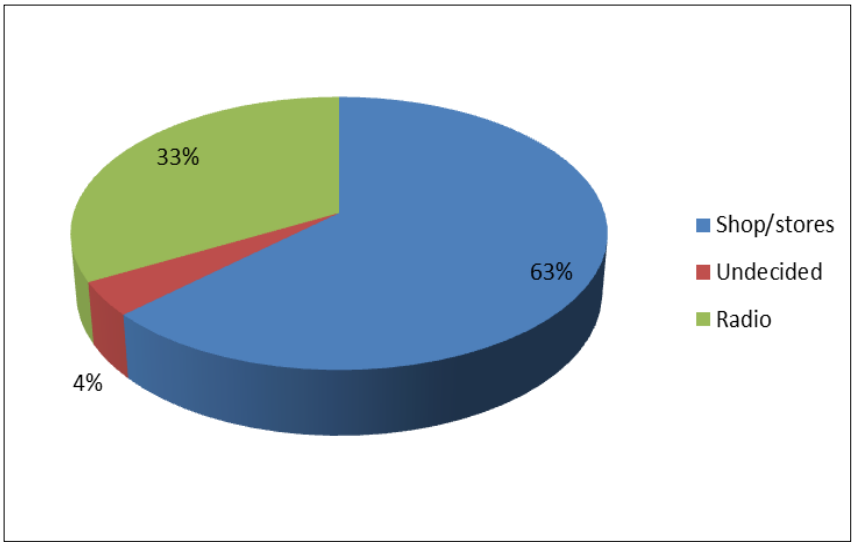


Figure 18: Places where farmers obtain market information

The crops mainly produced in the area considered were maize, bananas and cabbages.

Cost of mobile communication services

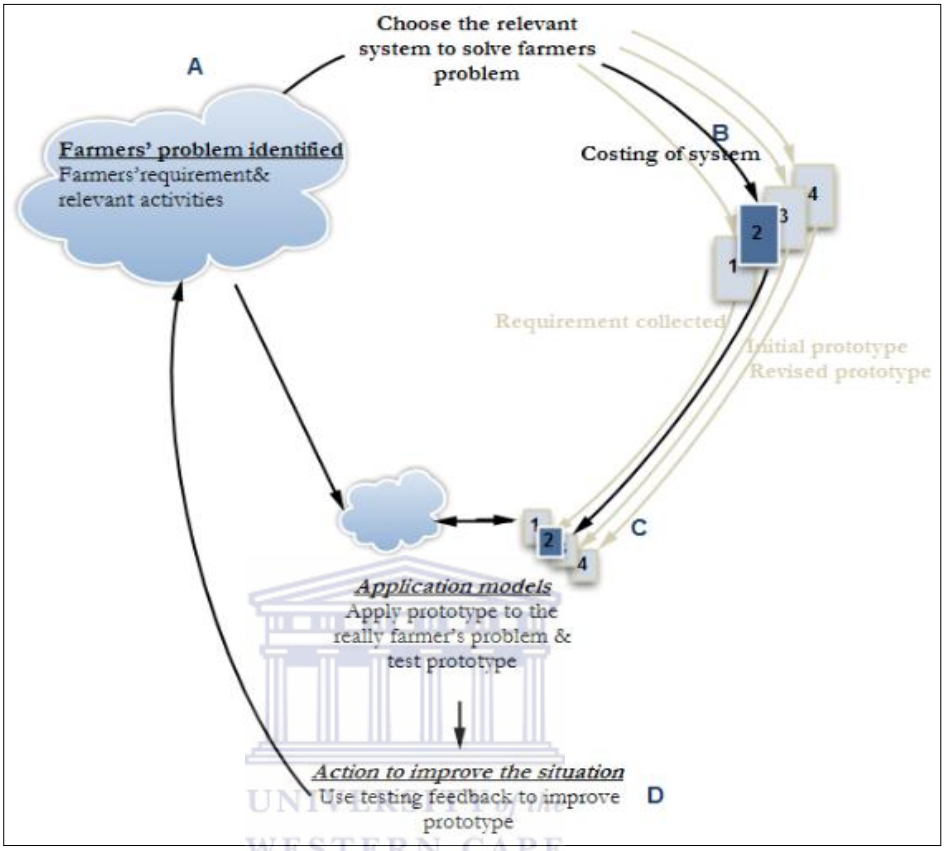


Figure 19: Costing of system

Table 2 is a summary of the mobile phone costs of South Africa's five mobile phone network operators during peak hours. These prices represent possible minimum charges that subscribers incur while communicating during the day (Etherington-Smith, 2010; International Telecommunication Union, 2008).

Network operator	Call price/minute	SMS cost/160 characters	MMS cost/300KB
MTN	R1.80	R0.80	R0.90
Vodacom	R1.80	R0.80	R0.80
Cell C	R1.50	R0.50	R1.00
Virgin	R0.99	R0.70	-
8ta	R1.50	R0.50	R0.50

Table 2: South African network operators' prices

USSD is session communication system that provides interactive dialogue between the user and the mobile phone application. MTN charges R0.21 (VAT inclusive) per USSD session (a session is 20 seconds). USSD has a time limit of two minutes and during a session the user must respond to a menu every 30 seconds; if not, the session times out (MTN, 2008). Vodacom charges a fee of R0.60 per session, incremented every 20 seconds, and the maximum time a session lasts is three minutes (Vodacom, 2011).

Size of website pages

The webpage sizes were measured according to the different tasks the website fulfilled. To measure the size of a web page a firebug tool was used. The result is given in kilobytes for the different tasks (see Table 3 and Appendix G). For example to measure the web page size required for the task of sending an SMS to a seller, the researcher took the size of the web page that allows the typing of the SMS- plus the size of the web page that confirms that the SMS-was sent.

Table 3 shows the different sizes of web pages (in kilobytes) required by the differente tasks.

Tasks	Size in kilobytes
Checking information	34.0
Send SMS to the seller	10.39
Send email to the seller	33.1
Post commodities	37.5
Modify information	20.5
Delete information	17.6

Table 3: Page sizes required by the website application

Cost of Internet services

In rural areas, the majority of people do not own a mobile phone with Internet features and thus they use Internet cafés to access the Internet. This costs approximately R5 per hour. People owning mobile phones with Internet features are able to buy data bundles or buy airtime to access the Internet. Table 4 shows the prices of data bundles as charged by the different local mobile operators as in October 2011 (MTN, 2008; Vodacom, 2011; Cell C, 2011).

	Bundles	Bundle cost	Price per MB in bundle	Price per MB out of bundle
MTN	2GB	R 389	R 0.19	R 1.20
Vodacom	2GB	R 349	R 0.17	R 2
Cell C (standard bundle)	3GB	R400	R 0.13	-
Virgin	10MB	-	R 0.6	-
8ta	10GB	R200	-	-

Table 4: Mobile operators' bundle prices

Summary of farmers' situation

Table 5 summarises the information gathered by means of interviews, questionnaires and document analysis regarding the situation of rural farmers.

Core activities	Current means adopted	Facility/cost of carrying out these activities	Farmers' requirements
Finding commodity prices	Through radio/shops/stores	Takes time and transport cost to visit shops or stores	Easy way to access information about commodity prices and buyers so they can make informed decision
Marketing farming produce	No marketing done. Only display of products at areas where people pass through such as at the side of the street, in a marketplace, stores and shops	Transport fee to transport their produce to market	Place or means to market their produce any time other than on market day only
Locating market (buyers)	Inquire from shops and stores	Takes time to personally go and meet buyers	Means to access information about prospective buyers
Accessing information	By means of radio, visits to shops, stores and the marketplace	Takes time / cost money	Need cheaper way to access information using other means without having to travel long distances

Table 5: Summary of users' requirements

User requirements defined

From the information gathered from the farmers, the user requirements were identified and are presented in Figure 20.

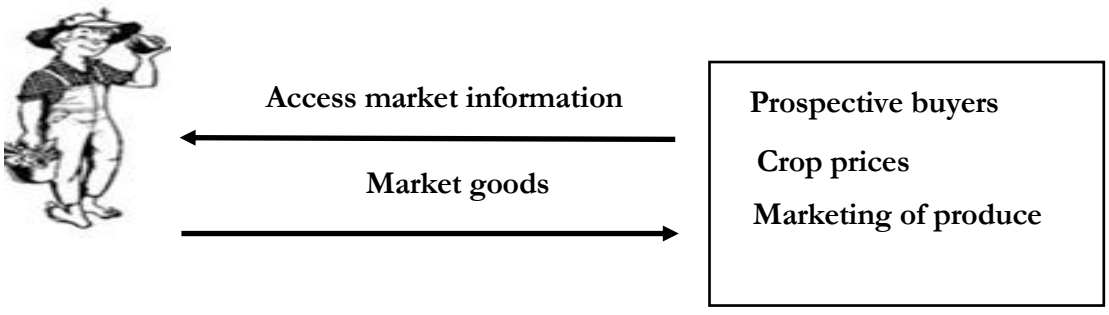


Figure 20: User requirements defined

PROTOTYPE DESIGN (STEP B)

After defining the user requirements, the research focused on identifying an appropriate system that would work for farmers as unique situation. UML was used to understand the existing problem and to design and develop a prototype to address the problem.

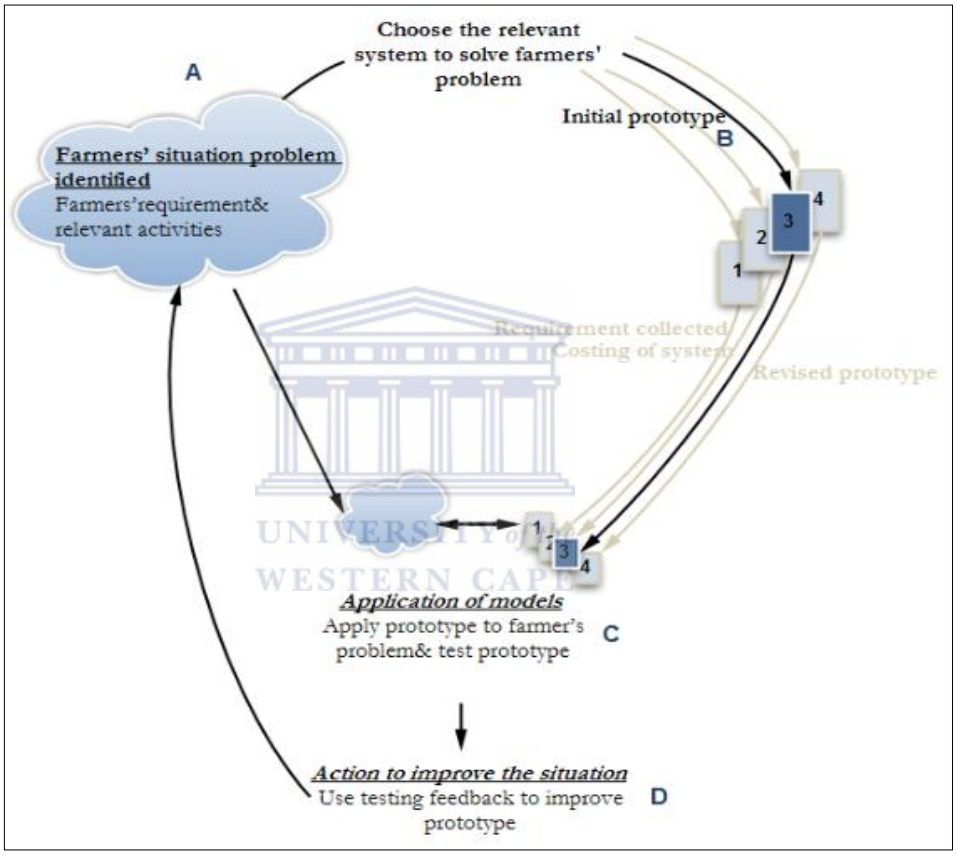


Figure 21: Building a purposeful system/prototype

The prototype consists of two parts: one is a web-based application and the other a mobile phone application. The user can post or retrieve information from the database using either of the two applications (see Figure 22).

