UNIVERSITY OF KWAZULU-NATAL

Enhancing Access to Socioeconomic Development Information using Mobile Phone Applications in rural Zimbabwe: The case of Matabeleland South Province.

By

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A thesis submitted in fulfillment of the requirements for the degree

of

Doctor of Philosophy

In Information Systems & Technology

School of Management, IT and Governance

College of Law and Management Studies

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2018

Declaration

I Vusumuzi Maphosa declare that

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Acknowledgements

The completion of my thesis was made possible through the support that I received from my supervisor, Professor Manoj Maharaj. I would like to thank him by expressing my appreciation for his ideas, time, patience and enthusiastic guidance that was offered throughout the process.

To my friends – Mr Ishmael Muzika, Mr Mhlupheki Dube and Ms Prestage Murima – who were involved in regular discussions regarding this work, I thank them for their insightful comments and suggestions. My appreciation also extends to family members, including my wife and children – whom I denied family time – and my mother and siblings. I would further like to thank those many others who provided moral and financial support for me to progress and finish my studies. This accomplishment is dedicated to my late father, who could not witness another milestone in my life.

Very special thanks go to the University of KwaZulu-Natal for providing the opportunity for me to attend summer school in France. This study was exciting, intriguing and often challenging. Its completion was made possible by many people, including the Bulilima district leadership and its community members, who were involved in the research. Finally, I would like to express a special appreciation to God for the strength I received and for helping me to come in contact with the people who assisted me through this journey.

Abstract

Mobile phone access has grown exponentially, transforming access to information and communication in Africa. Mobile phone penetration has increased dramatically across the urban-rural, rich-poor and literate-illiterate divides, which other technologies failed to bridge. The number of mobile phone subscriptions grew astronomically, from less than two million in 1998 to more than 620 million subscribers in Africa (Carmody, 2012). Internet users grew 85-fold from 4.5m users in 2000 to over 388m users in Africa at a rate higher than any other region (Internetworldstas, 2018).

Global mobile app downloads have reached 175 billion in 2017, generating more than $85 billion, yet most African countries possess an insignificant share of this, due to low literacy levels, low economic opportunities and an infrastructure that is still developing (The Guardian, 2014; Perez, 2018). The growing presence of mobile phones must be harnessed to enhance access to socioeconomic information, in order to improve standards of life in the global south. Scholars and communication enthusiasts have argued that simply providing access to the internet, without considering the relevance of content, will not change the fortunes of rural communities (Internet.org, 2014; GSMA, 2015). There is the need to provide localised and relevant content – such as local news, market prices and bus timetables – to these communities. This research resonates with Goal 9 of the Sustainable Development Goals, which seeks to increase access to information and communication technology, and provide universal and affordable access to the internet in least developed countries by 2020 (UN, 2016).

In Zimbabwe, radio and television are basic technologies used for disseminating socioeconomic information, yet most of the rural communities have no access to radio and television signals, 37 years after independence. Rural mobile phone ownership is about 80%, and broadband penetration is 46.5% (ITU, 2013). In addition, Zimbabwe's average rural literacy is about 90%. These two factors – high rural literacy levels and high rural mobile phone ownership – motivated the researcher to develop a mobile phone application prototype that could be utilised by rural communities to enhance their access to socioeconomic development information that could, in turn, anchor sustainable development. The mobile phone application prototype has the potential to provide a new platform for accessing socioeconomic development information in the rural areas of Zimbabwe, including information on agriculture, health, community activities, education and the markets, plus local and national news. These can all promote sustainable development.

The study followed a seven-cycle design science research methodology, from problem identification to communicating the utility of the aertefact which guided the development of the mobile phone application (Hevner, 2007). The development of the prototype followed a user-centred design, as well user experience, where high-fidelity prototypes were presented to participants selected through a random sample to be part of the development process. This process is iterative, incorporating user feedback and redesign of the prototype until the users and developers agree on the design. After designing the prototype, participants were randomly selected to evaluate the mobile phone application prototype using an adapted TAM2, whose main constructs relate to perceived usefulness and ease of use (Davis, 1989).

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List of abbreviations

APF - African Partnership Forum

AREX - Agricultural Extension workers

DSRM - Design Science Research Methodology

FAO - Food and Agricultural Organisation

FDI - Foreign Direct Investments

G2P - Government to Person

GDP - Gross Domestic Product

GPS - Global Positioning Systems

GSMA - Groupe Spéciale Mobile Association

HTTP - Hyper Text Transfer Protocol

ICT - Information and Communications Technology

IoT - Internet of Things

ISO - International Standardization Organisation

ITU - International Telecommunications Union

IVR - Interactive Voice Response

JSON - JavaScript Object Notation

MNO - Mobile Network Operators

NGO - Non-Governmental Organisations

P2P - Person to Person

PHP - Hypertext Pre-processor,

POTRAZ - Postal and Telecommunications Regulatory Authourity of Zimbabwe

RDBMS - Relational Database Management System

SCT - Social Cognitive Theory

SQL - Structured Query Language

SMS - Short Message Service

SPSS - Statistical Package for Social Sciences

TAM	- The Technology Acceptance Model
TRA	- Theory of Reasoned Action
UCD	- User Centred Design
UN	- United Nations
UNDP	- United Nations Development Programme
USF	- Universal Service Fund
WHO	- The World Health Organisation
ZIMASSET	- Zimbabwe Agenda for Sustainable Socio-Economic Transformation

Chapter 1: Introduction

1.1 Introduction and background

In his address in 2011, the United Nations (UN) Secretary-General noted that concerted effort in improving the digital divide would result in the narrowing of the chasm between the rural poor and the urban rich, through the broadening of opportunities to rural communities, to improve their lives through Information and Communications Technology (ICT) (Dzenowagis, 2011). ICTs alone will not bring about socioeconomic transformation but can bridge the isolation and remoteness that rural communities face due to barriers such as roads, transport as well as improving communication and access to information (Meshur, 2012). Diso (2005) concluded that ICTs had begun to play an important role in our everyday lives and it was almost inconceivable that humans could survive without this technology. Twelve years after this profound statement, the ubiquitous presence of the mobile phone has presented new opportunities for communication, access and sharing of information, thus making humanity dependent on these devices in order to make any progress. The expansion of mobile phone infrastructure addresses Sustainable Development Goals (SDG 9) directly and the provision of other services allows mobile phones to address SDG 1 (which relates to increased access to health information), SDG 3 (which relates to financial inclusion) and SDG 5 (which speaks to gender equality) (GSMA, 2017). In 2005, the UN Secretary-General highlighted that yearning for technology was no longer enough; it was now about what technology could do and make possible for humanity (Annan, 2015). The UN has declared unrestricted access to the internet and online content a human right, and the availability of infrastructure that supported access to the internet was a priority area for all states, in order to support freedom of expression (UN, 2011).

For developing nations, the idea that wider access to, and the use of ICTs had the potential to reduce broader inequalities in terms of access to information and improve quality of life for rural communities was compelling. Addressing delegates at a summit in India, whose theme tackled the lack of relevant local content online for most developing countries, Facebook CEO Mark Zuckerberg said: “Simply providing access to the internet will not be enough if devices cannot support local languages and relevant content is not available” (Internet.org, 2014). The United Nations Educational, Scientific and Cultural Organization (UNESCO) has partnered with other organisations in 25 countries to train young people to promote the development of locally relevant mobile applications that ensure creative and innovative ways to sustain socioeconomic development (Jemni & Khribi, 2017). The Global System for Mobile communication (GSM) group reported that many in the global south were yet to experience the benefits of mobile phone technologies and there was therefore the need for a multi-faceted approach to develop services that would reach greater numbers of people and result in improvements to their socioeconomic environments (GSMA, 2017).

Historically, rural communities in sub-Saharan Africa have faced many challenges, including lack of access to telecommunications networks, low literacy, poor road networks, difficulties in marketing their produce and lack of access to information related to their health (African Monitor, 2012). This translates to information poverty, with communities denied access to information, thereby diminishing opportunities for socioeconomic, political and educational advancement, as well as self-emancipation. According to Yu, (2006) information poverty is associated with information deprivation, inequality in terms of access, the digital divide and the information gap. Poor telecommunications and an inadequate road network infrastructure in Africa has hindered development, but the advent of mobile phones has the potential to spur socioeconomic growth through the exchange of vital information in communities (Ngumbuke, 2010).

The World Bank has concluded that the Gross Domestic Product (GDP) per capita would rise by 1.5% points, through a 10% increase in broadband penetration, while a causal relationship was observed with every 1% increase in mobile phone penetration, resulting in 0.03% growth in GDP (May & Adera, 2011; World Bank, 2015). Economist magazine editor Tom Standage noted that the mobile phone had become the biggest technology story of the 21st century and the most transformative tool for development (ITU, 2013). Improved access to, and use of mobile phones in many rural villages in Africa has the potential to directly impact local socioeconomic development, as it can allow, for example, access to financial and health information via mobile phones (Damasen & Uhomoibhi, 2014). The increase in mobile network coverage in developing countries could enable rural farmers and development work agents to share information and instantly access market information (Smith & Elder, 2010). Jahangirian, Taylor and Simon (2013) noted that effective mobile phone communication had a strong correlation with the cost of data, voice services and the user-friendliness of devices.

Through ICTs, rural communities of Africa can connect some of the most remote villages to global markets and allow agricultural extension workers to access the latest information and disseminate it to communities. ICTs have been used to disseminate important information to farmers, pertaining to the weather and the fight against pests and animal disease, and they have the potential to transform agriculture from being input-driven to knowledge-based (FAO, 2013). The exponential growth of the telecommunications sector in Africa, especially mobile technology, has the capacity to drive development in rural communities. Some scholars noted that ICTs have the potential to drive socioeconomic development that can help poor rural and disadvantaged communities by offering opportunities that increase their access to markets, health, and education (Musingafi, Dumbu, & Dube, 2011). In Ethiopia, in some communities that are extremely poor and have no schools and teachers, mobile phone tablets have enabled children who had never seen printed material to learn the alphabet on their own (Talbot, 2012).

This research focused on Zimbabwe's Matabeleland South province, one of the 10 administrative provinces in the country, which falls in region five and is located in the south and south-western parts of the country. The country has five agro-ecological regions, referred to as natural regions, mainly classified in terms of rainfall patterns, soil quality and vegetation (FAO, 2006). Region five is very dry, with the lowest annual rainfall in Zimbabwe of less than 650mm per year. The rains are highly erratic and inadequate, thus unable to support cropping and other agricultural activities. The soils in the region are poor, making them unsuitable for crop production, which is generally the main source of livelihood in most rural regions. The province covers 54,172 square kilometres and has seven districts – Gwanda, Bulilima, Mangwe, Beitbridge, Umzingwane, Insiza and Matobo (Zimstats, 2013). The research focused on Bulilima district, which is located about 120km south of Zimbabwe' s second-largest city, Bulawayo. The lack of economic activity, poor soils, severe droughts and access to agricultural and developmental information are among the factors contributing to weak economic activity in this province, which consequently leads to impoverishment experienced by communities.

Many scholars and development agents have recognised the importance of access as the first step in helping the poor to acquire information that is crucial to improving their livelihoods (McNamara, 2009). Mobile phone penetration in Zimbabwe was 103.5% in 2013, according to statistics released in 2013 and by end of 2017 it had marginally dropped to 100.5% (ITU, 2013, POTRAZ, 2107). This implies that most rural communities in Zimbabwe now have access to mobile phone telecommunication signals and are utilising mobile phones. Most entry-level android mobile phones have the capacity to connect to the internet and allow users to access vast amounts of data. These phones, once predominantly found in urban centres, have found their way into rural areas. Internet usage in Zimbabwe has grown more than ten-fold in the past decade due to the continuous growth in mobile phone usage, this has seen this usage percentage level rising to 49.5% in 2017, with more than eight million internet users, compared to less than a million users in 2006 (ITU, 2013; POTRAZ, 2017).