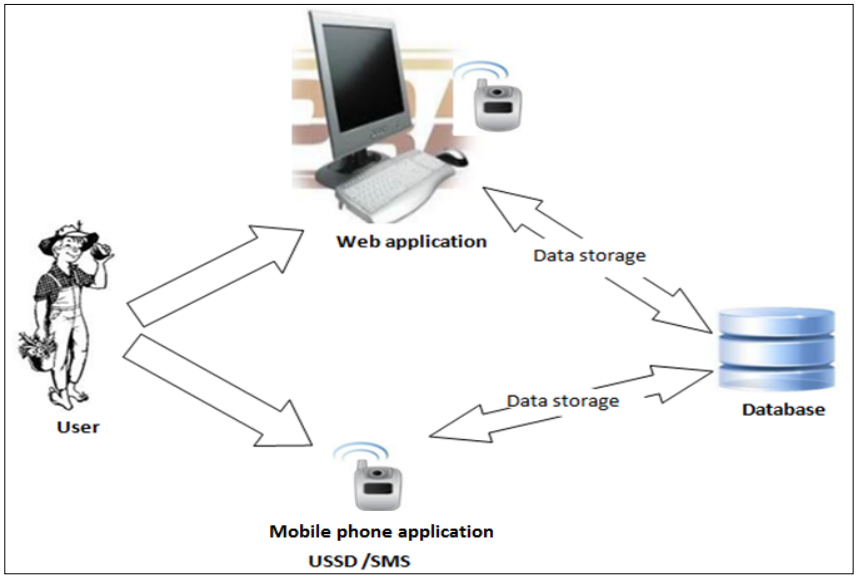


Figure 22: Proposed applications

Database design

The two applications that made up the prototype are linked by the same database. A model guided the development of a system that meets farmers' requirements and allows them to carry out their business efficiently. The model helps to describe the system's classes, their attributes and the relationships between the classes (see Figure 23).

Specification

Figure 23 shows the interaction and different relationships that exist between classes.

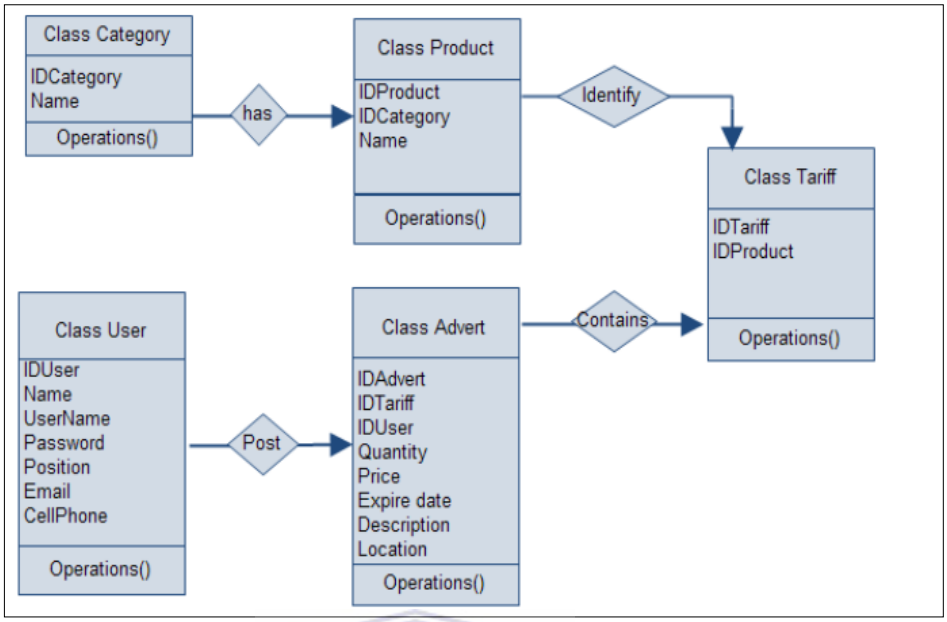


Figure 23: Class diagram

The class diagram in Figure 23 shows that there are different categories of food products and each category comprises several commodities, for example, in the category of grain, we have maize, wheat, etc., while in the fruit category there are bananas, mangoes, pineapples, apples etc. Also, each commodity has a price (tariff) fixed by the seller.

Web application

Specifications of the system

Overview of the web application

The farmer should be able to login to the website and access his/her account. On the website, the farmer should be able to post information about commodities and edit (delete, cancel) posted information. A buyer should be able to access the website and view posted information and should also be able to send emails or free SMSs's to the sellers using the links available on the webpage.

Requirements

The web application takes into consideration requirementws as stated by the farmers: usability, functionality and security. In terms of usability, the web application ensures that the graphical user interface (GUI) is user-friendly, and easy and efficient to use, particularly for users with low literacy. The system incorporates error-handling mechanisms with clear exits and provides feedback messages that keep the user informed about what is happening. Error messages should meet ethical standards and should be made clear and easily understood by the intended users.

The system should be fast (especially for sending emails and SMSs) and efficient – only a few steps should be needed to perform a given task. The design should allow shortcut commands, where appropriate, and autocomplete should be incorporated to help the user to input data. This will ensure the easy and effective prediction of words being typed, which will enable users to quickly find and select values.

Two GUI designs were disigned one for a website on a PC, and the other for a website on a mobile phone. The web application also ensures confirmation of SMS and email delivery, while the system provides an autodelete function for outdated or expired posts. In terms of security, the web application provides encryption and authentication where genuine users need to provide their username and password to enable them to login. Incription will enhance password security during login. A password should be a minimum of six characters in length, and when changing passwords, the system will not accept a password that has been recently used. Access right should be used to restrict users to a specific access level, allowing some users to read and update and others only to view data.

Interaction between users and the system

The use case diagram (see Figure 24) shows the interactions between the farmers and the website, as well as the interaction between the buyer and the web application.

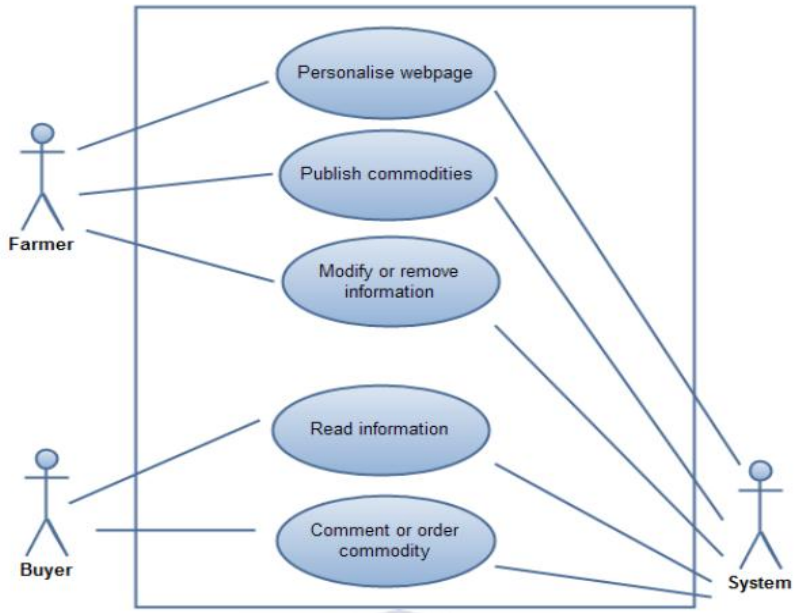


Figure 24: Interaction between farmers and website users case diagram

The web application will enable farmers to open and personalise an account. After accessing the system website, the farmer can login and personalise his/her webpage. This includes posting new adverts for commodities and changing or removing adverts. The buyer can access the website to read information about the commodities, comment or post adverts to order a particular type of commodity, and contact suppliers using an email or SMS.

Building of the web application

Client/server architecture and implementation

Different tools can be used to develop a web application, i.e. JavaScript, PHP and HTML programming languages. JavaScript provided functions that helped to make webpages dynamic and interactive; PHP was used as scripting language and was embedded into the HTML codes for web development. MySQL was chosen as the database to store information; it was preferred because it is an open source.

The web application was hosted on an Apache (HTTP) server. This was used because it is open source and easy to navigate and use. In order for one to be

able to view the application from a PC, an Internet connection is required, as well as a web browser that will retrieve the application from the server. For the PC client, a local area network (LAN) connection is used, as well as a Wi-Fi connection; for the mobile phone client, Wi-Fi is also used to connect to the server. The information given/requested by the user is stored in a dedicated MySQL database server, and this information is transferred/retrieved by the web application hosted on the Apache HTTP server.

Figure 25 shows the interaction between these web application tools.

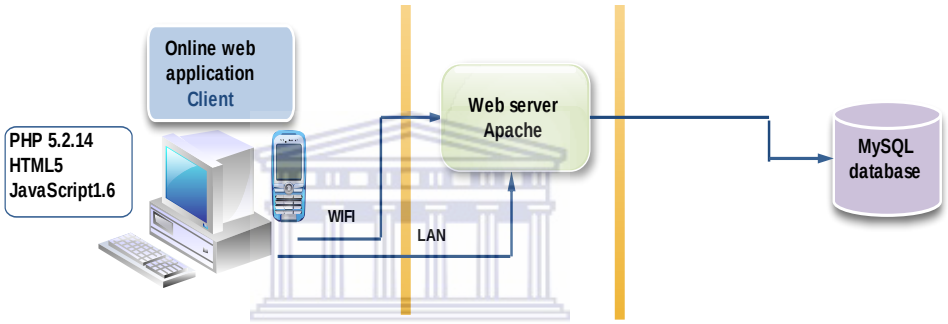


Figure 25: Client/server architecture (web application)

Implementation was carried out using different PCs, laptops and a mobile phone. For a user to be able to subscribe to the website and in order to be able to send SMSs, the BulkSMS API (application programming interface), which is based on the HTTP Internet protocol application, was used (BulkSMS, 2010). To access the website using a mobile phone, the phone needs to have wireless connectivity. Simple mail transfer protocol (SMTP) was used by the web application to transfer electronic mails to the subscribers of the application.

Web application modules

- *Post commodities*: The user needs first to login and then needs to fill in information about the commodities on the "post commodities" page. The system provides autocomplete for familiar words; if there are no proper words that the user wants to select, he/she can type in the appropriate words. After the posting, the user gets a confirmation message. The user is able to access his/her previously posted information and can delete or modify it.

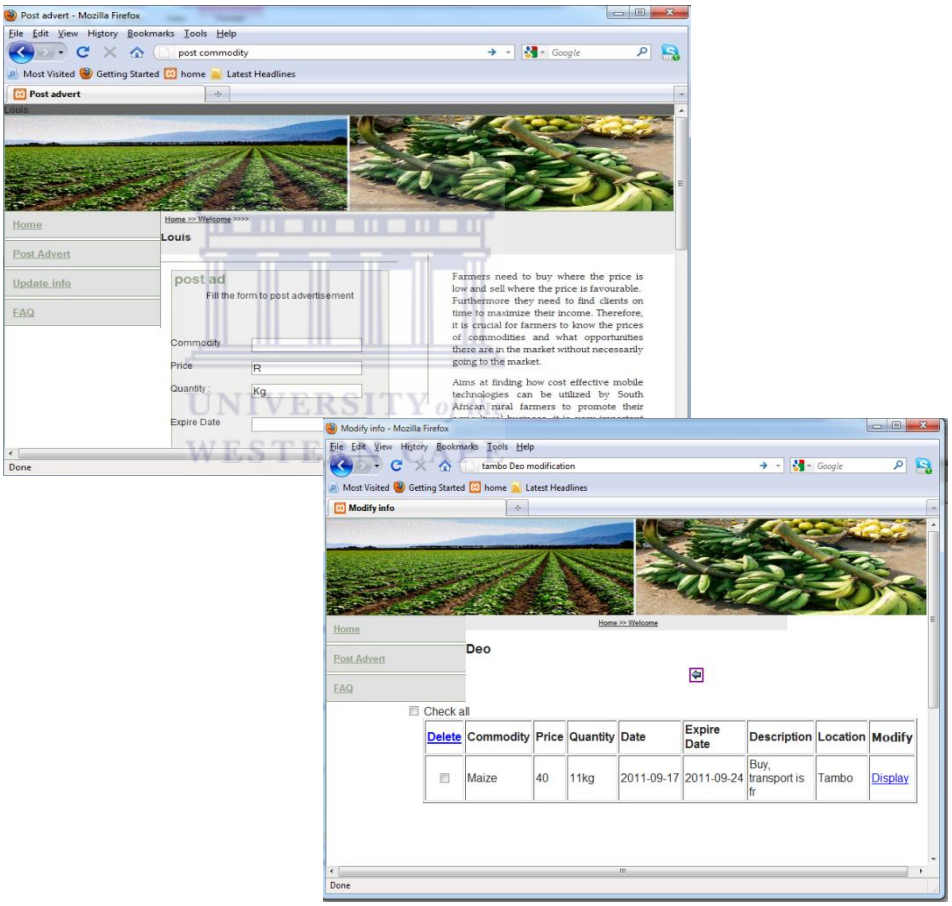


Figure 26: Sellers' page for posting, deleting and updating

- *Check information and contact sellers*: The user visits the website and can search and choose which commodity he/she is interested in. From the website, the user selects a contact and by clicking on the name,

can send an SMS or email. The user first selects the area or location where he/she wants to check information. After he/she types in the first words of the commodities, the system provides all possible commodities that start with these letters and provides the numbers of people who posted each item, then the user can choose from the list. The system deletes outdated posts on the page of the website to prevent users from viewing outdated information.

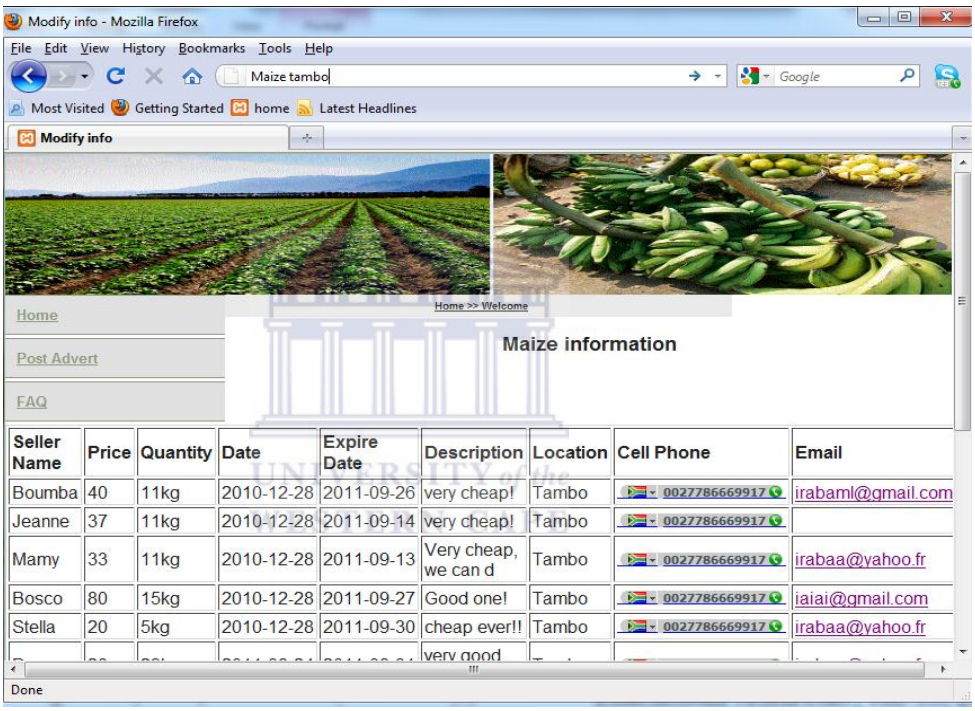
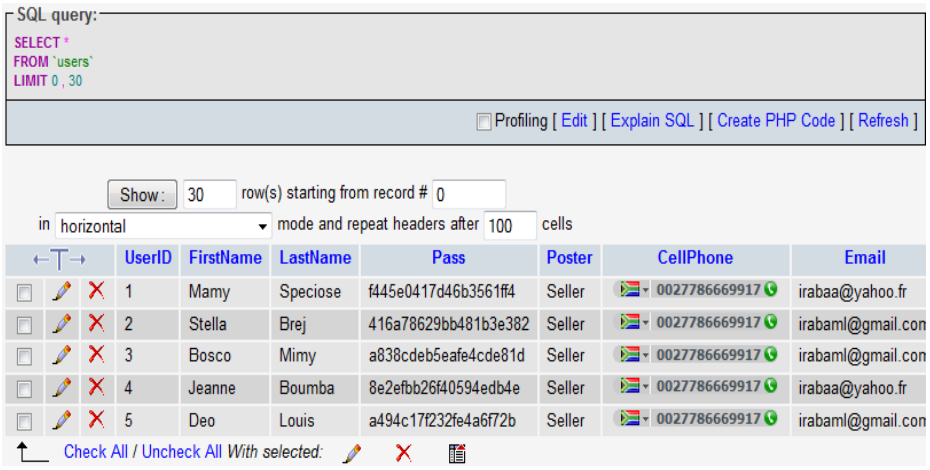


Figure 27: Sample of page for checking information

Security: A user needs to have an account to be able to post information. The user inputs information into the web application through a PC or mobile phone. The password will be encrypted. The encrypted data goes into the database and returning (feedback) data from the database is decrypted via the PHP function.


SQL query:

```
SELECT *
FROM `users`
LIMIT 0 , 30
```

Profiling [Edit] [Explain SQL] [Create PHP Code] [Refresh]

Show: 30 row(s) starting from record # 0

in horizontal mode and repeat headers after 100 cells

	UserID	FirstName	LastName	Pass	Poster	CellPhone	Email
	1	Mamy	Speciose	f445e0417d46b3561ff4	Seller	0027786669917	irabaa@yahoo.fr
	2	Stella	Brej	416a78629bb481b3e382	Seller	0027786669917	irabaml@gmail.com
	3	Bosco	Mimy	a838cdeb5eafe4cde81d	Seller	0027786669917	irabaml@gmail.com
	4	Jeanne	Boumba	8e2efbb26f40594edb4e	Seller	0027786669917	irabaa@yahoo.fr
	5	Deo	Louis	a494c17f232fe4a6f72b	Seller	0027786669917	irabaml@gmail.com

Check All / Uncheck All *With selected:*

Figure 28: Password encrypted in the database

Mobile phone application

Specifications of the system

Overview of the mobile phone application

The user can access his/her account using his/her username and password and can post information using the mobile phone application through his/her mobile phone. The user is able to check the daily maximum and minimum price using his/her mobile phone. First he/she chooses the location he/she is interested in, then will be able to post or check information. He/she can retrieve contact information and send SMSs.

Requirements of the mobile phone application

The mobile phone application has to ensure the system's usability, functionality and security. Usability ensures that the interfaces are simple and user-friendly. The graphic design is ordered in terms of a logical order, consistency and a familiar look. In terms of functionality, the application includes confirmation of SMS message delivery. For security purposes, the mobile phone application will also request username and password (which are stored as encrypted data in the database) in order to allow the posting of information.

The mobile phone application ensures the use of a limited number of steps to complete or perform a given task using USSD. The design provides an autocomplete function to help users post commodities, helping users to quickly find and select values to ensure easy and effective prediction of words being typed to speed up the tasks and save time.

Interaction between users and system

The use case diagram in Figure 29 represents a mobile phone application. Interaction within the system takes place through SMS and USSD technologies.

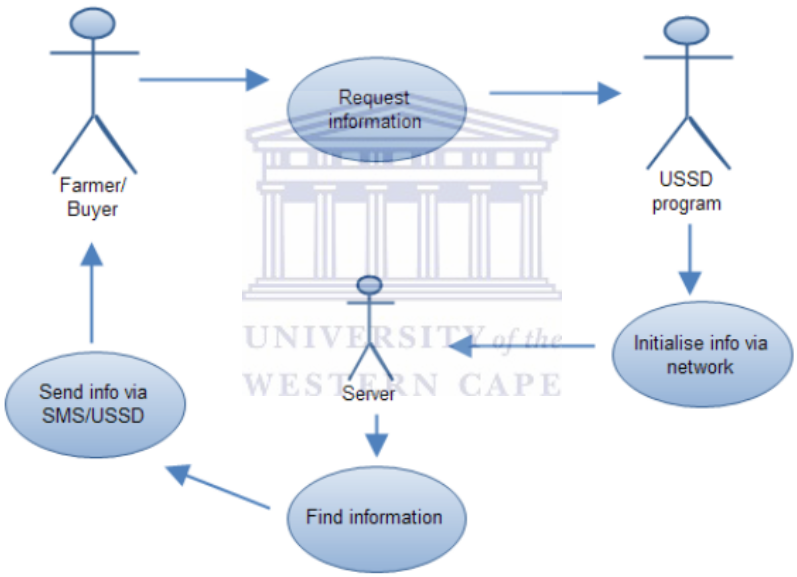


Figure 29: SMS/USSD user case diagram

The farmer and the buyer will be using USSD to request information. These requests will be initialised through the network connection. The server containing the information sends feedback to the farmer/buyer via SMS or USSD.

Building of the mobile phone application

Client/server architecture and implementation

The mobile phone application was developed using Java to Micro Edition (J2ME). This mobile-based client application communicates with the Apache HTTP server through the use of Wi-Fi for requesting data and uses GPRS (General Packet Radio Service) for sending SMSs. The data is then stored and retrieved from the MySQL database via the web server (Apache).

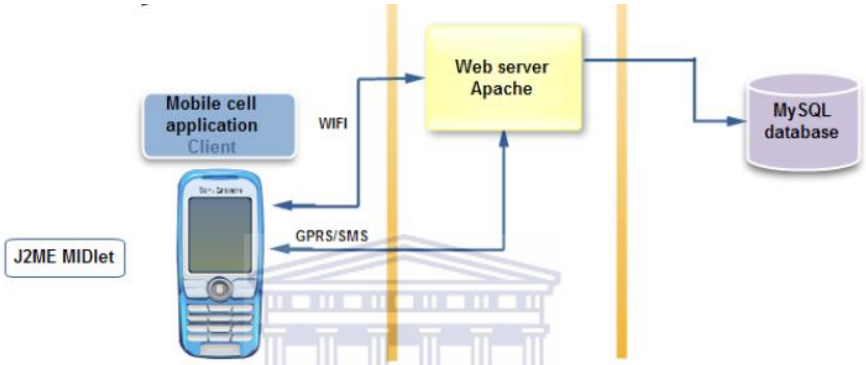


Figure 30: Client/server architecture

Instead of using mobile service provider's gateway, implementation was carried out using Wi-Fi, where the prototype was developed or implemented on a Symbian Series 60 Third Edition Feature Park 3 operating system platform (Nokia E52 was used). The Symbian prototype allows users to access and post information into the database (see Figure 30).

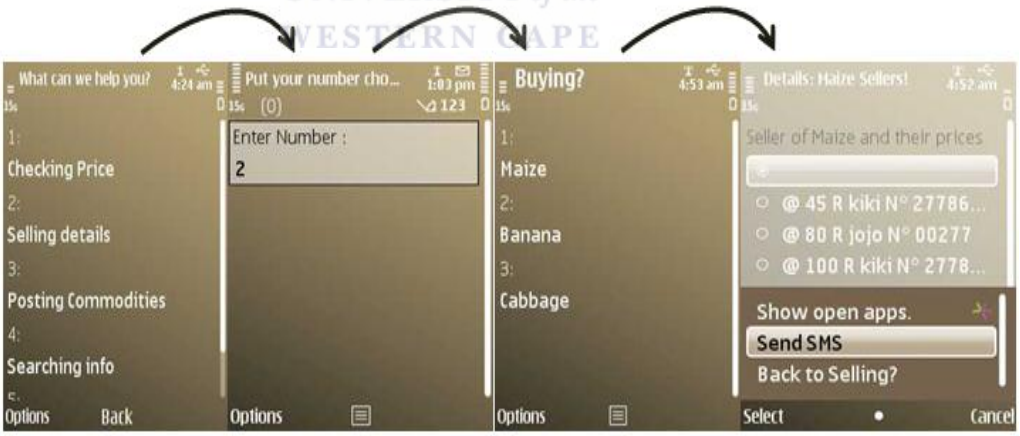
Modules of the mobile phone application

- *Posting commodities*: Users need to choose the location they are interested in and select which commodities they want to post (see Figure 31). The system requests the quantity and price for the items, and users will need to provide a password in order to login and post commodities. To make use easier and faster, the system enables autocomplete of words while the user is keying in his/her username or posting commodities. The autocomplete is done by the system, giving users the option of selecting words (data) stored in the

database. If the options are not satisfactory, the user can type in his/herown words.

Figure 31: Sample for posting commodities

- *Checking information and contacting sellers*: Figure 32 shows the stes for checking information. The user has to select the area (location) first, then select the appropriate service on the list provided by choosing whether to check the commodity price or selling details, post commodities, or search for information. The system ensures autodelete of information with expired



dates.

Figure 32: Sample step for checking information

- *Security*: To post commodities or information using the mobile phone application, a username and password are required. The mobile phone application also uses encryption/decryption functions.

SYSTEM TESTING (STEP C)

System testing was carried out to establish to what extent the system requirements have been met and to prove that the system is both usable and operable by the intended users. This allowed improvement to be made and helped to provide a system that would meet the necessary requirements.

The results have been analysed using the mixed-model approach. Users' attitudes to the system are illustrated and graphs are used to represent quantitative data (see Appendix C (i), C (ii)).

System testing was carried out in two cycles. The first cycle provided feedback and recommendations that were used to improve the quality of the system. The second cycle was executed to test whether the requirements were successfully met.