Improving access to telecommunications infrastructure results in improved access to information on basic services, such as education and health, plus the weather, the stock market, environmental protection and political situations (Song & Cornford, 2006; Tugnayat, Regulwar, & Tugnayat, 2012). The traditional means of disseminating agricultural and developmental information in Zimbabwe has been through radio and television broadcasts. Most communities in Matabeleland South have no access to radio and television signals, and therefore find themselves excluded from participation in the socioeconomic development of their own country. Over the years, telecentres have been established in many countries to help communities access computers and the internet to access a variety of information such as agricultural information, market information, government and other services as well as email communication (Pick, Gollakota, & Singh, 2014). Unavailability of telecentres in most rural districts of Zimbabwe motivated the development of app which provides access to these services.

The Zimbabwean government has never opened the airwaves to private players to participate in the broadcasting industry and, in 2018, 38 years after independence, the country still has just one television station. This has resulted in limited investment in broadcasting equipment and a lack of access for many rural communities to national news and knowledge of national issues. Not having access to radio and television signals is a gross violation of human rights (News Day, 2016). The use of mobile phones as an alternative source of information in the rural districts of Matabeleland South province has the potential to enable access for rural communities to vital socioeconomic information. The role of ICTs as an economic enabler appears in the Zimbabwe Agenda for Sustainable Socio-Economic Transformation (ZIMASSET), a blueprint that aligns all socioeconomic development endeavours. It highlights the critical requirement for ICT infrastructure investment, such as a fibre network rollout and improved mobile phone coverage and services (Zim-asset, 2013).

The International Telecommunication Union (ITU) reported that internet users had reached 4.3 billion by end of 2017, with 70% of internet users coming from developing countries, accounting for 55% of global broadband subscribers (ITU, 2017). This positive outlook is due to a forecast that rural areas in Africa would access the internet through their mobile phones, resulting in significant socioeconomic activities, accompanied by employment and provision of services (Wamuyu & Maharaj, 2011). Mobile phones are reaching residents in Africa's cities, towns, villages and rural areas more rapidly than anywhere else in the world, with the promise of a reduction in the digital divide. One of the top indices employed to measure socioeconomic development is access to information, which enables citizens to make informed decisions (Aker & Mbiti, 2010; World Bank, 2015; Alderete, 2017). According to the ITU, (2014) mobile phone penetration rates in Africa have reached more than 69%, compared to 0.5% penetration rates for fixed landline telephones. This reveals the rapid growth of mobile phone infrastructure in Africa, at a rate higher than anywhere else in the world.

There has been debate as to whether it is possible to narrow the digital divide to enable poor, marginalised rural communities to join the information superhighway and access appropriate information for their development (Tugnayat, Regulwar, & Tugnayat, 2012). The continuous growth in mobile phone access partly answers this debate, as the infrastructure is easy to deploy and access, and simple to use. Narrowing the digital divide serves to redefine social interactions and trade and commerce at a global level, by offering opportunities to reduce poverty and accelerate socioeconomic development (Junghoon, Dulal, Hyoung, & Shin., 2012). In Africa, it has been noted that improved mobile phone access and applications are beginning to positively impact business endeavours – specifically through mobile money schemes – and enhance democracy, through election monitoring, with pilot studies for mobile voting having been carried out in countries such as Kenya, Nigeria and Ghana (Mpekoa, 2014). Very few studies, however, have been undertaken in Zimbabwe that relate to the use of mobile phone applications as a tool for improved access to socioeconomic information that assists rural livelihoods and enhances development. Mobile phone coverage began to reach rural communities in Zimbabwe over the last seven years and some of the country's most remote communities have yet to be connected.

Existing studies support the use of ICTs to extend information access and communication in developing countries, resulting in improved efficiency in business, by lowering communication costs, improved access to markets and financial inclusiveness, access to education and health information (Gumede, Plauche, & Sharma, 2008; Aker & Mbiti, 2010; Ngassam, Ntawanga, & Eloff, 2013). ICTs and the internet can improve agricultural productivity in rural communities by allowing farmers to access to information that enable them to make decisions that impact on profitability and productivity (Zhao, 2008; Boateng, 2012). Other researchers have noted that access to information related to markets, weather, health, education, politics and governance play an important role in fostering socioeconomic development (Smith & Elder, 2010; Aker & Mbiti, 2010; Yeo, Hazis, Zaman, Songan, & Hamid, 2011; and Tugnayat, Regulwar, & Tugnayat, 2012; Deen-Swarray, Moyo, & Stork, 2013; Shambare, 2014). Development agencies have implored developing countries to invest in ICTs to address some socio-economic development problems, related to poor access to information related to health, financial and markets (Zhao, 2008; World Bank, 2011; FAO, 2013). In developing countries, many people have access to mobile phones than to other services such as clean water, electricity and shelter (World Bank, 2016). ICTs are not the panacea for socioeconomic development, but must complement other sectorial services to ensure full socioeconomic emancipation of rural communities.

1.2 Research problem

Lack of socioeconomic development in rural areas is attributed to a variety of underlying causes such as poor governance, poor infrastructure, lack of economic activities, lack of access to information, structural and market inefficiencies (Aker & Mbiti, 2010; Gollakotaa, Pick, & Sathyapriya, 2012). We now live in an information age and each day is influenced by the acquisition of information, with each connected person becoming part of the global information economy (Webster, 2014). The absence of television and radio reception in most districts of Matabeleland South compounds the problems that communities face, as they cannot access relevant information – such as weather forecasts, rainfall patterns, market related and national news – or monitor disease outbreaks and control, and this thus hampers their daily lives (Matsa & Simphiwe, 2014). The road network in Bulilima district is very poor and this worsens in the rainy season, where bridges linking remote areas are destroyed, cutting off traditional forms of communication. The lack of radio or television signals in the district exacerbates communication woes (David & Dube, 2013). Most communities in Matabeleland South province, situated close to the national borders, rely on radio and television broadcast signals from neighbouring countries, which do not convey appropriate local and national developmental information (Technomag, 2017). The digital isolation of these communities over the years has had a negative impact upon their socioeconomic development and engagement in national development issues. Before the mobile phone telecommunications infrastructure began to penetrate rural communities in Zimbabwe over a decade ago, it had been difficult for them to communicate easily and transmit socioeconomic information within their wards, districts and beyond, due to the inferior road network and unavailability of transport. Communication of important messages – such as death and burial notices, cattle sales and community meetings – was through written letters and by word of mouth.

ICTs in developing countries have become an agent for poverty reduction, business promotion and increased competitiveness in the global economy, as they allow informal businesses to make savings, access markets and customer databases (Deen-Swarray, Moyo, & Stork, 2013). Many researchers have concluded that ICTs have the ability to reverse marginalisation in Africa, reduce poverty, assist communities in decision making and support socioeconomic development (Aker & Mbiti, 2010; May & Adera, 2011; Isife, Nnodim, & Albert, 2013; Shambare, 2014). Scholars have argued that successive innovations in ICT offer new possibilities to transform human activities and enhance socioeconomic development (Smith & Elder, 2010).

In the developing world, strategies that promote the use of ICTs are worth pursuing and researching, as some communities are yet to fully utilise them for their development. In many developing countries, rural telecentres were believed to be the answer to bridging the information access gap, but these initiatives had not yet been implemented in Zimbabwe. In Uganda, the Grameen Foundation has set up a technology hub, where it is using ICTs as a tool to improve access to health, economic and agricultural information for the poor, thereby unlocking new socioeconomic opportunities (Grameen Foundation, 2011).

The sub-Saharan Africa region is among the least developed areas in the world, with just 15% of its rural community connected to the electricity grid (IFPRI, 2004; Damasen & Uhomoibhi, 2014). This means that efforts to alleviate poverty and enhance development will remain hindered for decades to come. Some rural communities in developing countries remain alienated from this superhighway and have no computers, internet, email, Twitter or Facebook accounts. The World Bank Group noted in 2012 that ICTs could be utilised as agents to overcome poverty and increase economic growth and productivity in societies. Oyewole, SaheedIge and Oyetunde (2013) highlighted trends considered to be an impetus for the employment of ICTs in agriculture and rural development, such as the use of low-cost and pervasive devices, improved data storage and sharing, and the harnessing of social media for knowledge sharing. In 2014, the poverty levels in Zimbabwe had been estimated to be 63%, with 16% of the population living in extreme circumstances. Rural household poverty was more widespread, accounting for 76%, due to marginal rainfall, poor road infrastructure, lack of access to information and ineffectual economic policies, aggravated by the country's low food production and agricultural productivity (IFPRI, 2004; ZimVac, 2014).

The ITU noted that many underdeveloped regions lacked much socioeconomic activity, leading to extreme poverty, and it concurred that ICTs were crucial for fostering rural development and enabling communities to connect with the global society and for stimulating development (ITU, 2013). This meant that if people in remote communities became aware of the potential of ICTs, they could easily operate the technology and access vast repositories of valuable information on the internet, in order to meet their socioeconomic needs.

An India-based franchise, Drishtree Company, established telecentres that benefitted millions of the country's rural residents, empowering these communities by providing access to information that included government and private sector services, health information and other services related to education and the economy (Yeo, Hazis, Zaman, Songan, & Hamid, 2011). This easily allowed villagers to share critical socioeconomic information with each other and join the global village. Mobile phone applications (apps) refer to software that has been developed to operate on mobile devices that facilitates the gathering, storage and dissemination of socioeconomic information (McNamara, 2009). The utilisation of mobile phone applications can empower rural communities in Matabeleland South and Zimbabwe to share agricultural and developmental information at local, national and international levels, and allow them to make decisions that could improve their socioeconomic development. Mobile phone application users can be classified according to usage patterns and, in this research, this scholar focuses on those who use the applications more frequently than others – and they were be engaged to assist in the development of the mobile phone app. Such consumers were classified as intensive mobile phone application users, deemed to have more exposure to mobile phone apps.

The lack of high-speed broadband mobile phone network infrastructure in Africa has resulted in voice and SMS applications being the predominant mobile phone functions in use over the years (Donovan & Donner, 2010). According to a report released by the ITU, most rural communities have no access to 3G signals and are therefore limited to basic mobile phone functions, such as making calls and text messages, and in Zimbabwe, 57.9% of the base stations are 2G type, while 42.1% are faster 3G and 4G networks (ITU, 2014; POTRAZ, 2017). Mobile phones with internet connectivity have found their way into rural communities, allowing people to access the internet via 2G, although there is an increase in access to 3G networks.

Researchers Eggleston, Jensen and Zeckhauser (2003) contended that even with the promise of ICTs promoting socioeconomic development and alleviating poverty, there remained a lack of theoretical detail to foster this assumption. Other researchers (Shambare, 2014; Smith & Elder, 2010; Deen-Swarray, Moyo, & Stork, 2013; Aker & Mbiti, 2010; Yeo, Hazis, Zaman, Songan, & Hamid, 2011; Tugnayat, Regulwar, & Tugnayat, 2012) have substantiated, through their work, the intrinsic relationship between ICT adoption and socioeconomic development.

1.3 Problem statement

Rural communities of Matabeleland South Province in Zimbabwe have limited access to the socioeconomic information necessary for development, due to the unavailability of radio and television signals, poor ICT infrastructure and an inadequate road network. The Zimbabwean national ICT policy report highlighted huge disparities between high-speed broadband in urban and rural areas, so widening the digital divide (TechZim, 2015). Improved mobile phone ownership in rural communities provides an opportunity to develop mobile phone applications that can solve the information access gap and thus has the potential to improve socioeconomic development. Access to region specific content or adaptable content in rural communities is an important ingredient for socioeconomic development (Stratigea, 2011). Rural communities have faced challenges in utilising ICTs, while their deployment in rural areas has also been slow, further widening the digital divide.