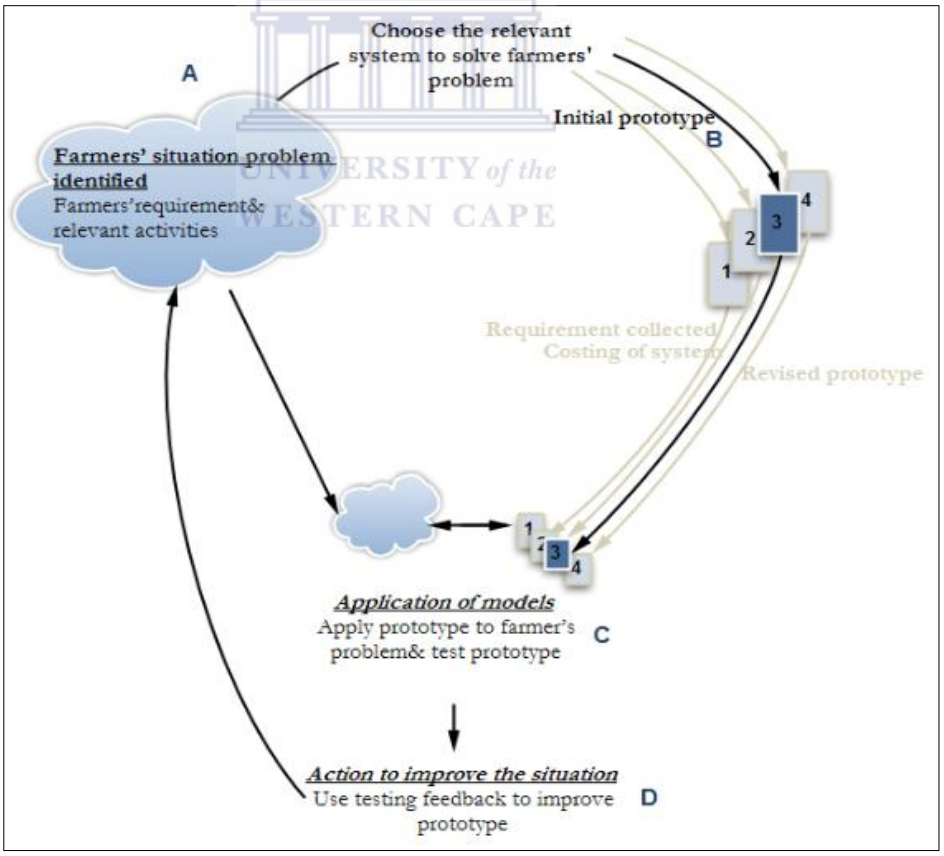


Figure 33: Testing

Testing strategies

During the system development cycles every cycle involved system testing that involved different strategies to evaluate the software in terms of its functionality.

- *Unit testing:* This strategy was used to test whether the individual units of the system worked as required and that the source codes were fit for use. The mobile phone interface and the web application were tested separately. Webpage tools tested include command buttons, links and combo boxes. For the mobile phone-based application, the USSD menus and their commands, the SMS command and area list were tested.

- *Integration testing:* This testing strategy combines individual software modules to be tested as a group. During this phase, the module testing included posting commodities, checking information and testing security modules. These were tested as a unit to ensure a fully functional system.

- *Black box testing:* This technique used valid and invalid input to test the output and system behaviour. The system behaviour was tested using invalid input such as commodities that were not yet recorded or wrong user login information.

- *Stress testing:* This involved load testing over a protracted interval of time. For the website application, users were assigned tasks and the tasks were timed to assess how long it took to complete them. For the mobile phone application, tests were done to evaluate the processing time of the central processing unit (CPU) over a given module.

First cycle results

User attitude towards the system

To get feedback on how to improve the prototype, it was demonstrated to

first-year computer science students who provided feedback by completing a questionnaire. Sixty questionnaires (see Appendix C (i)) were handed out; however, only 41 completed questionnaires were returned. Due to the low return rate, seven postgraduate students were also asked to evaluate the prototype and complete the questionnaire. To enrich data, unstructured interviews (using probes) were conducted with ten randomly selected postgraduate students (see Appendix C (ii)). During this cycle, users were observed while using the system to discover errors and areas needing improvement.

Interviews results

Interviews were conducted during the first cycle of testing (see Appendix C (ii)) to obtain users' opinions on the system's strength in terms of functionality and relevance to the community in order to identify any weaknesses so that the necessary improvement could be made.

The usefulness of the system was one of the questions addressed to participants. The responses that were obtained proved the system to be useful (see Appendix C (ii)): it can help to solve major problems farmers experience in the marketing of their commodities and will raise awareness of what they have to offer and attract more customers. This should provide them with new opportunities and allow them to buy and sell without using newspapers or the radio, because everyone who has a mobile phone will be able to access and benefit from the services provided.

It seems as if farmers are keen to acquire new tools that can contribute productively to their economic activity. Also, farmers were found to be familiar with some USSD application such as "Please call me", the USSD application of the system is simple, and it is designed in a way that illiterate people can quickly learn how to use it. The performance and reliability of the system were assessed positively by respondents (see Appendix C (ii)).

Suggestions were made regarding the improvement of the system. These

included the integration of payment functionality using airtime, adding a help button and proving technical manual documentation. A few weaknesses were identified on the prototype. It supported only one platform, Nokia, and it was suggested that it should be made compatible with other models of mobile phones.

Interestingly, one participant said that most farmers do not like innovations. They tend to stick to their own ideas and traditions passed down from generation to generation, and changing their current ways of working would be a problem. However, another participant pointed out that everyone quickly grew used to using mobile phones without any problem.

Questionnaire results

Website evaluation

From the quantitative analysis, it was found that most respondents were positive about the usability and functionality of the website (for both PCs and mobile phones). Most felt it was easy to negotiate the website (19% said it was very easy, 47% said it was easy and 28% found it moderately easy). Only 2% felt that the website was difficult to negotiate and the remaining 5% did not comment.

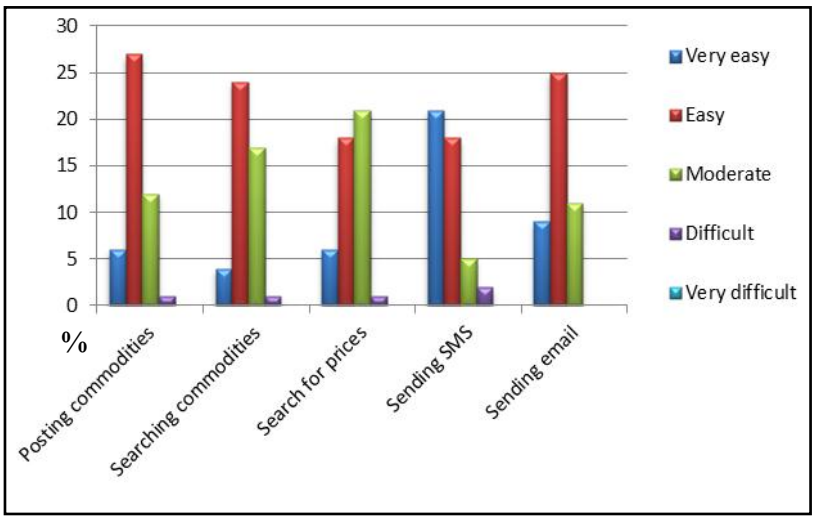


Figure 34: Website evaluation

Usefulness of the website

Respondents gave their feedback on the usefulness and relevance of the website to farmers. Forty-five percent found email and SMS very useful, 43% found them to be useful, only 4% found them not useful, and 6% did not respond.

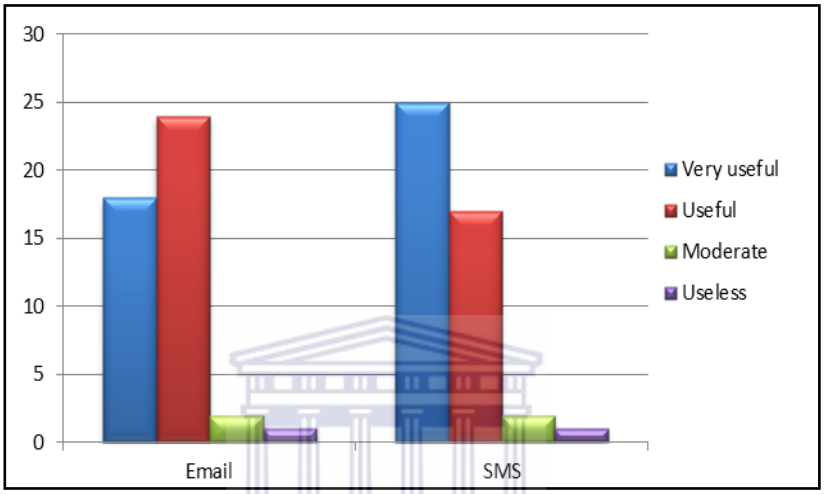


Figure 35: Email/SMS valuation

Mobile phone application evaluation

Most of the users found the mobile phone application easy to use, especially for sending SMSs (42% found it easy and 16% very easy). Only 33% found the application to be moderately difficult, especially in terms of checking prices and sellers' details. Only 3% found the mobile phone application difficult or very difficult to use (especially in terms of checking sellers' details).

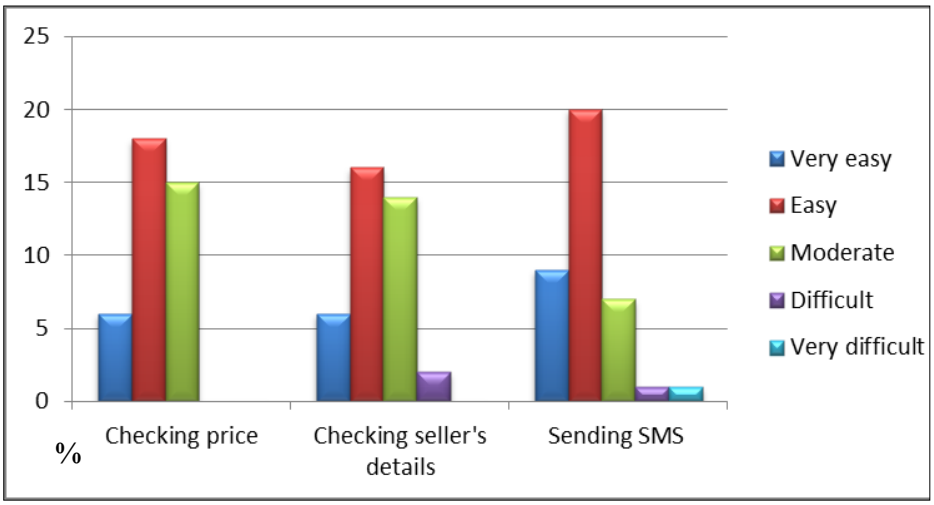


Figure 36: Mobile phone application evaluation

User recommendations

Respondents were given the opportunity to recommend what they felt should be done to improve the prototype. Most users (65%) were satisfied with the prototype's performance, while 14% requested that the design should be revised, especially the website's design. Only 11% wanted added functionality, mainly to the mobile phone application.

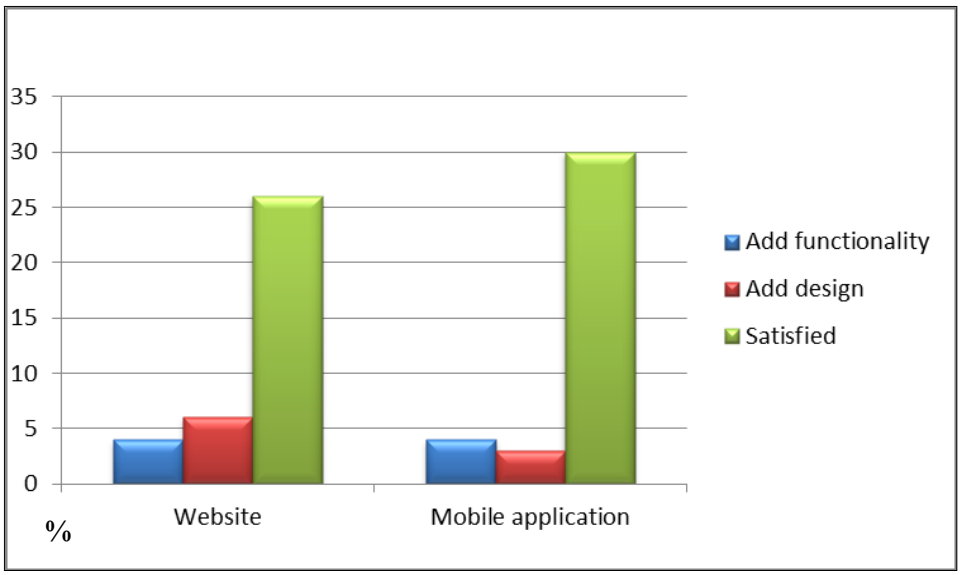


Figure 37: Users' recommendations

From users' recommendations, the following changes were made to improve the system (see Tables 6 and 7).

Improvements proposed by users to the website:

Additional functionality	**Additional design**
Additional commodity categories	Additional images
Displaying maximum and minimum prices of product	Colours for each commodity
Ranking price and classification by area	Flash functionality
Help (guide) option and reference technical manual documentation	

Table 6: Improvements proposed to the website application

Improvements proposed by users to the mobile phone application:

Additional functionality	**Additional design**
Posting commodities	Additional images
Sellers' registration (signing up to a new user account) using mobile phone	Reorganising menus
Help (guide) option and reference technical manual documentation	

Table 7: Improvements proposed to the mobile phone application

ACTION TO IMPROVE THE SYSTEM TO BETTER ADDRESS THE PROBLEM (STEP D)

Second-cycle result

The application was upgraded according to first-cycle results and user recommendations (see Tables 6 and 7). A second cycle of testing was then done. During this investigation, the prototype was evaluated using a questionnaire (see Appendix D) with 60 second-year computer science students.

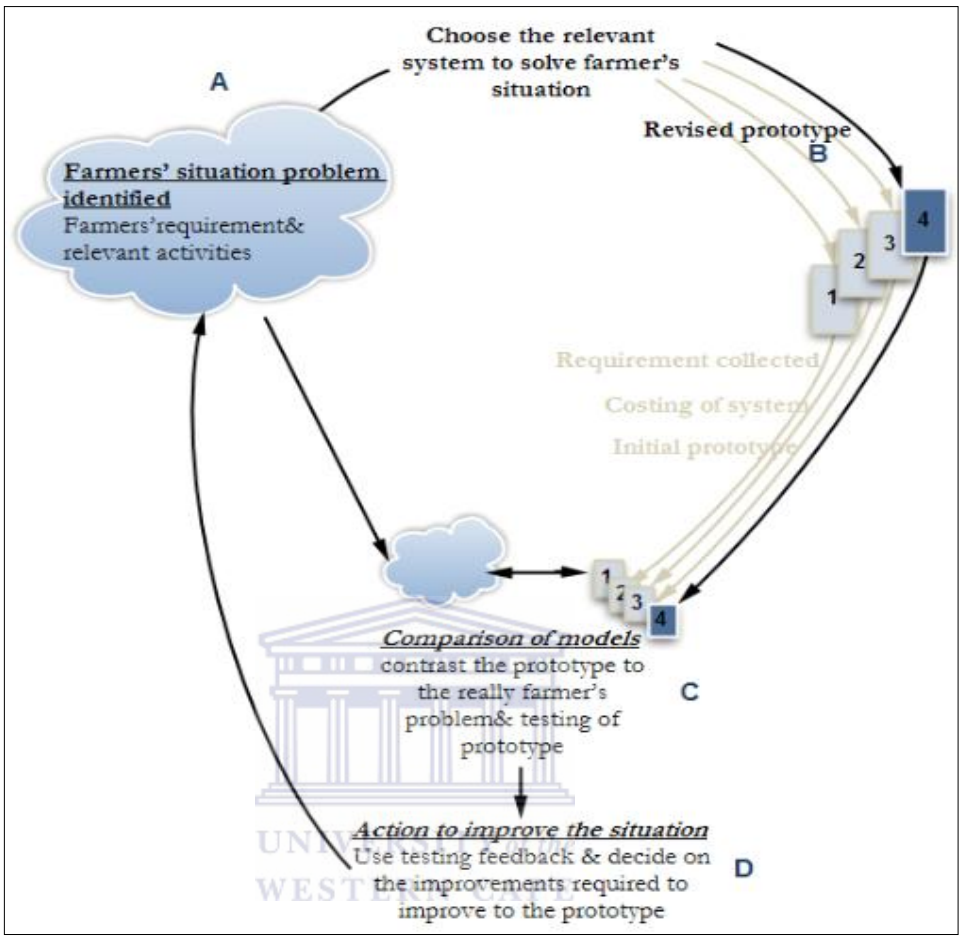


Figure 38 Revised prototype strategy

Further improvements made to the system (after the second cycle)

Based on users' recommendations (after the second cycle), further changes were made to improve the system (see Tables 8 and 9). Improvements made to the website functionality included adding more commodities, allowing the buyer to compare the prices of products in stock, ranking prices and classifying prices by area. In terms of website design, more images were added, colours were used for each commodity and flash functionality was added. In light of users' recommendations, on the mobile application design more images were added and menus were reorganised, while functionalities to register as a seller and post commodities were added.

The navigation in the application was tested and the majority of users reported that the system was easy to navigate, understand and use. Very few mouse clicks were required to complete an entire process; some shortcut commands were improved so that the application could function better.

Figure 39 represents users' assessments of the user-friendliness of the system.

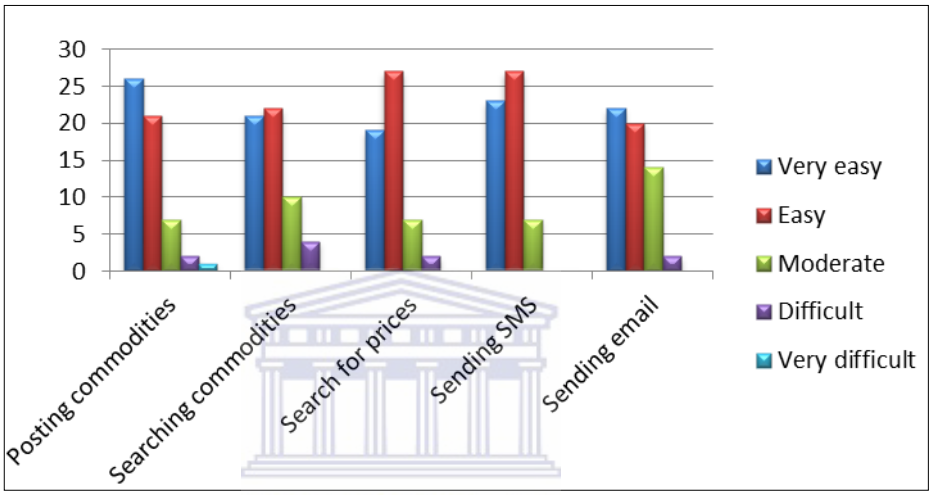


Figure 39: Website evaluation

The website evaluation shows that most people found the system to be easy (41%) or very easy (40%) to use, and only 15% indicated that the system was moderately easy. Very few people said that the system was difficult (4%) to use. These figures show improvement when compared to the first cycle, where about 19% had indicated that the system was very easy to use and 47% indicated that the system was easy to use.

Usefulness of website (SMS and email)

The majority of users said that the email and SMS functions would be useful. In the previous cycle, 44% of users said that the system was useful (4% indicated that the system was useless because there was no Internet in rural areas); however, after the improvements to the system, 64% found the system useful.

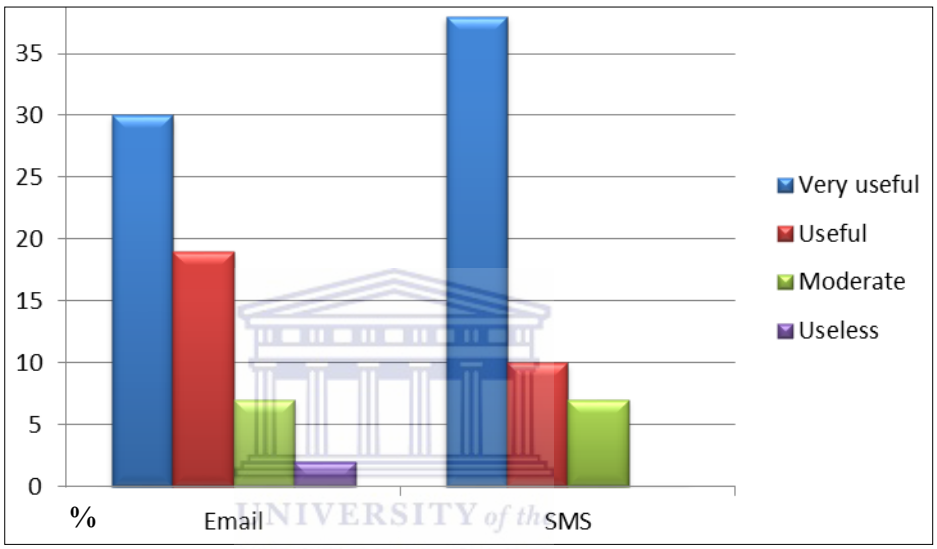


Figure 40: Usefulness evaluation

Figure 40 shows the result of the mobile phone application evaluation. Compared to the first cycle, the second cycle showed that a higher percentage of users found the mobile phone application to be very easy to use. For example, the functions to send an SMS and check prices were now considered easy, which was not the case in the first cycle.

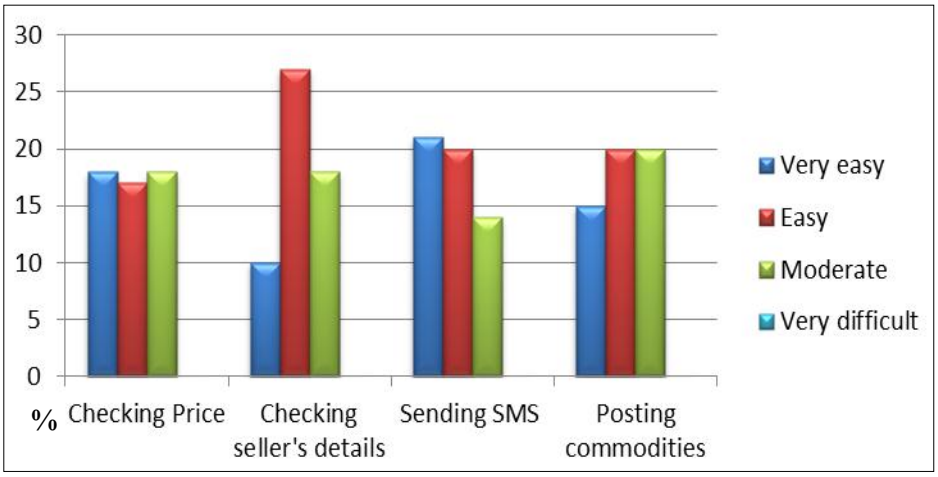


Figure 41: Mobile phone evaluation

Users' recommendations

Users recommended adding Google Maps to the mobile application and website to simplify the localisation of sellers.

It was also suggested that a visualisation tool to visualise statistics should be added. This feature would help users to view statistics about crops and economic activities in the area, etc. as graphs.

Website and mobile phone testing

The various units/tools of the website and mobile phone application were tested independently to evaluate their functionality and compatibility (Tables 8 and 9 display different tool-testing results).

Website testing

Tools tested	Outcome of testing
Command button	Works perfectly, but sending SMSs is bit slow as the system has first to retrieve information from a database
Links	All links were found to work properly
Database	Works successfully and can update and retrieve information effectively
Stress testing	Tested using Diesel Test; 50 users were able to use the system simultaneously without inconvenience
Compatibility testing	The application was tested with a PC, laptop, mobile phone and different browsers (such as Firefox, Internet Explorer, mobile phone browsers such as Opera Mini, etc.) and it worked properly

Table 8: Website testing outcomes

Mobile phone testing

Tools tested	Outcome of testing
Command button	Functioned impeccably; well organised
Database	Found to be effective by all users
Stress testing	The system was tested for one user and for four users at the same time and worked efficiently
Compatibility testing	The performance of different type of mobile phones was tested and all were found to be compatible

Table 9: Mobile phone testing outcomes

CONCLUSION

This chapter discussed the technique used to test the system, the results obtained and the recommendations.

During the first cycle of action research, out of 60 students approached, only 47 filled in the questionnaire. However, the response rate improved during the second cycle where all 60 students approached responded to the questionnaire. The researcher was able get user requirements directly from farmers, but during the testing stage the researcher was unable to test the prototypes with Eastern Cape farmers. Students from rural aeas were targeted since it was felt that rural students' reponses would be similar to the reponses from farmers.

The overall testing was successful; the first cycle's recommendations were implemented during the second cycle and helped to improve the functionality of the system.

In the following chapter, the results will be discussed and recommendations will be made.

C h a p t e r 5

FINDINGS AND CONCLUSIONS

INTRODUCTION

The previous chapter presented the results of the study which mainly included the prototype design and system testing results. SSM was used to manage the research process designed to obtained a durable solution to the research problems. In this chapter, the findings of the study are discussed and conclusions are drawn.

Advances in information technology play an important role in modern society, and ICTs reach almost all the regions of the world, although not to the same extent. In South Africa, urban areas dominate in terms of ICT access and utilisation, while in rural areas many forms of ICTs are underutilised due to the financial constraints experienced people with low incomes, such as rural farmers. According to the reviewed literature, the mobile phone is a tool that can help to reduce poverty in rural areas if it is applied to empower rural people in a cost-effective way. Previously, some mobile phone applications have been developed and successfully implemented to support rural development projects in health, education and business using SMS, USSD and the Internet.

The encouraging finding is that members of the rural community of the Transkei area possess sufficient basic literacy to understand and use mobile applications. Considering the types of mobile phones available in the rural Eastern Cape the literacy level of its inhabitants and the fact that it is a low-income community, the research was designed to develop a system that could work effectively in such conditions.

The project's main aim was to find how mobile technologies could create opportunities for rural farmers to promote their agricultural business cost-

effectively. This aim was translated into three main research questions, which will now be revisited.

FINDINGS IN TERMS OF THE RESEARCH QUESTIONS

How should farmers be empowered to advertise their produce and be put into contact with potential clients?

It was found that a mobile application designed to use the economic USSD protocol could empower farmers to advertise their products and communicate with a wide range of potential customers. The type of ICT most applicable in the rural context was identified as being the mobile phone. Other forms of ICTs are scarce in rural areas.