1.4 Purpose of the Study

The study explores ways in which ICTs can be utilised to enhance access to information by allowing rural communities to create, share and collaborate on socioeconomic information through the development of a mobile phone application. The aim of the thesis is to develop a mobile phone application and also answer questions related to design, access to information as well as barriers to access to information. Providing computers and the internet may not transform the lives of rural communities unless appropriate and relevant information is provided. The study is also motivated Kumar and Singh 2012, who noted that rural communities lack access to ICT infrastructure and awareness on the potential that ICTs have in offering opportunities for information access. The study also investigates other key factors that inhibit the adoption of ICTs by rural communities, mobile app usage trends and the level of awareness on the potential of ICTs. To enable rural communities to connect online, there is a need to address connectivity barriers, including ensuring that the content of websites, mobile phone apps and other online services are relevant to their socioeconomic development and are able to be read in local languages (Internet.org, 2014). Mobile phone technologies have developed to include phone functions, such as short messages, mobile internet and apps. This study's findings could apply to other rural communities with similar socioeconomic environments and enable government and development agents to apply some of its results.

1.5 General research question

What are the information access challenges affecting rural communities in Bulilima District, Zimbabwe and how to develop a mobile phone app that enhances access to information and communication that promoting user adoption?

1.6 Research objectives

i. Design a mobile phone application that allows rural communities to access information that is important for their socioeconomic development needs.
ii. Assess opportunities offered by improved mobile phone coverage in rural areas and how this correlate to socioeconomic development,
iii. Investigate factors that influence the uptake and use of mobile phone applications in rural communities for socioeconomic development,
iv. Evaluate the impact of the developed prototype

1.6.1 Specific research questions

i. What are the development processes and methodologies considered when developing mobile applications for rural communities?
ii. How are communities utilising improved mobile phone coverage to access socioeconomic development information in rural communities?
iii. What are the main issues that communities face in the uptake and use of ICTs in rural communities of Zimbabwe?
iv. What is the impact of the instantiated artefact?

1.7 Justifying the proposed solution

ICTs are a vital source of information and knowledge, allowing communities to make informed decisions and access vital information, thus this makes them central in supporting rural development (Pade-Khene & Sewry, 2011). Development agencies mainly offer general information where communities are passive recipients of information, this solution allows communities to participate in the creation of local relevant content.

The effective use of information by rural communities requires the production of contextual information specific to a region, which allows communities act upon it and make informed decisions (Samaddar, 2006; Isife, Nnodim, & Albert, 2013). The Grameen Foundation's AppLab, based in Uganda, is a mobile phone application development hub that produce apps to empower the poor, by enabling them to access information important to their socioeconomic development (Grameen Foundation, 2011). This resulted in raised productivity levels and improved socioeconomic development and is consistent to findings by Shams, (2009).

Mobile phones provide a low-cost means of accessing information and have become an effective tool for poverty reduction for poor rural communities (Rashid & Elder, 2009). Research has also revealed that smartphone usage in rural areas was high due to production of low-cost Android smartphones being sold for less than $100 (GSMA, 2017). Researchers in South Africa revealed that 41% of respondents admitted that they sacrifice buying food items inorder to communicate and buy airtime (Rey-Morenoa, Blignaut, Tucker, & May, 2016). This is consistent with findings from other scholars who revealed that residents from low income countries consumers often opt to acquire mobile phones, to improve communication and information access (Wesolowsk, Eagle, Noor, Snow, & Buckee, 2012; Quadir, 2013).

Mobile phone penetration in Zimbabwe was reported to be over 110% by mid-2016, with rural literacy at 90% (Lancaster, 2016). This means that rural communities are capable of utilising mobile phone applications. From the literature reviewed most mobile phone aplications cover a specific category of information like agriculture, health and markets among others (Lopez, 2013; Lester, et al., 2010; Akturan & Tezcan, 2012; Semali & Asino, 2014; (McNabb, et al., 2015). The proposed mobile phone application attempts to aggregate and offer general socioeconomic information, for further detailed information, hyperlinks will be provided. The mobile application will provide general information which is provided through radios, television and newspapers to keep the community informed with relevant content for their socioeconomic needs. Many rural communities do not have enough financial resources to buy air time and often access slower 3G and 2G networks (ITU, 2014; POTRAZ, 2017). While noting low bandwidth in rural communities, this mobile phone application will be designed to support offline access to content when the connection is intermittent or when the user has run out of credit.

1.8 Research methodology

The Design Science Research Methodology (DSRM) has been chosen for the development of the mobile phone application as it supports a practical building of innovative artefacts.
This is consistent with other scholars who applied design science in IS research to develop software applications that were technically and theoretically grounded (McLaren, Head, Yuan, & Chan, 2011; Hevner & Chattejee, 2010). Design science research has been associated with pragmatism as a philosophical orientation that attempts to bridge science and practical action, which results in the creation of an artefact that solves real-world problems (Simon, 1996; Cole, Purao, Rossi, & Sein, 2005). Orlikowski and Iacono (2001) have defined IT artefacts as bundles of material (hardware or software) that are created and are socially recognisable, capable of solving real world problems. DSRM can produce product artefacts or process artefacts. In this study a product artefact will be produced, which is a socio-technical artefact which people in the community must interact to provide the expected utility (Venable, Pries-Heje, & Baskerville, 2012).

The DSRM must provide an explanation or prediction on how a target population will use the artefact (intention to use some technology) and how the population finds the artefact useful (perceived usefulness). The DSRM aligns well with the chosen research model adapted TAM2) as the two share some similar constructs and variables. Design science research also seeks to explain the overall impact of the artefact on the community or organisation. In design science research, two questions are critical and empirical evidence must reveal an attempt to answer the questions.

i. What functionality will the new artefact offer?
ii. How is the functionality demonstrated?

For an artefact to contribute to a new body of knowledge, it must be new or show improvement, in comparison with existing artefacts.

Table 1.1: Linking DSR activities with thesis chapters

DSR activities	Thesis chapters
Problem identification and motivation	Chapter 1, Chapter 2, Chapter 3, Chapter 4
Artefact objectives definition	Chapter 1, Chapter 3, Chapter 4, Chapter 5,
Design and development	Chapter 6
Demonstration	Chapter 7
Evaluation	Chapter 7
Communication	Chapter 7, Chapter 8

1.8.1 Research Contributions

The research provides empirical evidence on the status of mobile phone usage, as well as issues that hinder uptake of ICTs in rural communities. The research contributions to design science include the designed mobile phone app artefact and its claimed benefits, which enable the researcher to contribute towards ongoing research on mobile phone apps and rural development. As posited by Gregor and Hevnor (2013) the aim of this study is instatiating an artefact that solves an existing problem and therefore there is less theory generated in contrast to studies that focus on building abstract theory for building future artefacts. The knowledge contributions for this research falls in the exaptation quadrant by extending a known solution to a new problem. The iterative nature of the DSRM provides some design theory which can be applied to developing similar products. The evaluation results of the artefact provide valuable information that can guide development of related artefacts. This is an innovative solution which can be applied to solve information access challenges in rural areas. The Information Systems Development Model was adapted as the framework for developing the mobile phone application that enhances access to socioeconomic information in rural communities. A number of mobile phone apps have been developed and many have been designed to solely provide access to a particular category of information such as agricultural or health information. This prototype aims at providing access to most of the basic information that a rural community would require. The novelty of this application is its ability of the mobile application to enable users to view content while offline or when they have exhausted their air time credit. The research shows how DSR, ISDM and UCD can be used to guide the development of an artefact that addresses information access in rural communities.

1.8.2 Socioeconomic development

Many different meanings are associated with socioeconomic development and, for the purposes of this study, its meaning is summarised in figure 1.2. Socioeconomic development refers to the basic activities that support the social and economic being of an individual or community that, in turn, has the potential to improve the standard of life and reduce poverty. For the purposes of this study, it will refer to economic activities that include income generation and increased profits, and also improved access to information on markets, health, government and education, and local and national events – the latter to result in engagement with civic activities. In figure 1.1, socioeconomic development is encouraged when citizens have access to development information, community participation, national news, economic activities, health information, entertainment, education, political participation and agricultural information. Access to technologies, such as mobile phones and mobile phone applications, can help rural communities to enhance their socioeconomic development if the technology is accessible, affordable, available and relevant. The development and use of ICTs have the capability of accelerating socioeconomic development and improving the quality and standard of life of a community and even a nation. Socioeconomic development in general refers to the ability of an individual or community to produce goods and services adequately and efficiently, and to distribute them in an equitable manner within a geographic unit (Jaffee, 1998). The role of ICTs as a strategic anchor for social and economic activities that influence society has been phenomenal (World Bank, 2011).

Providing access to ICTs alone, however, may not change the socioeconomic conditions of the community, unless specific interventions are addressed, such as the availability of economic opportunities, access to energy and water among others. Mobile phone apps could be utilised to lower information access costs for poor communities, by reducing information asymmetries between buyers and sellers, and eliminating costly journeys through ubiquitous information access (World Bank Group, 2016). The development of an artefact in this research will improve access to socioeconomic information that affects the daily lives of the community.

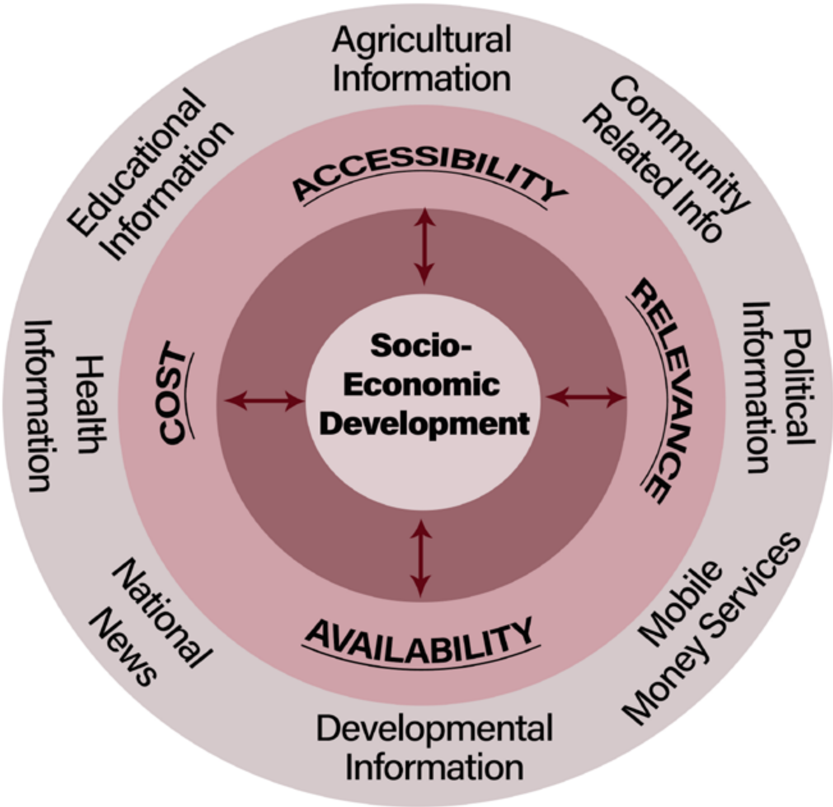

Figure 1.1: Socioeconomic development through ICTs

1.9 Study population

The research focused on rural communities of Zimbabwe, with a special focus on Matabeleland South province, which has seven districts within an area of 54,172 square kilometres. The study focused on Bulilima district. It has a population of about 90,561, who live within 22 wards, and 17 secondary schools (Zimstats, 2013). The study population for this research included all adults in Bulilima district and pupils in secondary schools. Learners are the next generation and have a great potential to use mobile phone applications, since they are digital natives – the Google generation (Helsper & Eynon, 2010). Communities in these districts have remained marginalised, with no access to television and radio services, a poor road network and limited agricultural and economic opportunities, due to low rainfall.