In this research, similarly to what was found in research conducted by the World Bank (2008), the mobile phone was found to be the most commonly owned communication device and could be a tool to reduce poverty if wisely used. The designed system took advantage of the availability and popularity of mobile phones among farmers and focused on establishing a cost-effective platform for communications between them and their potential clients.

How shoud inexpensive mobile technologies be harnessed to provide market-related information to rural farmers?

Farmers felt that they could not afford mobile phone services such as phone calls or SMSs to run their businesses, because this would cause an unacceptable increase in their expenses. Thus, the USSD protocol and mobile phone Internet bundles were the main features that were principally focused on in the development of a system for farmers that would minimise communication costs. For example, a USSD session cost R0.21 (when using the MTN network), and thus with an outlay of R2 per week (which is the most that farmers could afford), the system allows the user to have 10 USSD sessions. This was found to be much more efficient and cost-effective than paying R2 for approximately two SMSs. Currently, around 67% of

participants spend R2 per week on SMSs, which implies that using USSD would provide a considerable advantage for users.

Rural farmers do not use the Internet very much, as it is expensive for them and they mostly do not have access to it. The few who do have access (50% of farmer respondents) do not use it often and spend very little money on it. The cost of accessing the Internet in the rural Transkei through cyber cafés was found to be very expensive compared to cyber cafés in towns or urban areas. While the majority of farmers' phones do not have Internet facilities, some 20% of respondents had mobile phones that had Internet features and about 50% of respondents said that they sometimes used the Internet. The number of mobile phones that have the Internet feature is growing; however, only 4% of the farmers interviewed for this study owned such a phone. For this reason, the web application was integrated into the system to allow farmers to use data bundles to operate the system if they owned an Internet-enabled phone. Using data bundles minimises the cost of posting and using the system in general. For example, when a farmer posts commodities, only 37.5KB is consumed, and 10MB cost only R1 (according to the MTN tariff). Considering that 1MB = 1024KB, the farmer can make approximately 30 postings of commodities and each posting would cost around R0.0036.

It was observed that in normal circumstances farmers are often reluctant to use their phones to make calls due to their fear of overspending. They therefore tend only to call when there is an emergency. They are thus unlikely to regularly use their mobile phone in their normal activities. The designed system is equipped with both a USSD and a web application and should empower farmers to easily access information, communicate with their clients and make better deals. The popularity of such a system will increase as farmers realise it is cost-effective.

The lack of agricultural information has been identified as one of the major barrier to farmers' success, and the project addressed the problem by finding ways to harness inexpensive mobile phone technologies and provide a

platform allowing information exchange between users.

Toyama & Dias (2008) argue that it is more advantageous to fit technology into the existing social fabric, and if technology can work within existing social structures, the community will be more likely to embrace it. Currently, farmers access market information by means of the radio, by going to the market or communicating directly with clients. It was also observed that farmers who are not able to sell their produce at the end of the market day are faced with a dilemma of how to deal with perishable products in terms of their transportation and storage. This study does not completely change these existing patterns, but rather complements them by introducing a further means of accessing the required information, namely a technological method of doing so. This technological means was achieved by providing a USSD application or a web-based platform where they would easily get information.

The USSD- and web-based applications have been integrated into one system, thus creating a platform that provides a simple method for disseminating information. For example, many users would use the mobile application or the USSD application to post information, which is stored in a database, and any user of the system will be able to access this information upon his/her request.

How should the uptake of this technology be promoted?

Of the many ICT projects conceived in the area of rural development, only a few are successfully implemented. One of the reasons is that the implementation and promotion of new ICTs involves developers who usually want to supply a system that allows them to make profits from farmers rather than reducing the latter's costs (Maritz & Maponya, 2010).

This study provides a different concept in which all aspects of the system would benefit users. The USSD and web applications were chosen to provide services at a minimal cost.

The promotion and uptake of this technology will therefore not be a simple

task, but will be achieved if the government or farmers' associations can assist in the development and hosting of farmers' website and pay mobile service providers to implement farmers' mobile phone applications. This will promote farmers, as they will be accessing and registering on the website for free and using mobile phone applications for free. In return, the mobile phone service providers will benefit, because their services will be applied in different contexts.

It was found that farmers do not normally sell directly to major buyers like supermarkets, but to intermediate buyers. These buyers buy the produce from farmers at the lowest prices possible and sell the products to supermarkets or food factories at a much higher price. This prototype will allow direct communication between farmers and major buyers, thus eliminating the role of intermediary buyers; equally, it will be effective and user-friendly enough for farmers who might not be computer literate.

The current system is not fully compatible with most types of mobile phone, because the USSD application was developed on the Symbian Series 60 (Third Edition) Feature Park 3 operating system and it can only be deployed on Nokia mobile phones of that edition. For further studies, it will be necessary to improve the USSD application in order to adapt it to other models of mobile phones. Furthermore, this application has not as yet been tested on different mobile phone networks.

In this study, the focus of attention was the farmers who produce and sell, i.e. most of the functionality developed in the system was for sellers. However, it would be important to add more search options and tools for use by buyers to provide them with fuller usage of the system, for example, allowing buyers to send orders to different sellers using SMS or email and putting in place a system of storing order information. This will benefit farmers because they would be better able to sell to their customers.

From the survey, two important suggestions originated from participants during the second cycle of system testing. It was suggested that tools for statistical data storage and visualisation should be introduced for both applications. The first suggestion was to include tables and graphs reflecting the evolution of agricultural data and a tool allowing users to compare and contrast information using different criteria such as location, crop or price. The second suggestion was to incorporate geographic maps such as Google Map in web application that would allow farmers and client to physically locate each other.

CONCLUSION

After completion of this research, the results that were obtained support the hypothesis that inexpensive mobile technologies can greatly contribute to the improvement of rural farmers' business by allowing them easy access to market- and farming-related information. These inexpensive mobile technologies are mobile phone applications mainly based on USSD. USSD works with minimum cost and is operational on the various mobile phone models owned by rural famers.

Currently, most farmers source information from shops or the radio, neither of which allow the farmers to get detailed information of particular interest to them.

With the proposed mobile application, farmers would be able to easily access the specific information that pertains to them and it would allow them to disseminate information about their own products by posting it on a common database. The easy access (by means of a mobile phone) to information makes it possible for farmers to get accurate and timely information, since most farmers have access to a mobile phone. This will reduce the cost of transport or time spent getting information. Farmer will be empowered as they will have the means to directly interact with a wide range of potential customers and hence will be able to choose the best offer or negotiate the best deal.

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APPENDICES

APPENDIX A (I): STUDENTS' QUESTIONNAIRE

Wednesday, 25 August 2010

Dear Student,

Thank you for completing this questionnaire. It will be used as data for a pilot study towards a masters degree. Your participation in this survey is voluntary.

Kind regards

Marie-Louise Iraba

1. What is your home province?

   Western Cape ☐ Eastern Cape ☐ Northern Cape ☐ Others ☐

2. How many people are in your immediate family (live with you at home)?

   ☐

   Fill the number in the above box.

3. How many cell phones do you have in your family? Indicate with X or fill in

   ☐ NoSne ☐ 1cell phone ☐ 2 cell phones Fill in the number ☐

4.(a) What do you (not your family) use your cell phone for? (You can tick more than one box.)

Making calls:	Yes	☐	No	☐
Sending SMS:	Yes	☐	No	☐
Please call me	Yes	☐	No	☐
Accessing Internet:	Yes	☐	No	☐

(b) Estimate the following:

Cell phone expenses (for calls) per month: R ☐

Approximate number of SMS per week: ☐

Approximate number of Please call me's per week: ☐

5. To your knowledge what do your family use their cell phones for mostly?

Making call:	Yes	☐	No	☐
Sending SMS:	Yes	☐	No	☐
Please call me:	Yes	☐	No	☐
Accessing Internet:	Yes	☐	No	☐

6. (a) Where is your home? (please tick)

On a farm: ☐ In the city: ☐ In a small town: ☐ In a rural area: ☐

(b) If you are from small town, a farm or a rural area can you access the Internet in your area apart from using your cell phone?

Yes ☐ No ☐

(c) If yes, where _____

and how much does it costs per hour? R _____

7. If you are from a farm or rural area –

(a) What are the main crops cultivated in your area?

_____
_____
_____
_____

(b) What are the main crops sold on your local market?

_____
_____
_____
_____

APPENDIX A (II): STUDENTS' INTERVIEW

29 September 2010 at 4:30 p.m.

I am looking at the usage of cell phones by rural area students from the Eastern Cape Province. Some following questions concerning the Eastern Cape:

I: What is your home district?

I: Do you have farmers people in your home district?

I: which kind of food do farmers cultivate there?

I: How do farmers sale or else keep their crops especially perishable products.

I: How do farmers manage to find a remunerable market for their produce?

I: What is the many challenge faced by farmers

I: Is there some business?

I: Let's talk about cell phone telecommunication in your home district. Does every adult person (at least a person who has 15 ages and above) own cell phone?

I: If you look the majority people, do the majority persons have cell phone?

I: Which kind of cell phone the majority owners have?

I: Looking at literacy of people, do the majority of people in your community know how to read and write?

I: is it possible to access Internet there?

I: Concluding remarks: Thank you for helping me.

31st September 2010 in Afternoon

Interview conducted with first year students from Eastern Cape on information pertaining farming activities in their community, the usage and cost of cell phone as well as the business which is there.

I: How often do you have access on Internet at home?

I: When you look in area what is the percentage of people who have cell phone which can use Internet?

I: Which type of business do you think is the most successful in your area? And are there other small businesses?

I: How most people get information about the market, such as price of commodities?

I: What mostly people use their cell phone for, in rural area?

APPENDIX B: FARMERS 'QUESTIONNAIRE

Questionnaire Number:

University of the Western Cape

Departments of Computer Science

DearSir/Madam,

Thank you for completing this questionnaire. It will be used as data for a pilot study towards a masters degree. Your participation in this survey is voluntary.

Kind regards

Marie-Louise Iraba

Please answer the questionnaire by circling the selected answers on the questionnaire.

1. Are you a boy (male) or a girl (female)?

Boy/Male	A
Girl/Female	B

2. How old are you?

15 or younger	A
16- 30	B
31or older	C

3. How do you access to the Internet? using::

Mobile phone	A
Cyber café	B
Other manner	C

4. How often do you use a Internet?

Often	A
Sometimes	B
Seldom	C

5. Do you have your own Mobile phone?

Yes	A
No	B

6. Have you Heard about USSD (unstructured Supplementary Services Data) word?

Yes	A
No	B

7. What do you mostly use your cell phone for::

Making call	A
Sending SMS	B
Accessing Internet	C
Send Please call me	D
Playing Games	E

8. Howmuch money do you spend per week?

Marking call	
Sending SMS	
Accessing Internet	

9. What are the main crops cultivated in your area?

Maize	A
Cabbages	B
Banana	C
Others	D

If you circled D - "Another Crops",
PLEASE fill the crops

_____

10. What are the main crops sold on your local market?

Maize	A
Cabbages	B
Banana	C
Others	D

If you circled D - "Another Crops",
PLEASE fill the crops

_____

11. How do you get information about the price on the market in your area?

Radio	A
TV	B
Cell phone	C
Internet	D
On the place	E
Others	F

If you circled F - "Another Crops",
PLEASE fill it

_____

12. How many cell phones do you have in your family?

Thank you for your cooperation.

Regards
Louise

APPENDIX C (I): FIRST YEAR & POSTGRADUATE STUDENTS' QUESTIONNAIRE TO EVALUATE PROTOTYPE (CYCLE ONE)

Questionnaire Number:

University of the Western Cape

Departments of Computer Science

Dear Student,

Thank you for volunteering to complete this questionnaire. The data collected will be used for a pilot study towards a master's degree. Your participation will be highly appreciated.

Please answer the questionnaire by selecting and circling the answers on the questionnaire.

SECTION A:

PERSONAL DETAILS

1. Select your gender

Male	A
Female	B

2. Where do you live?

Town	A
Small village	B
On a farm	C

3. How old are you?

18 or younger	A
19 - 25	B
26 - 40	C
41 - above	D

4. Select your home province

Western Cape	A
Eastern Cape	B
Northern Cape	C
Other	D

SECTION B:
QUESTIONS ABOUT WEBISITE

1. How do you find the process of posting the commodities?

Very easy	A
Easy	B
Moderate	C
Difficult	D
Very difficult	E

Why is it so? _____

2. How do you find the process of checking the prices and seller's detail?

Very easy	A
Easy	B
Moderate	C
Difficult	D
Very difficult	E

Why is it so? _____

3. How useful do you think capability of sending email and SMS?

Very useful	A
Useful	B
Moderate	C
useless	D

Any comments or recommendations

_____

4. How do you find the processes of sending email and SMS?

Very easy	A
Easy	B
Moderate	C
Difficult	D
Very difficult	E

Any comments or recommendations

_____

5. Do you have any comments or recommendations for improving the website?

_____

6. Are there any other capabilities you wish could be added?

_____

SECTION C:
QUESTIONS ABOUT CELL PHONE APPLICATION

1. How could you describe USSD (unstructured Supplementary Services Data) is?

_____

_____

2. Do you use your cell phone for sending "Please call me's"?

Yes	A
No	B

3. Do you use your cell phone for checking your available airtime?

Yes	A
No	B

Next step: back on our prototype

4. How do you find the process for checking price on the market?

Very easy	A
Easy	B
Moderate	C
Difficult	D
Very difficult	E

Why is it so? _____

5. How do you find the process for checking seller's details to you?

Very easy	A
Easy	B
Moderate	C
Difficult	D
Very difficult	E

6. How do you find the process of sending SMS to sellers?

Very easy	A
Easy	B
Moderate	C
Difficult	D
Very difficult	E

7. Do you have any comments or recommendations for improving the system?

_____

8. Are there any other capabilities you wish could be added?

_____

Thank you for your assistance
Regards
Louise

APPENDIX C (II): POST GRADUATE STUDENTS' INTERVIEWS TO EVALUATE PROTOTYPE (CYCLE ONE)

- Having tested the system, post graduate students were asked to identify its weaknesses and strengths in terms of design, process and efficiency. Here are the responses extracted from the interviews:

- The application currently supports only one platform; Nokia, there is no help functionality on the mobile application which is very important for users. But the strengths include good performance and reliability which means that the speed is totally normal and everything works.
- The application supports only one type of relational database. The user asks if the application could be developed in oracle to identify other functionalities. However the prototype is effective and also efficient, I really appreciate the prototype.
- About weakness: there is no reference technical manual documentation and no users guide the on mobile application. The strengths: The thing which is good is that the application supports different browsers and it has multi functionality.
- I think there are no weaknesses. The first strength is security; you can't access the database without authenticating your username and password, and the second is model, simplicity and familiar, there is no steep learning curve for the farmers and they are happy with the application.
- One weakness is that the website design is bad and you must add categories of crops. Strength is that you can be able to communicate with buyer and seller via SMS and Email.
- The website is has limitation because it does not show areas. You can use Google map to find the seller location. It advantage is that you can find people using searching option which is an easy way.
- There is no help on mobile application. It strength is that the application uses a cell phone; it's easy for users to navigate using their own cell phone.
- The application works only with WIFI. On USSD menu you can add back option like the way you put on command. The strength is that it is not complex; it is easy to use and easy to learn.
- Improve the search option and compatibility on cell phone.
- It's good application more access can save time and the transport money. The weaknesse is that it lacks record of time when advert were posted on website e.g. posted two days ago.

- Do you think the system will be user friendly enough for farmers in the Eastern Cape who might not be very computer literate? Do you think they will be able to use it effectively?

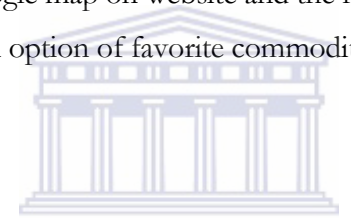
- Yes, most farmers are eager to learn any tool that can contribute productively to their course.
- Yes, simplicity of the design allows any literate and most illiterate to easily learn and use it.
- Learnability is excellent (straight forward).
- I can't tell you that many people buy a cell phone without guide book, in few days they know to use, do you think is strange? No training, nothing evens the people who do not know how to write.
- Yes, I think most of farmers are familiar with USSD, they use USSD and that will make it to be more users friendly.
- Yes, now the farmers will have skills of how to use cell phones and also computers.
- Yes and No, most farmers don't like the revolutionary things, they stick to their own ideas generation to generation and also like to much their tradition to add some changes to their own current work, I don't think that can work, they may be reluctant to involve cell phone technology and applications in their farming activities. The way the farmer maybe can be interested is for them to find or post information of their produces without loosing time or traveling.

- Do you think this system will be useful and will assist farmers with the marketing of their produce? Please explain your answer.

- The system solves a major problem that has affected farmers (mostly South Africa) for a long time now which is how sell to the market their produce and raise awareness, enough to bring in more demand.
- Yes, because it will update them on prices and different information.
- Yes, it should give them a new opportunity and a new dimension to buy and sell without using new paper, radio...
- Yes, because everyone has cell phone and they will need to check some adverts
- It will be useful, helpful to them, they will have the market system.

- What do you think can be done to improve the system (in terms of design and functionality)?

- First put functionality of payment using airtime to buy some commodities.
- Put my favorite commodities when I want to check without scrolling all list of commodities.
- Size and type of fonts, also help buttons
- More visually pleasing color (the combination can be better specially the background with food produce as icons).
- On the menu you can add website when you click to the option it will go on home page of website
- Make the application work on all phone.
- On website put option of adding pictures of commodities.
- Give us enough information concerning the prices depending of period even the graphs if it's possible.
- Classifying the area using Google map on website and the help option on cell phone application.
- Add on cell phone application option of favorite commodities just it must display the commodities which I like.



APPENDIX D: SECOND YEAR STUDENT' QUESTIONNAIRE TO EVALUATE PROTOTYPE (CYCLE TWO)

Questionnaire Number:

University of the Western Cape

Departments of Computer Science

Dear Student,

Thank you for volunteering to complete this questionnaire. The data collected will be used for a pilot study towards a master's degree. Your participation will be highly appreciated – your response is totally anonymous,

Please select and circle the appropriate answers on the questionnaire.

SECTION A:

PERSONAL DETAILS

6. Select your gender.

Male	A
Female	B

7. Where do you live?

In a town	A
In a small village	B
On a farm	C

8. How old are you?

18 or younger	A
19 -25	B
26 -40	C
41 - above	D

9. Select your home province.

Western Cape	A
Eastern Cape	B
Northern Cape	C
Others	D

If *other* please fill in_____

SECTION B:
QUESTIONS ABOUT WEBSITE

2.How do you find the process of posting the commodities?

Very easy	A
Easy	B
Moderate	C
Difficult	D
Very difficult	E

If you chose difficult (D or E), why is it so?

_____

3.How do you find the process of searching the commodities?

Very easy	A
Easy	B
Moderate	C
Difficult	D
Very difficult	E

If you chose difficult (D or E), why is it so?

_____

4. How difficult do you think the process of searching for a price is?

Very easy	A
Easy	B
Moderate	C
Difficult	D
Very difficult	E

If you chose difficult (D or E), why is it so?

_____

5. How difficult do you think the process of sending an SMS is?

Very easy	A
Easy	B
Moderate	C
Difficult	D
Very difficult	E

If you chose difficult (D or E), why is it so?

_____

6.How difficult do you think the process of sending email is?

Very easy	A
Easy	B
Moderate	C
Difficult	D
Very difficult	E

If you chose difficult (D or E), why is it so?

_____

7.How useful do you think it would be if the user could send an email from the website?

Very useful	a
useful	b
Moderate	C
useless	D

Any comments or recommendations?

_____

8.How useful do you think it would be if the user could send SMS's from the website?

Very useful	a
useful	b
Moderate	C
useless	D

Any comments or recommendations?

_____

8. Do you have any comments or recommendations to improve the website?

_____

_____

9. Are there any other functionalities you think should be added?

_____

_____

_____

SECTION C:
QUESTIONS ABOUT THE CELL PHONE APPLICATION

3. How would you describe USSD (unstructured Supplementary Services Data)?

_____

_____

4. Do you use your cell phone for sending “Please call me’s”?

Yes	A
No	B

9. Do you use your cell phone for checking your available airtime?

Yes	A
No	B

10. How do you find the process for checking a price on the market?

If you chose difficult (D or E), please inform why you think so?

_____

_____

Very easy	A
Easy	B
Moderate	C
Difficult	D
Very difficult	E

11. How do you find the process for checking the seller‘s details?

Very easy	A
Easy	B
Moderate	C
Difficult	D
Very difficult	E

12. How do you find the process of sending an SMS to the sellers?

13. How do you find the process of posting commodities?

Easy	B
Moderate	C
Difficult	D
Very difficult	E

14. Do you have any comments or recommendations for improving the prototype?

_____

_____

15. Are there any other capabilities that should be added?

_____

_____

Thank you for your assistance
Regards
Louise

APPENDIX E: DATA DICTIONARY

Class Category

Name	Description	Data Type	Example
IdCategory	Identification of category	Integer	302
Name	Name of category	String	Vegetables

Class Product

Name	Description	Data type	Example
IdProduct	Product identification	Integer	209
IdCategory	Identification of category	Integer	302

Class Advert

Name	Description	Data type	Example
IdAdvert	Advert's identification	7 numbers	1234959
IdProduct	Product's identification	20 Characters	Miss
IdUser	Seller's identificastion	20 Characters	Sara
Description	Description	String	New version
Quantity	Quantity of product	integer	50kg
Date	Date of expiration	Date	12/10/2010

Class user

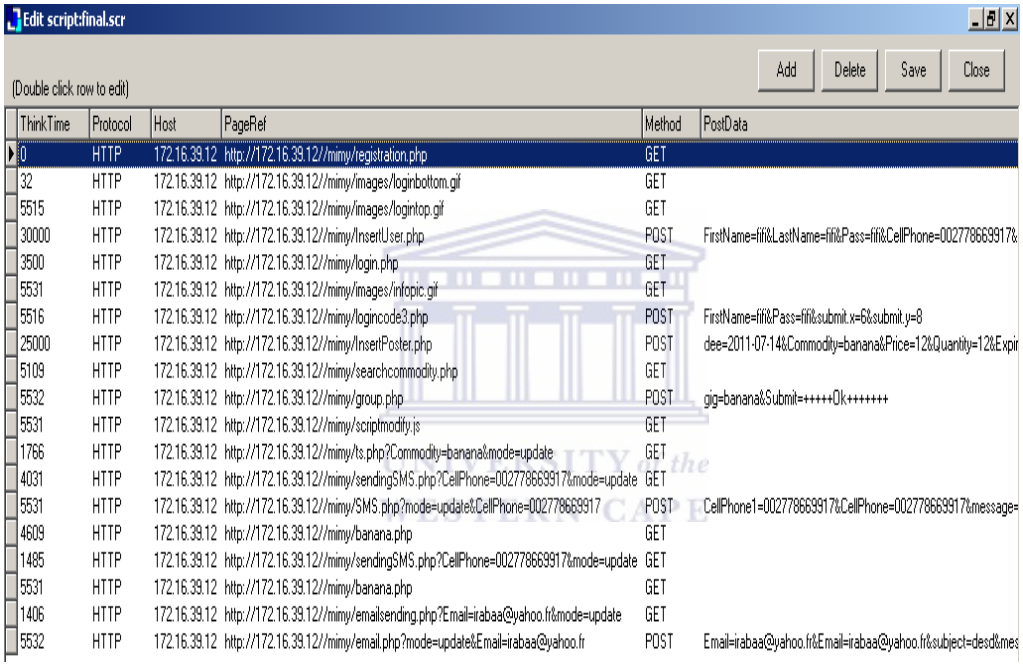
Name	Description	Data type	Example
IdUser	User identification	7 numbers	12349
Title	User 's title	20 Characters	Mr
Surname	Last name of the student	20 Characters	Bosco
Name	First names of student	20 Characters	David
Gender	seller's gender coded M (Male), F (Female)	20 character	Male

Class Tariff

Name	Description	Data type	Example
IdTariff	Tariff identification	111 numbers	12349594544
IdProduct	Product identification	Integer	209

APPENDIX F: COMPATIBILITY TESTING

The DieselTest tool was used to evaluate the web application's ability to handle several users simultaneously over an extended period of time.