1.10 Study Sample

The population under study forms the universe of all possible participants for the research and is the basis from which the study sample is constructed, through methodological assumptions (Given, 2008). Time, accessibility and financial resources may not permit the study of the entire population of Zimbabwe or even just of Matabeleland South province, therefore, Bulilima district became the focus of the research, through purposive sampling. Two of the wards in the district were sampled and two villages per ward employed for the study, through means of cluster sampling. The arms of government related to socioeconomic development in the selected wards were provided with questionnaires, in addition to a number of Agricultural Extension workers (Arex), members of the Social Welfare ministry, traditional leaders, Non-Governmental Organisations (NGOs), health practitioners, secondary level pupils and school teachers. Through means of cluster sampling, appropriate questionnaires were distributed to pupils from forms four to six, who were attending two secondary schools in the district. After their responses were evaluated, the intensive users of mobile phone apps were identified and then asked for assistance in forming another sample group, to be used to design the artefact. Semi-structured interviews were conducted with the selected intensive app users, so as to solicit information for the design of the new app.

1.10.1 Other sample properties

The sampling frame is a complete list of all possible cases within the study population and for the requirements of this research, the frame was comprised of all of the rural districts in Matabeleland South. The sample for this study included all of the wards within the rural districts of Matabeleland South, while the sample unit comprised of the villagers.

1.10.2 Sampling techniques

According to Kothari (2004), probability sampling includes other types of sampling – random, systematic, stratified and cluster – while non-probability samples are premised on judgment and quota sampling techniques. Cluster sampling allows the researcher to group participants into identifiable clusters – such as age, race and religion – that represent the entire population. Through this technique, minority groups that include government officials employed by Arex, social welfare workers, NGO agents and health workers, key informants can easily be included in the sample. Where both the completeness and accuracy of the sampling frame cannot be guaranteed, cluster sampling is preferred, as it allows the sample to be grouped and critical and information-rich samples identified that otherwise would not be chosen through general random sampling. The last census was conducted in 2012 and after a period of four years, the demographics have changed and the population sample differed. The drawback of this technique is that the sample may not be representative of the entire population. Random sampling was the technique employed to gather information from select respondents residing in villages and schools, and from special interest groups. The selection of sample strata and respondents follows iterative steps until a sample is selected using random sampling techniques.

Matabeleland South province was chosen through purposive sampling, because it lies in region five, which experiences low rainfall, poor soils and low economic activity among its many minority communities, which include the Tonga, Venda, Suthu and Kalanga. Just a few districts enjoy radio and television signals, while most of the communities have no access to newspapers and fixed telephones. The Bulilima district was chosen through the use of purposive sampling, as it lacks access to information, with limited access to telephone, radio or TV signals. All of the secondary schools for the entire population, for the requirements of the secondary school cluster, were considered and, through random sampling, two schools were selected with the sample comprising every pupil from forms four to six. Table 1.1 demonstrates how the sample was chosen from the population for the secondary school cluster, while table 1.2 reveals how individual schools were chosen, by assigning a unique number to each school and then undertaking random sampling. Questionnaires were then distributed to senior pupils in schools that had been randomly sampled.

Table 1.2: Cluster, Random Sample and Sample example for Secondary Schools

Population	All Secondary schools in Bulilima District.
Group (Cluster)	Eight different Secondary schools in Bulilima District.
Random Sample	Two Secondary schools from the list of all schools in Bulilima District.
Sample	Every form four student in the school.

1.11 Information systems development methodology

When developing information systems for rural communities, it is important to ensure that the technology is effective, meet the needs of the potential users by considering the socio-technological factors. The Information systems development methodology (ISDM) framework that was developed by Wayi and Huisman, (2010) and implemented in some information systems projects in rural communities was adapted. Developing information systems in rural areas following a frame helps in ensuring that the intervetion is not rejected by end users as it may fail to meet the expectations and limitations of the target community (van Reijswoud, V, 2009).

1.12 Theoretical framework

Design science researchers have to develop artefacts that can overcome problems that have been highlighted in organisations or society. The output of a DSR is an artefact, which must be evaluated in terms of its ability to solve the perceived problem. For my study the Technology Acceptance Model (TAM) developed and modified by Venkatesh and Davis, (2000) was chosen to evaluate the mobile phone application. TAM2 has been widely used in research that focuses on the use and acceptance of a broad range of end-user computing technologies by a target population. Two important individual constructs of the TAM are perceived usefulness (PU) and perceived ease of use (PEOU), which support attitudes (At) that determine the utilisation of a certain information system or technology. Over the past years, TAM has proved to be a reliable and robust model for predicting user acceptance of an information system in a work environment. This study adapted the TAM2 which added other variables that could affect the adoption and use of mobile phone apps in rural areas. The main constructs that could affect PEOU that were introduced in the adapted TAM2 were language, experience, simplicity, effectiveness, reliability, acceptability, appropriateness, cost and acceptability, which were important determinants of mobile phone application acceptance in rural communities.

TAM2 has been adapted to include constructs that would apply in an informal setup like a rural community and removed those constructs which appeal to an organisational setup. Gender and culture issues are very important in a rural community setup compared to job satisfaction, image and output which are more appropriate to an organisational setup.

Information system usage or adoption by an individual or community is determined by behavioural intentions, which are a product of an individual or a group’s attitude towards using a particular information system and that are determined by PU and PEOU. TAM2 and its variants have been widely used in Western cultures and been rigorously tested while few studies have been published on TAM2’s application in other cultures like the African culture to enhance our understanding and verify cultural validity (Teo, 2013).

Knowledge of the perceptions of rural communities with regard to the use of mobile phone applications and related technologies can assist local government, development agencies and rural community leaders to come up with strategies for rolling out such technologies to other rural communities in Zimbabwe. PU is considered as the degree to which rural community members believe that mobile phone apps and related technologies will enhance access to information to improve socioeconomic development. The added variables are critical when it comes to determining the adoption and use of mobile phone applications in rural areas.

There is limited literature on the potential of mobile phone applications and related technologies in enhancing socioeconomic development in the rural communities of Zimbabwe that focuses on issues such as knowledge, culture and gender dynamics, appropriateness and affordability.

1.13 Linking research questions to the theoretical framework

Table 1.3: Linking research questions to the theoretical framework

Research questions	Theoretical framework constructs
How have improvements in mobile phone coverage translated into socioeconomic development in rural communities?	Accessibility – the model must measure the accessibility of mobile phones and applications that influence their adoption and usage.
What are the main issues that communities face in the uptake and use of ICTs in rural communities of Zimbabwe?	Appropriateness, cost, language – the model must investigate issues that affect the uptake of mobile phones and their applications.
What is the projected growth pattern in the usage of mobile phones and mobile phone applications in rural communities?	Accessibility, experience and simplicity – these factors will reveal the projected growth pattern.
To what extent are rural communities utilising mobile internet and related technologies in support of socioeconomic	Experience, result demonstrability – these two factors helped in determining whether rural communities had used mobile phones

development and the promotion of rural development?	and their applications for socioeconomic development.
Which mobile phone application development issues are pertinent in terms of designing mobile phone applications for rural communities?	Reliability, simplicity and effectiveness – these constructs from the model relate to design issues.

The research model forms the theoretical framework for the study and, therefore, research questions, questionnaires and interview questions must relate to the model. This provides a proven concept or theory underpinning the study, which helps with interpretation of the data.

2.1 Mobile phone application design

The mobile phone app must enhance access to socioeconomic information that could have an impact upon the day-to-day living of the rural community. From the literature, scholars have posited that rural communities require access to information such as local and national news, market information on commodity prices and particulars on cattle sales, the weather, community activities, education, health and agriculture (Best & Kumar, 2008; Aker & Mbiti, 2010; Kivunike, Ekenberg, Danielson, & Tusubira, 2011; Bank World, 2012; Mtega & Benard, 2013).

i. Communities require information on where to sell their crops and livestock as well as new and better methods for crop production and animal rearing.
ii. information on services provided by the local villages and other activities that affect them such as meetings and community gatherings.
iii. Access to agricultural extension services
iv. Access current local and national news, as well as local news stories within the community.
v. Provide access to basic health tips and information on common diseases and conditions.
vi. Communities require access to educational material and career information and advice.
vii. Access to political information which allows communities to make their own decisions.

This information will be refined once the baseline survey has been conducted as well as through the input of the community members during the mobile phone application development.

2.2 Application Architecture

The mobile phone application has been logically divided into two main parts – the client side/front-end and the server side/backend as shown in figure 1.5.

2.2.1 Client Side:

Client devices operate on the Android Mobile Operating System and interacts with the backend using RESTful web services/API. The RESTful web services receive HTTP (Hypertext Transfer Protocol) requests and respond using HTTP responses by returning JSON (JavaScript Object Notation) data, which is a lightweight data-interchange format (envyandroid, 2014). The advantage of using RESTful web services is that the developer can build multiple clients on the same backend, such as IOS, Symbian and Windows.

2.2.2 Server:

Custom web services are powered by an Apache web server. RSS feeds from accredited sites could be utilised to provide information, such as weather updates and news, and then build web services to feed the application with aggregated information that is not readily available to the Matabeleland South community. Collaborations with affiliate organisations, such as health institutions help to update the mobile application with information, including health alerts using web services. For community related news, ward representatives responsible for information dissemination could be engaged and also closely follow community structures used to relay information.

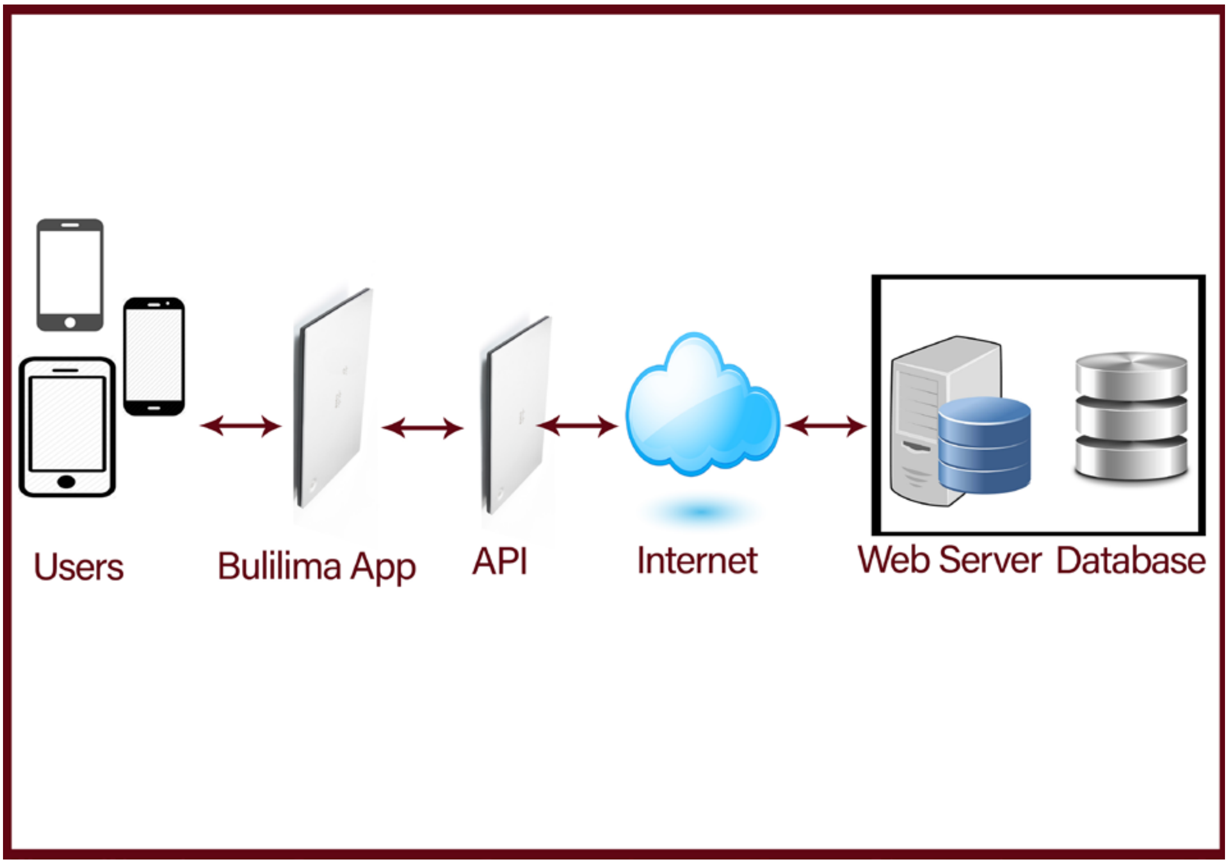

Figure 1.2: Mobile phone application architecture by author

2.3 Tools to be used:

i. Programming environments

- Java/Android
- PHP (Hypertext Pre-processor),
- JavaScript
- SQL (Structured Query Language)

ii. Database

- MySQL is a freely available open-source Relational Database Management System (RDBMS) that uses SQL.

iii. Web Server

- Apache is an open-source web server creation, deployment and management software.

iv. Development libraries

- Volley is an HTTP library that makes networking for Android applications easier and, most importantly, faster.

- Slim is a PHP micro framework that helps one to quickly write simple, yet powerful, web applications and APIs. At its core, Slim is a dispatcher that receives an HTTP request, invokes an appropriate call-back routine and returns an HTTP response.

v. Mobile phone application platform

- Android is a mobile software application developed for use on devices powered by Google's Android platform.

vi. Integrated development environments

- Android Studio is used to develop the Android application.
- PHP Storm is used to develop the RESTful web services in PHP and consume pre-existing ones.

2.4 Apps for Socioeconomic Development in Sub-Saharan Africa

Some top mobile phone applications that have transformed lives of people in Africa include M-Pesa, Ushahidi, iCow, Mixit, Ecocash, MumbaBora, MPedigree, Afrinolly and mFarm, among others, as they apply to health, agriculture, communication, mobile money and education (Africa.com, 2015). Mobile phone apps such as Amref have been designed for mobile learning (m-learning) in Kenya, Tanzania and Uganda, and are being used by nurses for life-long learning, as well as developing their careers and providing access to information that helps provide healthcare in their communities (AMREF, 2012). An application was developed in Uganda to allows mobile phone users to send a message to enquire on the weather forecast for any city or place (Kuek, Qiang, Dymond, & Esselaar, 2011). Ghana's Motech application, developed by Grameen foundation's mLab, allows women to receive weekly, time-specific information about pregnancy and childcare information, if they are pregnant and/or have babies (Grameen Foundation, 2011). A mobile phone app was developed in Kenya to monitor incidences of violence during elections, which allows citizens to gather information from anywhere, at any time, to report on election violence (Ushahidi Inc, 2017). Another mobile app is being used in Mozambique, Senegal and Nigeria that offers a virtual marketplace where small scale-farmers can access national and international agricultural commodity prices and advertise their produce (Kuek, Qiang, Dymond, & Esselaar, 2011).

2.5 Research instrument

Research methods determine how data is obtained from a study's target population and the academic has to pick specific methods, based on the type of questions to be asked and the perceived answers. Yin (1994) has recognised five popular ways of collecting and analysing empirical data in research – experiments, survey, analysis of archival information, histories and case studies. Several methods can be employed to collect primary data when conducting mixed-methods research, including: observations, interviews, focus group discussions, questionnaires and content analysis.

2.6 Questionnaire

The questionnaire survey was employed as the main data collection instrument for this research. A questionnaire is a formalised schedule for collecting data from respondents and consists of a series of questions that respondents must answer to capture unpublished data. The purpose of the questionnaire in this research was two-fold, as noted by Creswell (2009), firstly to attend to the initial research questions that sought to solicit information on issues related to mobile phone usage and the status of ICTs in rural areas. Secondly, it aimed to use the results from the questionnaire to identify participants deemed to be intensive mobile phone application users, who were then to become involved in the participatory development of the mobile phone app (Creswell, 2009). The questionnaire survey enables researchers to examine and explain relationships between constructs (Saunders, Lewis, & Thornhill, 2009). Don Dillman (2000) defines the questionnaire as a predetermined, written list of questions, posed to an interviewee, who is to answer them. For the research, a pilot questionnaire was distributed to staff members at the Bulilima Rural District Council offices, who pre-tested it in order that the researcher could address any issues pertaining to the clarity of the questions, so that answerability could be ascertained.

To ensure that the overall study questions were easily answered, the researcher split each one into more investigative questions, with the intention of the sub-questions being succinct and quite clear, and then he began to identify variables whose data has to be collected, as shown in table 1.3 (Saunders, Lewis, & Thornhill, 2009). The questionnaire included a combination of open, closed, ranking and rating questions, and one based on the Likert response scale. Open-ended questions employed as part of a questionnaire, for example, allowed respondents to provide their opinions, attitudes, or even a single word that represented how they felt about the topic under study (Given, 2006). Open questions are also known as open-ended questions, where respondents have the liberty to answer in their own way. Closed questions have to pinpoint the answers provided, such as: yes, no, true and false.

Some questions sought to measure attitude, using a five-point Likert-type response scale, towards the use of mobile phone applications and technologies, by referring to aspects such as the cost of airtime, connectivity and utility. Further questions utilised levels of agreement (“strongly agree” or “strongly disagree”, for example), while others employed “yes” or “no” responses or were open-ended. The questionnaire also gathered demographic data, such as gender, level of education and age. Some questions measured the use of mobile phone applications and the internet, and also sought to reveal any benefits derived from these technologies. The questionnaire was translated into the local language and during its distribution, respondents could choose to answer either the English or the Kalanga version. A total number of 150 questionnaires were to be distributed, as shown in table 1.3.

Table 1.4: Data collection tool, participants and their number

Data collection tool	Participants	Purpose	Number of participants
Questionnaire	Villagers, schoolchildren (over 18 years) and stakeholders	Provide empirical evidence on the use, and availability of ICTs in rural areas.	150
Semi structured interviews	Intensive users of mobile phone applications	Help in the development of the mobile application as per UCD and DSR guidelines	15
Questionnaire	Community members	Evaluating the mobile application as per guidelines of DSR	5

2.7 Semi-structured interviews

Semi-structured interviews were used during the development of the mobile phone application, as a way to gather user feedback. According to one study (Saunders, Lewis, & Thornhill, 2009), during the interview phase, some questions may be omitted or altered, depending on the response of the interviewee and the flow of the questions. Others may be asked as follow-up questions. Fifteen intensive mobile phone app users were involved in the design and development of the mobile phone app prototype – from refining its requirements through paper-based, low-fidelity prototypes, to actually testing the application. Research assistants were engaged to help capture user feedback. They had two questions to answer: "What design issues do you think can be included in the mobile phone application?" and "What sort of content would you like to see included in the mobile phone application?".

2.8 Triangulation

During any study, it is important to use a process called triangulation, which utilises multiple methods to explore a research problem (Given, 2006). Use of multiple data sources, analysis of previous work and comparisons with other generalisations within the same domain helps to ensure that results drawn from a study are consistent and that they can be applied in a general sense. One study (Saunders, Lewis, & Thornhill, 2009) noted that peer debriefing is a technique where a researcher allows peers who are not pursuing a similar study to probe the researcher's line of thinking on parts or the rest of the research. This process is termed triangulation. In this study, triangulation was achieved by asking the same questions of different respondents and also through the use of different data gathering techniques for data solicitation, such as questionnaires and semi-structured interviews.

2.9 Data analysis

The purpose of this study was to develop a mobile phone app for rural communities in Bulilima district and Zimbabwe as a whole, to enhance access to socioeconomic information. The study also sought to determine how mobile phone access and mobile applications could be used to enhance socioeconomic development in Zimbabwe's rural communities. The data gathered here must measure constructs based on the TAM, such as the suitability of the mobile phone app, which determines PEOU, PU and the actual usage of the artefact, among others. The analysis of data involves the manipulation of raw data so that it can reveal hidden relationships and noticeable occurrences between these constructs through statistical operations. Data produced from this research was subject to statistical analysis, through means a commercial statistical software package such as Excel and SPSS. It was analysed using descriptive statistics, which investigates responses and extracts meanings that measure variance, mean, mode and standard deviation. Other data analysis techniques – such as cross tabulations, chi-square tests and correlation tests – were utilised to generate insight into relationships existing between constructs and their level of significance. The data produced in the semi-structured interviews was quantified, based on key thematic areas of the model. Any correlations discovered were calculated to show relationships between constructs, based on the coefficient value. If the coefficient value was zero, this implied there was no linear relationship between the variables and if the coefficient value was one, then a perfect linear relationship became apparent. The analysis was based on key themes derived from the proposed model, where the respondents' comments on perceived usefulness, perceived ease of use and attitude towards usage of mobile phones would provide the base of the analysis. Table 1.5 provides an overview of the objectives, research questions, data collection instruments, sources of data and analysis procedures that were applied.

Table 1.5: Objectives, Research questions, Data collection instruments, sources of data and analysis procedure

Research objectives	Research questions	Data collection instrument	Sources of data	Analysis procedure
Design a mobile phone application that allows rural communities to access information that is important for their socioeconomic development needs.	What are the development processes and methodologies considered when developing mobile applications for rural communities?	Questionnaires, Semi structured interviews Literature review	Rural communities, local government, development agents	The analysis of the data begins with the preparation of the raw data through transcription. Coding of data based on thematic areas. Grouping coded data according to the objectives and variables provided by the research model the adapted TAM2. Illustrate the themes, variables and concepts to see their relationship and to get a detailed understanding of the
Assess opportunities offered by improved mobile phone coverage in rural areas and how this correlate to socioeconomic development,	How are communities utilising improved mobile phone coverage to access socioeconomic development	Literature review Questionnaire Semi-structured interviews	Selected districts, literature	

	information in rural communities?			objectives through selective coding. Interpret and elaborate upon the findings.
Investigate factors that influence the uptake and use of mobile phone applications in rural communities for socioeconomic development,	What are the main issues that communities face in the uptake and use of ICTs in rural communities of Zimbabwe?	Literature Questionnaires Interviews	Rural communities, Local government	Using an iterative process of gathering requirements, designing the application and going back to the community to refine design and functionality.
Evaluate the impact of the developed prototype	What is the impact of the instantiated artefact?	Questionnaires Semi-structured interview	Rural communities, Local government, development agents	

2.10 Significance of the study

This research aims to contribute new knowledge, through the design of a new artefact in the form of a mobile phone application that could be utilised to improve access to information vital to socioeconomic development in rural communities in Zimbabwe. The app would also improve communication within the district and has been adapted for communities with low income, low digital skills and low bandwidth. The research identified major issues that were hindering the adoption and use of mobile phone apps in rural areas and provided empirical evidence on the role of mobile phones and their apps in Zimbabwean rural communities. From the literature, there is related research in other countries, including South Africa, Kenya and Uganda, but very few traceable studies exist in Zimbabwe, let alone in Matabeleland South province. As rural communities begin to connect to various mobile phone infrastructures, it is critical that scholars identify any advantages, of which mobile apps appear to be one. The inadequate political and socioeconomic environment in Zimbabwe demands home-grown solutions and interventions that can improve people's lives, as many development agencies cannot operate in the country due to sanctions. This is one of a very few studies to be conducted in Zimbabwe and its output could help other researchers who may want to carry out further research on the use of mobile phone apps for socioeconomic development to gain insight into the Zimbabwean context. The research outcomes from this study could be generalised to other rural communities in Zimbabwe and elsewhere with similar socioeconomic environments.