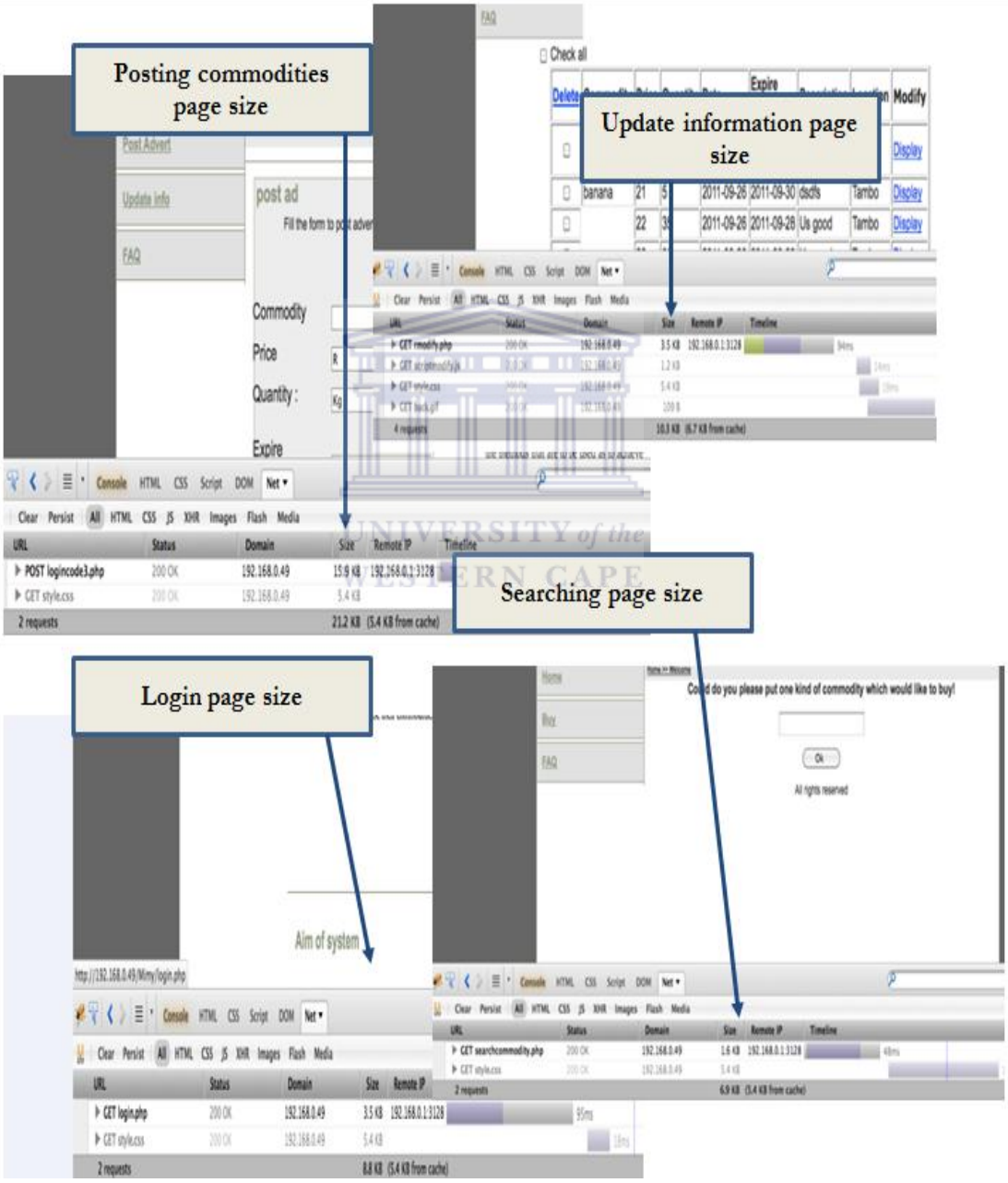


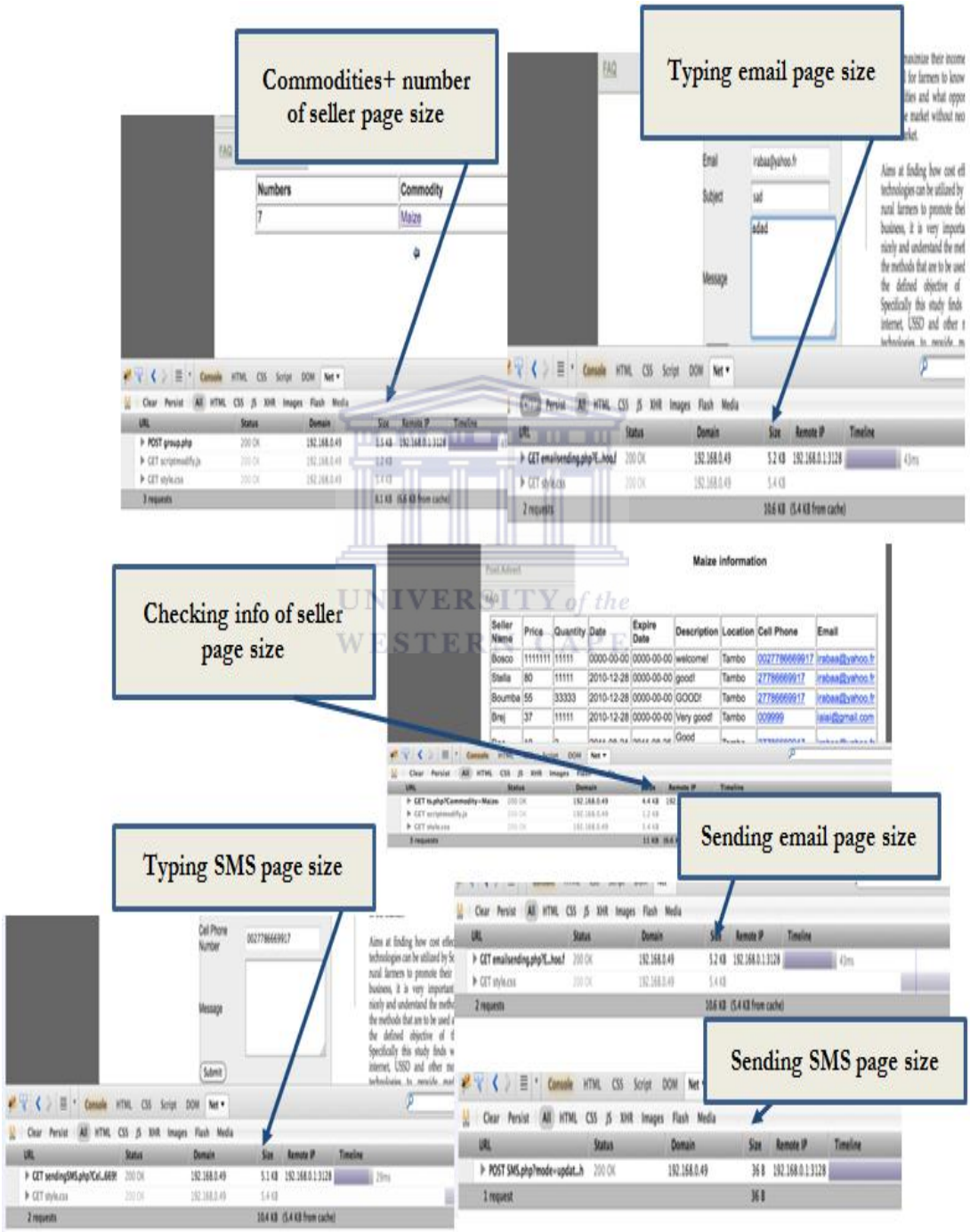
ThinkTime	Protocol	Host	PageRef	Method	PostData
0	HTTP	172.16.39.12	http://172.16.39.12//mimy/registration.php	GET	
32	HTTP	172.16.39.12	http://172.16.39.12//mimy/images/loginbottom.gif	GET	
5515	HTTP	172.16.39.12	http://172.16.39.12//mimy/images/logintop.gif	GET	
30000	HTTP	172.16.39.12	http://172.16.39.12//mimy/InsertUser.php	POST	FirstName=fifi&LastName=fifi&Pass=fifi&CellPhone=002778669917&
3500	HTTP	172.16.39.12	http://172.16.39.12//mimy/login.php	GET	
5531	HTTP	172.16.39.12	http://172.16.39.12//mimy/images/infopic.gif	GET	
5516	HTTP	172.16.39.12	http://172.16.39.12//mimy/logincode3.php	POST	FirstName=fifi&Pass=fifi&submit.x=6&submit.y=8
25000	HTTP	172.16.39.12	http://172.16.39.12//mimy/InsertPoster.php	POST	dee=2011-07-14&Commodity=banana&Price=12&Quantity=12&Expir
5109	HTTP	172.16.39.12	http://172.16.39.12//mimy/searchcommodity.php	GET	
5532	HTTP	172.16.39.12	http://172.16.39.12//mimy/group.php	POST	gig=banana&Submit=+++++Ok+++++++
5531	HTTP	172.16.39.12	http://172.16.39.12//mimy/scriptmodify.js	GET	
1766	HTTP	172.16.39.12	http://172.16.39.12//mimy/ts.php?Commodity=banana&mode=update	GET	
4031	HTTP	172.16.39.12	http://172.16.39.12//mimy/sendingSMS.php?CellPhone=002778669917&mode=update	GET	
5531	HTTP	172.16.39.12	http://172.16.39.12//mimy/SMS.php?mode=update&CellPhone=002778669917	POST	CellPhone1=002778669917&CellPhone=002778669917&message=
4609	HTTP	172.16.39.12	http://172.16.39.12//mimy/banana.php	GET	
1485	HTTP	172.16.39.12	http://172.16.39.12//mimy/sendingSMS.php?CellPhone=002778669917&mode=update	GET	
5531	HTTP	172.16.39.12	http://172.16.39.12//mimy/banana.php	GET	
1406	HTTP	172.16.39.12	http://172.16.39.12//mimy/emailsending.php?Email=irabaa@yahoo.fr&mode=update	GET	
5532	HTTP	172.16.39.12	http://172.16.39.12//mimy/email.php?mode=update&Email=irabaa@yahoo.fr	POST	Email=irabaa@yahoo.fr&Email=irabaa@yahoo.fr&subject=desd&mes

Figure 42: Stress testing report

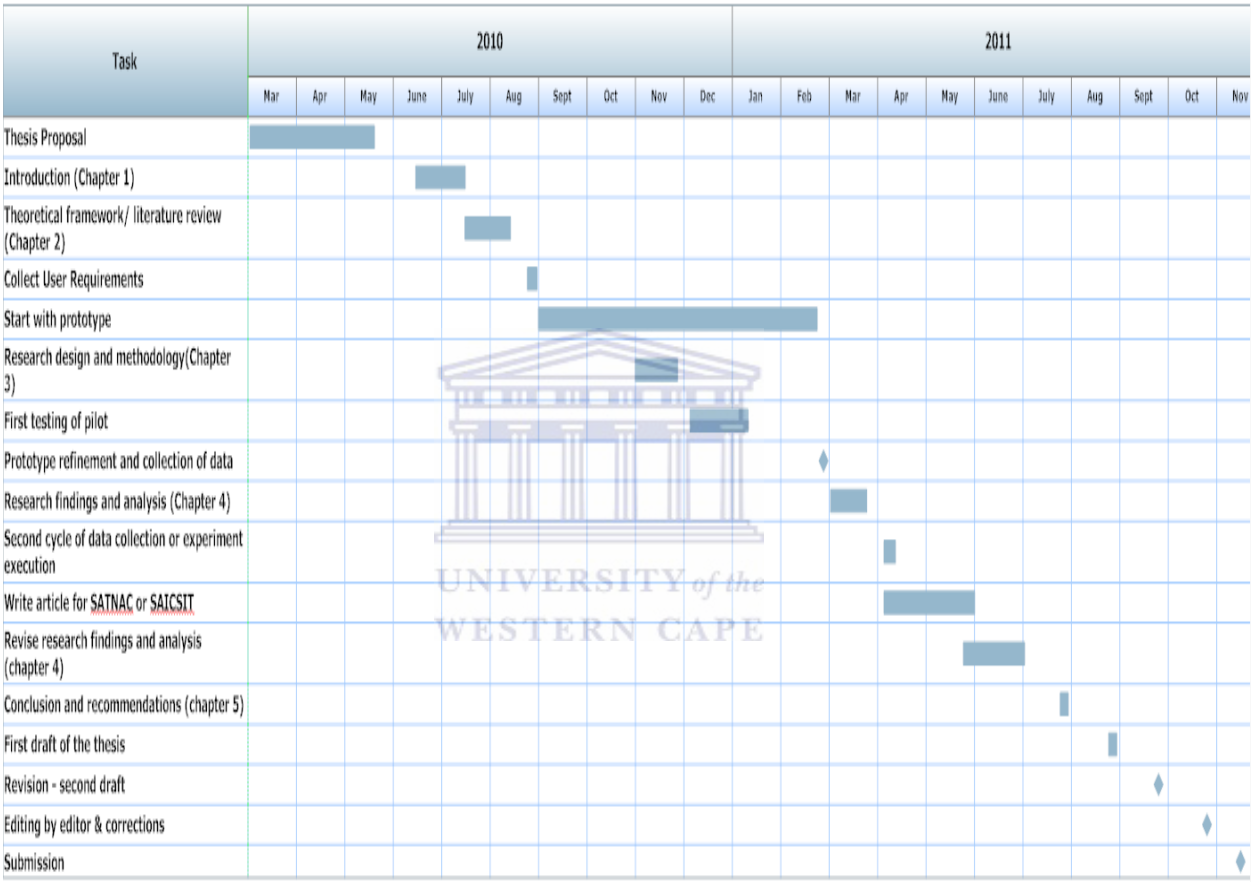
In this test, 50 users were simulated to be using the system simultaneously the test gave a Processor think time of 120 seconds (2 minutes).

APPENDIX G: THE SIZING OF PAGES IN WEB APPLICATION




Commodities+ number of seller page size
Typing email page size
Checking info of seller page size
Typing SMS page size
Sending email page size
Sending SMS page size
Maize information

APPENDIX H: TIME TABLE



PUBLICATIONS

Two papers were published based on this thesis they can be found at the following pages:

INDEX

P

Q

R

S

T

U