Some of the major outcomes of this research include:

- The design of a mobile phone application that helps rural communities to access information that is vital to their socioeconomic development.
- Iterative design steps that were followed to develop the mobile phone application
- The provision of valuable insight into how access to mobile phones and their apps can encourage socioeconomic development within rural communities in Matabeleland South province and Zimbabwe.
- Assisting rural communities to understand better the opportunities that mobile phone access and apps could offer in enhancing socioeconomic development.
- Data generated to inform development agents, arms of government and community leaders on the impact of mobile phone access and apps for enhancing socioeconomic development.
- The provision of empirical evidence in a Zimbabwean context on how the expansion of the mobile phone technology infrastructure could possibly be employed to bridge the digital divide in rural communities.

2.11 Ethical considerations

Volunteers in the study received a detailed outline and purpose of the research, plus an informed consent form, which they signed to signal their participation. Respondents were informed of their rights to refuse participation in the research if they so wished. In this study, the identities of the respondents remained anonymous and their responses used for academic purposes only, while the data generated was kept private. No personal information was obtained from the respondents and the school's ethics committee granted an ethical clearance certificate to the researcher (attached as appendix 5). This research involved gathering data from rural areas, therefore all cultural settings and norms were adhered to. The research did not cause any harm, embarrassment or discomfort to the participants. The results of the study were disclosed to the respondents.

2.12 The outline of the thesis is as follows:

Chapter one:

This chapter lays a firm foundation, by providing relevant background information, a statement of the problem, objectives, methodology, project outcomes and ethical considerations.

Chapter two:

This chapter provides valuable literature on other related work pertaining to the use of mobile phone apps in rural development and also focuses on the proposed work by the researcher.

Chapter three:

This chapter provides an overview of some challenges that rural communities in Zimbabwe face. These challenges augment some issues that were raised in the literature review.

Chapter four:

The focus of this chapter is to provide the rationale used in the selection of the research methodology, research instruments, the data collection and the statistical analysis techniques that were employed.

Chapter five:

The chapter provides a baseline survey on some selected wards in Bulilima District, the research findings and their interpretations help in specifying the objectives and the functions of the app.

Chapter six:

This chapter provides an outline of the processes that were followed to design the artefact, the methodology and tools that were used.

Chapter seven:

This chapter presents the demonstration and evaluation procedures that were taken and documents the results.

Chapter Eight:

This chapter presents the study's concluding remarks. Recommendations, limitations and directions for future research work are presented. Appendices provide additional information such as the instrument and other relevant documents.

2.13 Chapter summary

This chapter presented the background of the study, problem definition, proposed research methodology, research objectives and questions. An overview of the proposed artefact was also presented, outlining the tools and technologies that will be used. The research instrument was also presented and other data gathering techniques that will be used. The significance of the study was presented. The next chapter will provide an overview and a review of relevant literature that underpins this study.

Chapter 2: Literature review

3.1 Introduction

Chapter one articulated the research problem and its background, the research method that guided the study and its objectives, and provided an introductory literature review, as well as an overview of the dissertation. This chapter analyses and reviews the existing literature on the subject area, in order to demonstrate the relevance of this study and place this research into context (Creswell, 2007). The themes articulated in this section will include the role of mobile phone apps in supporting activities on agriculture, health, education, access to news, the digital divide, social media and rural development. As highlighted in the previous chapter, rural communities in Bulilima district are facing challenges in accessing socioeconomic information necessary for their development, due to unavailability of radio and television signals, inadequate fixed telephone infrastructure and a poor road network. Rural communities have the same constitutional rights to access of information affecting the community's socioeconomic situation in areas such as agriculture, health, education, politics, and rural development. Most of Africa's rural communities are remote and inaccessible by road, with no fixed telephone access, yet mobile phones are beginning to offer new opportunities for information exchange, providing access to markets and thereby simplifying business (African Monitor, 2012).

The mobile phone is pervasive and ubiquitous, and its rising influence on humanity should be utilised to harness its ability to enable access to socioeconomic information and communication in developing countries. Advances in the mobile phone network infrastructure have led to mobile phones virtually reaching every part of Africa at a time when the role of ICTs in socioeconomic development has become more apparent than ever before (Tugnayat, Regulwar, & Tugnayat, 2012). The GSMA group highlighted that the mobile phone would be the key access technology to reach out to communities in Africa, who were once isolated and unconnected, thereby bridging the digital divide (GSMA, 2014). Rashid and Elder (2009) concluded that the mobile phone had become the most dominant and transformative technology for the developing world and had easily found its way in developing countries. Rural communities can use mobile phones and other ICTs to enable rural extension workers to gather, store, retrieve and disseminate a broad range of information needed by farmers and other stakeholders (Agbelemoge, Dada, & Alabi, 2015). ICTs can provide access to information, but often remote communities have limited access to infrastructure and some cases are not aware of its potential in addressing deficiencies in information access (Kumar & Singh, 2012). Studies conducted in India among rural farmers and fisher folk support the conclusion that ICTs can improve income and quality of life among the rural poor (Goyal, 2010).

Having realised the potential of ICTs in development, in 2010 the European Union launched its 2020 strategy, whose thrust was to maximise the application of ICTs in education, commerce, work and culture, to drive socioeconomic development (Vaněk, Jarolímek, & Vogeltanzová, 2011). This resulted in raised productivity levels and improved socioeconomic development (Shams, 2012). In India, some local governments, such as the authorities for Kerala, have widened access to vital information, including booking for driver's licences, land allocations, voter registration and casting ballot papers through mobile phones (Kannabiran & Banumathi, 2008). In order to make information available to its citizens, the Malaysian government established cybercities with a number of ICT-based projects, among them smart schools, e-government and others (Meng, Samah, & Omar 2013). The overall objectives of a number of ICT-enabled initiatives in India were to provide information access and empower rural communities, as noted by Kannabiran and Banumathi (2008). ICTs have been utilised in African countries – including Uganda, Kenya and South Africa – to reduce the digital divide and allow rural communities to access useful information that enhances and improves education, business and health, and fosters greater development (Meshur, 2012). From the scholars reviewed, mobile phones can provide a low-cost means of accessing information in rural communities.

In 1967, Julius Nyerere once lamented that "while other countries in the world aim to reach to the moon, we must aim for the time being at any rate to reach the villages by providing them with necessary information" (Agoulu, 1989). Scholars have agreed that successful ICT interventions in rural communities have to provide access to location-specific knowledge and content as well as recognising community dynamics (Best & Kumar, 2008; Gorla, 2009; Aker & Mbiti, 2010; Beuermann, McKelvey, & Vakis, 2012). For rural communities to fully utilise information, requires the production of contextual information specific to a region, which allows communities to act upon it and make informed decisions (Samaddar, 2006; Isife, NNodim, & Albert, 2013).

In 2017, Zimbabwe experienced the worst cyclone in over 50 years, which killed more than 246 people, 20 000 livestock and damaged bridges and dams, and about 538 schools, 54 clinics and 15 000 toilets (The Financial Gazette, 2017). The worst affected areas were rural communities, yet could barely access any information – due to lack of access to radio, television and newspapers. Inhabitants could not access information that could save their lives and warn them to evacuate, or inform them of the devastating effects of the cyclone, over 50 years after Nyerere's profound statement. Researchers have revealed that less that 19 percent of inhabitants in sub-Saharan Africa read a newspaper once a week and this figure is even less in rural and remote communities (Aker & Mbiti, 2010).

3.2 Role of information access in steering socioeconomic development

Existing studies support the use of ICTs to extend information access and communication in developing countries, which can support socioeconomic development. The growth of mobile phone use in Africa is contributing to improved business activities, through the reduction of communication costs, improved access to markets, access to financial services and health information (Aker & Mbiti, 2010). Some researchers have concluded that ICTs could foster socioeconomic development in the least developed and poorest communities, with the key advantages of increased mobile phone access resulting in better access to markets and financial inclusiveness (Gumede, Plauche, & Sharma, 2008; Ngassam, Ntawanga, & Eloff, 2013). ICTs and the internet have the capacity to improve agricultural productivity, as they can provide farmers with access to information and superior technologies that farmers can harness to make decisions that impact on profitability and productivity (Zhao, 2008). In Ghana, rural communities have used ICTs such as mobile phones and radios for networking and sharing information related to agriculture, health, education and marketing, specifically for their produce, and this has uplifted standards of living (Boateng, 2012).

Research carried out by other scholars (Shambare, 2014; Smith & Elder, 2010; Deen-Swarray, Moyo, & Stork, 2013; Aker & Mbiti, 2010; Yeo, Hazis, Zaman, Songan, & Hamid, 2011; and Tugnayat, Regulwar, & Tugnayat, 2012) has proved that ICTs play an important role in fostering socioeconomic development. ICTs have a potential to address some of the problems that poor countries have been facing, such as limited access to health, financial and market information, with organisations such as the UNDP, FAO, World Bank, UN Economic Commission for Africa and the ITU encouraging developing countries to make huge investments in ICT infrastructure (Zhao, 2008; FAO, 2013; World Bank, 2011). Many countries have begun to use ICTs to support rural extension workers, enabling them to provide farmers with advisory information, as these growers remain hampered by lack of access to information and acute transport problems (Agbelemoge, Dada, & Alabi, 2015).

A decade ago, Chrisanthi (2003) contended that the promise that ICTs would promote socioeconomic development and alleviate poverty required further empirical evidence. The benefits of deployment an ICT intervention in rural communities are clear from literature, but how can these be achieved? Two common approaches involve deploying telecentres in rural communities or developing mobile phone applications. The themes of these studies in this section help to answer the questions raised in 2003 by both Chrisanthi and the researchers Eggleston, Jensen and Zeckhauser on whether ICTs could foster socioeconomic development.

3.3 Rural telecentres

Telecentres were established to bridge the information access gap as well as provide other ancillary services that promote development such as use of email, faxing, e-government within a particular community (Whyte, 2000). Other scholars described the establishment of telecentres as a way to fight poverty and under development in developing countries (Unwin, 2009). The government of Bangladesh established over 6700 information centres which provide access to information such as mobile banking, telemedicine and information on agriculture among others to remote communities (Ullah, 2016). Researchers have noted that communities need to be informed in order to develop (Breitenbach, 2013). In other countries, telecentres became the answer to connecting rural communities to the global information highway, but in Zimbabwe these were rarely implemented and unsuccessful, as the economy has been on a downward trajectory and there were no signs as to when it could recover (RBZ, 2006). Research conducted in Tanzania revealed that the setting up of a telecentre in Sengerema district improved people’s standards of living and wellbeing in general, with revelations that it could propagate information in the local language (Mbangala & Samzugi, 2014). The success of telecentres was based on the provision of local content or provision of services that meet the needs of the local community and mitigation from exclusion (Conradie, Morris, & Jacobs, 2003). In many telecentres, information maintained include prices for local farm produce, health information, access to government services, access to news and local information such as job opportunities (Breitenbach, 2013).

Telecentres rely heavily on external funding for the equipment, labour expenses and bandwidth. Zimbabwe has been on international sanctions after disputed elections in 2003 and therefore it is not eligible for related funding (RBZ, 2006). Many telecentres in Africa closed down due to sustainability, lack of administrative skills and failure to provide relevant information for use by the community (Breitenbach, 2013). Most telecentres fail because of lack of continued financial support, lack of adequate technical skills for repairing hardware and lack of new relevant local content (Best & Kumar, 2008). There are currently no telecentres in Bulilima district due to the socioeconomic challenges affecting the country. As telecentres have been at the epicenter of providing access to information, the proposed mobile phone application has the same objectives. Designing the mobile phone application will be guided by prior research on telecentres, which revealed that the generation of local content was a major sustainability issue to be considered (Hudson, 1999).

3.4 Enhancing access to information using mobile phone applications

Mobile phone apps are software programs designed to work on mobile technology by allowing users to gather and share data that is vital for socioeconomic activities (McNamara, 2009). Over the years some developing countries have been intensively developing mobile phone apps to support financial services, weather forecasting and enhance agricultural productivity has matured and evolved in developed countries. Mobile phone apps touch every aspect of people's lives, in developed countries these have been extensively used to support activities that improve livelihoods, as they purvey information concerning financial services, learning, the news, transportation and entertainment, among others. In developing countries, where ICTs have not yet influenced every aspect of life, mobile applications must be localised and tailored to meet the specific needs of communities since, in some instances, there is no other complementary technology for information access (NHS, 2014).

Mobile phone apps have been developed to cater for specific needs or categories of information, such as health applications for HIV and Aids, diabetes, pregnancy related diseases and health related information supporting traditional media. Some applications target market related information, such as prices, market information and financial services. Other apps service the agricultural sector, for information on weather forecasts, pest control and animal diseases. In the education sector, mobile phone applications have been developed to cover m-learning and access to e-resources, among other services. Since the community in Bulilima has limited access to socioeconomic information – due to the unavailability of traditional transmission media – the proposed mobile phone application attempts to aggregate and offer general information (Technomag, 2017). This covers most areas that are critical for socioeconomic development, because the provision of access to just one category of information may not solve the current information access needs within the community. Access to a single category of information may not support any meaningful development. The market for mobile phone application development is still in its infancy in Zimbabwe, mainly due to a lack of financial resources to establish innovation and development hubs. Statistics reveal that only two applications have reached more than 50 000 downloads – the Shona Bible and the Ecocash application – with most apps struggling to reach over 10 000 downloads (TechZim, 2016).

3.5 ICTs, mobile phones in poverty reduction

FAO has noted that the development of the mobile phone has had a positive effect on the farmer, as it has improved the access and sharing of vital agricultural information, but the body observed that this potential had not been fully realised in developing nations (FAO, 2013). Mobile phones provide a low-cost means of accessing information and are an effective tool for poverty reduction in poor rural communities (Rashid & Elder, 2009). There is a general consensus that improved and increased use of ICTs in rural communities will provide mobile phone developers and development work agents with new opportunities to assist rural communities in poverty alleviation (Ngassam, Ntawanga, & Eloff, 2013).

Poor and remote areas of India have benefited greatly from the use of mobile phones to access services that were once out of their reach, including knowledge of crop prices and being able to pay suppliers through mobile money transfer services (Chandra & Malaya, 2011). The Grameen village phone project had more than 30,000 women working and earning a net profit of between $50 and $500, thus reducing poverty levels and improving socioeconomic development (Shams, 2009). Mobile-money service providers, including Econet, M-Pesa and Tigo Cash, have provided new opportunities for rural communities to access banking services. For instance, in less than a minute, a loan request can be sent, approved and an amount of money transferred to the individual (The Economist, 2016).

The Zimbabwean government has noted that the absence of ICTs has worsened the plight of the poor, who cannot access health information, education, prices and public information (Ministry of ICT, 2015). From the literature reviewed, mobile phone apps could play a major role in poverty alleviation strategies in developing countries, as they offer easy access to vast amounts of developmental information in rural communities.

3.6 Role of ICTs and mobile phones in socioeconomic development

Within the developed world, every sphere of economic activity relies upon ICTs, yet some developing countries are yet to embrace ICTs, due to poor telecommunications infrastructure, low literacy levels and lack of electricity, among other hindrances (Farhadi, Ismail, & Fooladi, 2012). The use of ICT applications, such as mobile internet and mobile communication in rural areas, could improve access to markets, increase exchange of information and open avenues for economic development. The European Union set up an Information Society policy in 2009, with the main aim of reducing the digital divide, plus a 2020 strategy to maximise ICT investment in education and commerce (Hanke, 2009; Vaněk, Jarolímek, & Vogeltanzová, 2011). This would be achieved through the introduction of broadband access in rural communities that lagged behind in ICT development. A decade ago, one study (Chan & Fang, 2007) concluded that the proliferation of technologies such as Wi-Fi, social media platforms, blogs, RSS feeds and podcasts would propel internet usage even among the less privileged – and this has been backed up by an increase in broadband use in Zimbabwe, from about 0% in 2000 to 46.6% in 2014 (POTRAZ, 2014).

The secretary-general of the UN's Economic Commission for Africa highlighted some technological innovations in Africa, such as a low-cost mobile virtual tutor in East Africa, an m-farm application that allows farmers to access current information on agricultural trends and a virtual platform that represents a meeting place for buyers and sellers, among others (Lopez, 2014). Mobile phones have found their way into the poor rural communities of Africa, raising hopes that they would address some challenges related to livelihood, such as the improvement of agricultural activities through the provision of timely information (Mcnamara, Belden, Kelly, Pehu, & Kevin, 2011). Research has revealed that consumers often opt to acquire mobile phones, even if they do not have the income to do so (Wesolowsk, Eagle, Noor, Snow, & Buckee, 2012; Quadir, 2013). This amplifies the potential role that the mobile phone plays even among the poorest citizens. In developing countries, people may often sacrifice their meals for airtime to communicate and this cements the role of mobile phones as a tool for day-to-day living. This was confirmed by research in South Africa, which found that 41.2% would forgo their meals just to be able to communicate (Rey-Moreno, Blignaut, Tucker, & May, 2016). These scholars highlight the possibilities inherent in mobile phone applications and the effect they have on poor communities. The mobile phone is foremost a communication tool, its ubiquitous nature, improved access to the internet are some of the greatest innovations that have the potential to change the economic landscape of developing nations (Andjelkovic, 2010).

Access to information has been a major challenge for rural communities, limiting them from making accurate and timely decisions that help them to access market prices and buyers (Anandaraja, Rathakrishnan, & Philip, 2006; Mtega, 2012). ICTs are a vital source of information and knowledge that assists communities to make informed decisions through the provision and access to information and they are central drivers in supporting rural socioeconomic development (Pade-Khene & Sewry, 2011). Many economies in Africa are agrarian and the contributions made by subsistence farmers are enormous, despite the lack of skills and information. Rural communities still rely on each other for information on new and better methods of farming, on better varieties of crops that offer higher yields, weather patterns and soil conditions. Several NGOs provide technical support and advisory services in rural communities, but donor fatigue has crept in and most of them have closed (Mbiba, 2006; Hansen, 2011). Indigenous knowledge systems play a critical role in preserving and passing information and knowledge from one generation to another, and ICTs could be employed to document such knowledge systems, as they are slowly becoming extinct (Mcnamara, Belden, Kelly, Pehu, & Kevin, 2011). Access to such socioeconomic information could be through ICTs, such as mobile phones.

Rashid and Elder (2009) concluded that mobile phones had become a dominant mode of communication in the developing world and had found their way into the most remote and poverty-stricken areas. Many scholars, researchers and organisations have agreed on the potential of ICTs to promote socioeconomic development in developing countries and reduce poverty by enhancing business processes, allowing access to global markets and improving the flow of business transactions (Rashid & Elder, 2009; FAO, 2013; ITU, 2014; World Bank, 2011; Deen-Swarray, Moyo, & Stork, 2013).

3.7 Relationship between mobile phone growth and economic development

Developing regions have witnessed an increased growth in mobile phone infrastructure, leapfrogging the fixed telephone at a faster rate than global averages. A causal relationship has been observed between telecommunications infrastructure investment and economic growth, and the advent of the mobile phone has cemented that assertion by revealing that a 0.03 percent growth in GDP is realised through every one percent increase in mobile phone penetration

(May & Adera, 2011). The GSMA group reported that a 10% increase in mobile phone penetration resulted in a 4.2% increase in Total Factor Productivity and a GDP per capita growth of 1.2 percentage points (Waverman, Meschi, & Fuss, 2005; GSMA, 2012). Other studies conducted by the World Bank also revealed that a broadband penetration increase of 10% would result about 1.5% increase in GDP per capita growth (World Bank, 2015). The internet will fuel economic growth in Africa and contribute more than $300 billion in GDP by 2025 (GSMA, 2016). The literature cited in this section indicates a positive correlation between the use of mobile phone applications in rural communities and improved socioeconomic development. The GSMA (2016) reported that, to realise this target, there must be collaboration between governments and mobile operators and development agents to increase digital inclusion and strengthening of local content ecosystems. Developing this mobile phone application will help rural communities in Bulilima to access new socioeconomic possibilities.

3.8 Growth of mobile phone ownership in Africa

The developing world is the largest consumer of mobile phones, with India recording a staggering 20 million new mobile phone subscribers per month, with many illiterate and semi-literate people seemingly having no problem on learning how to use a mobile phone (Assa, 2011). The African Partnership Forum (APF) in 2008 reported that ICTs were increasingly becoming an efficient tool for accessing new markets and business opportunities, resulting in improved profitability, while affording the poor a platform to air their views (Ngumbuke, 2010). The growth of mobile phone use in Africa is contributing to improve business activities, through the reduction of communication costs, improved access to markets, access to financial services and health information (Aker & Mbiti, 2010). The mobile phone is being viewed by many as a tool and driver for socioeconomic development in the developing world, while it is a primary tool for communication in Africa, promising social and empowerment initiatives for the poor (Ekine, 2008; Ngange & Beng, 2017).

Although the African continent has lagged behind in many ways, it has witnessed tremendous growth in mobile phone applications that target healthcare, agricultural information, e-government and other that apps that concern learning and finance – Ecocash, iCow, Mixit, Mafuta-go and Afritab (Lopez, 2013). A report highlights that Africa is the second most active region, with 59.45% of mobile internet traffic as a percentage of total internet traffic, trailing Asia, which leads with 65%, compared with a global average of 49.73% (Go-Globe, 2017). Mobile phones are changing business and lifestyle activities in Africa, particularly in hard-to-reach places, where this disruptive yet very simple technology is providing solutions for the continent. Mobile phones are reaching people in Africa's cities, towns and villages more rapidly than anywhere else in the world, promising to promote socioeconomic development (Aker & Mbiti, 2010). More so, research conducted by the Pew Group revealed that mobile phone ownership in South Africa had increased from 33% in 2002 to 89% in 2014, while for Ghana the increase was from eight percent to 83%, from 2002 to 2014, and for Zimbabwe, from about eight percent in 2002 to 100% in 2014, as shown in figure 2.1.

In Zimbabwe, mobile phone penetration in rural areas per household was reported at 84%, while that of urban populations was 97% in 2014 and these figures will keep on rising as the price of mobile phones and data continues to drop tremendously (Zimstats, 2014). Statistics reveal that Zimbabwe is ahead, in comparison with an average household mobile phone ownership, with the sub-Saharan Africa region having an average of about 61%, as reported by the Gallup Group, (2016). This provides a fertile ground for new mobile phone applications and extensive services beyond the provision of traditional voice, text and data. Advances in mobile phone network infrastructure and improved investment has led to mobile phones virtually reaching most parts of Africa redefining communication and information access.

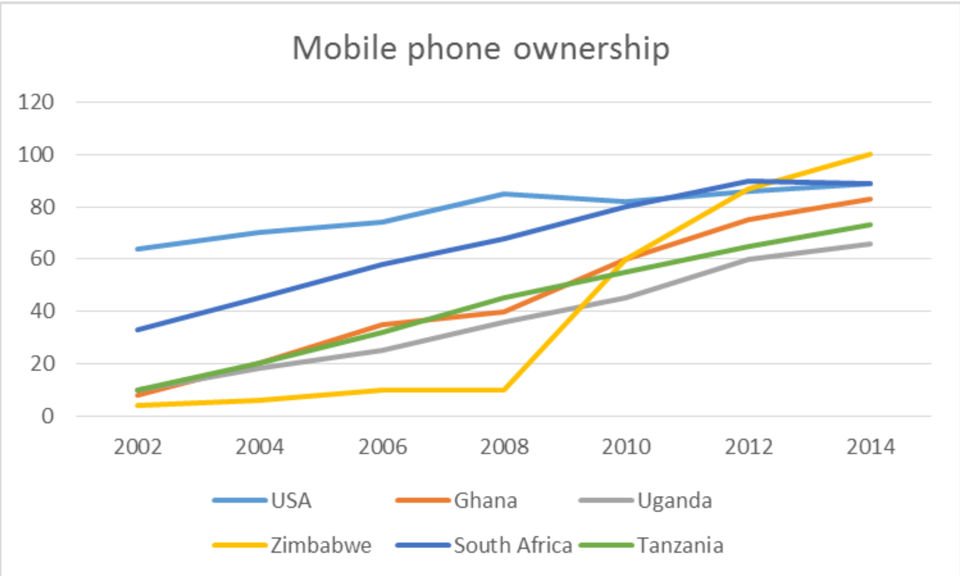

Figure 2.1: Cellphone Ownership, adapted from the Pew Research Centre, 2014

3.9 Causes of mobile phone internet growth

Improvements in telecommunications network infrastructure can offer new avenues for improving the lives of rural communities. These may include remote access to healthcare information, mobile money services, learning opportunities and agricultural information. The number of global internet users has grown from 1.023 billion in 2006 to 3.611 billion users in 2016, with about 70% of internet users living in developing countries (Internet World Stats, 2016). Global mobile broadband subscriptions will reach 8.3 billion in the next five years, with 55% of broadband subscribers living in developing countries (ITU, 2017, Molla, 2017). Mobile internet traffic will rise by over 300% in 2014 to 21 exabytes in 2017, as consumers spend more time online and by end of 2016 traffic had surpassed this forecast and had risen to 87 exabytes (Lunden, 2013; CISCO, 2017). More than 10 years ago, the Vodafone group concluded that the mobile phone infrastructure investment had a shorter return on investment, revealing that the cost of setting up such infrastructure was six times lower than that pertaining to a fixed line and easier to expand (Vodafone, 2005). Some developing countries such as the Central Africa Republic were yet to establish fixed landline telephone networks, have leap frogged into the digital age (World Bank, 2008).

This phenomenal internet growth over the years has been fuelled by high mobile phone penetration rates, apps, social media, breakthroughs made with wi-fi and other developments in broadband technology. Mobile phone applications have been the dominant mode of access to the internet, with surveys in the US revealing that 86% of users' time on the mobile internet was spent through applications (Internet Society, 2015).

To enable communication in a remote rural village in Mexico that did not have a mobile phone network, as major operators had deemed it uneconomical, the villagers banded together to build their own network and the charges were 13 times less than those of the major players in the cities (Wade, 2015). Internet growth has not been uniformly taking place everywhere in Africa, as the ITU reported that only two percent of the population in Ethiopia had access to the internet and if the Mexican experience could be replicated in Ethiopia, this would improve information access and communication (ITU, 2014). The telecommunication regulator reported that broadband internet in Zimbabwe had increased from about 0.45% in 2007 to 50.1% in 2016, as shown in figure 2.2 (POTRAZ, 2014). This remarkable growth rate of over 1200% was due to the rapid growth of mobile phone usage, reduced data costs and improvements in mobile phone coverage in the country. Mobile phones have driven broadband penetration to amazing levels that other technologies have failed to reach, thereby unlocking information access across the digital divide. Mobile phones are becoming ubiquitous and the world has realised that mobile data presents new opportunities for development, although challenges such as availability, affordability and accessibility must still be tackled (Cartesian, 2014).

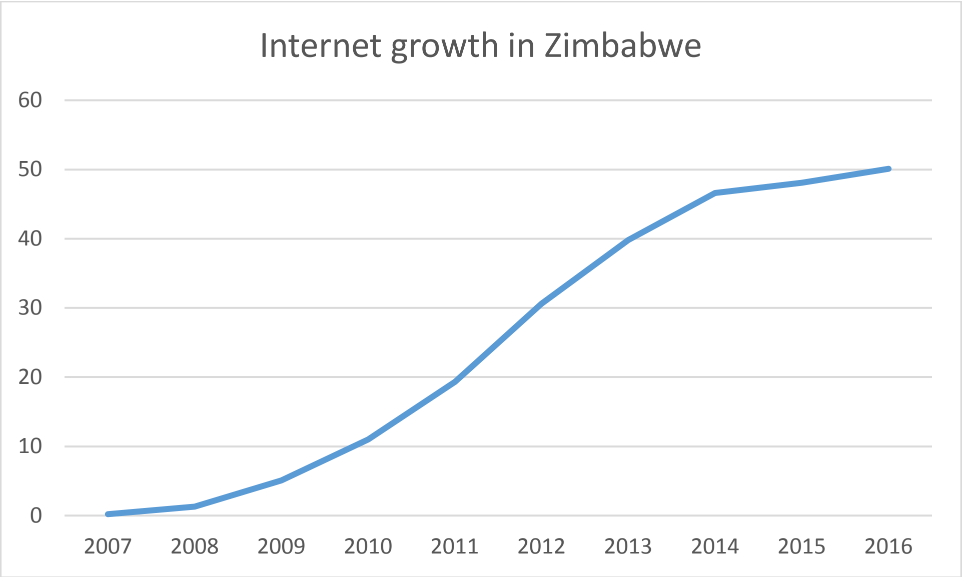

Figure 2.2: Internet penetration, POTRAZ 2012, 2016

3.10 Mobile phone subscriptions

The ITU forecasted that by the end of 2016, the number of mobile phone subscribers would reach seven billion, representing 96% of the earth's population and by mid-2017, the world had 7.7 billion subscribers (ITU, 2014; ITU, 2017). Surprisingly, it was found that mobile phone usage and growth was higher in developing countries, with more usage by the world's poorest nations. The results of a study by the Cartesian group revealed that most people in the world's poorest countries had regular access or owned a mobile phone (Cartesian, 2014). Goodman and Harris (2010) noted that Africa's mobile phone growth rate was 47% annually, compared to the global average growth rate of 20%, implying that Africa was poised to take advantage of the new opportunities that such phones provided. A study carried out by GSMA revealed that the cost of mobile phones had dropped by over 80% from an average price of about $300 in 2003 to about $60 in 2013 (GSMA, 2014). As the cost of data is falling a considerable increase in the use of smartphones that can access the internet has been noted (Cartesian, 2014). The Gullup group reported that mobile phone ownership grew from 26% in 2008 to 80% in 2013, while POTRAZ reported that mobile phone ownership in Zimbabwe among the adult population had steadily increased as reflected by over 100% penetration (Gallup, 2014; POTRAZ, 2017). This positive outlook on internet growth in Africa requires home based solutions that will transform improved internet access into improved livelihoods, this proposed application has the potential to change the information access challenges faced by rural communities.

3.11 Literacy levels

Low literacy levels, in some cases, have failed to hinder internet growth. Studies in India have revealed that mobile phone applications are used in rural communities, where most people are illiterate, through the means of audio-visuals and graphics, thus enabling these communities to interact with the digital content (National Geographic, 2012). The average literacy level in sub-Saharan Africa is about 64%, while Guinea has the lowest literacy levels of about 25% (UNESCO, 2013; Damasen & Uhomoibhi, 2014). Zimbabwe ranks amongst the top countries in Africa, with literacy levels of 99% for the 15 to 24-year olds, and the government has ensured that almost all children of school-going age have access to education (UNESCO, 2012). To foster any development, information must be accessible and understood within a community's context for proper utilisation. While low literacy levels hinder deployment of ICTs in most countries in the Global South, at 90% adult literacy rates, rural populations of Zimbabwe can generally read and write, and are therefore capable of using mobile phone applications.

3.12 Android platform and decreasing prices of mobile phones

Globally, the smartphone and tablet have become a part of every household and have an effect on how people live, interact and are influencing every aspect of human life. The cost of data, mobile phones and tablets has decreased tremendously, and in most developing countries, mobile internet is the only option available to access the internet (Alliance for affordable internet, 2017). The global mobile application market is exploding, with over two million apps and mobile app downloads expected to exceed 268 billion by end of 2017, while global app revenues were forecast to increase from $35 billion in 2014 to over $77 billion in 2017 (Business 2 Community, 2017). Revenue from mobile apps will continue to grow and this present an opportunity for countries in the global South to make inroads in the digital space.

This remarkable growth is due to the affordability of low-cost devices, consumer demand for cheaper data and mobile phone applications. The GSMA group predicted that the growing use of smartphones and tablets would increase data traffic in sub-Saharan Africa 20-fold, from 2013 to 2019 (GSMA, 2014). The Android phone is very popular in developing countries, as most low-income customers prefer these devices, which are more affordable, when compared to Apple’s iOS. In 2015, India had more than 220 million smartphone users and recorded the greatest number of app downloads from Google Play at more than 3.6 billion (Quartz, 2017).

Mobile phone operators have also responded by offering promotions that increase connectivity, with Econet in Zimbabwe launching an unlimited WhatsApp bundle that encourages subscribers to move to affordable data-driven services and Telecel offering free access to Facebook (GSMA, 2014). The three mobile phone operators reported an increase in mobile data utilisation of 25% within 12 months (POTRAZ, 2016). This continuous growth in data usage provides an opportunity to develop applications that can improve lives of rural communities.

3.13 Higher speed networks

In developing countries, mobile broadband is prohibitively expensive and this has led to a minimal use of applications that connect to faster 3G and 4G networks. Most mobile phones found in rural communities can connect to the slower 2G network. This means that over the years the design of most mobile phone apps for the developing world had to be compatible for use on the slower 2G network. Breakthroughs in 4G wireless networks will allow transmission of data over longer distances using the same amount of power employed by previous wireless technologies such as 3G (IEEE, 2011). Sub-Saharan Africa has experienced some growth in the installation of faster 4G and LTE networks, which support higher bandwidths, especially in urban centres. LTE networks can offer high speeds that allow subscribers to watch internet TV, video stream and use other apps that require fast internet. When users realise that they can download movies, files and make Skype and WhatsApp calls, the use of the internet will increase. This means that mobile phone apps will be utilised, when users know their value and function. In Zimbabwe, the LTE network is currently at 10.64%, but this figure will continue to improve (POTRAZ, 2017). In the third quarter of 2017, Zimbabwe registered 4,793 2G base stations, constituting 57.9% and 2,604 3G base stations equivalent to 31.5% and 881 LTE, which is 10.6% (POTRAZ, 2017). From this literature it is clear that there is a steady increase in faster 3G and LTE networks which are finding their way into the rural areas, and therefore it is worth considering developing mobile apps for rural communities.

3.14 Mobile phone applications for rural communities

Mobile phones can support socioeconomic development in rural areas by providing information for individuals to make choices and act based on it for socioeconomic empowerment (Heeks & Duncombe, 2001). Mobile phone applications promise to provide the most economic, practical and accessible routes to information, markets, governance and finance for millions of people excluded from the digital superhighway (NHS, 2014). Rural communities can use mobile phones and other ICTs to enable rural extension workers to gather, store, retrieve and disseminate a broad range of information needed by farmers and rural communities (Agbelemoge, Dada, & Alabi, 2015). In 2012, the World Bank Group highlighted that ICTs could be used in developing countries as a means of overcoming poverty and fostering economic growth – they could provide opportunities, improve accountability and governance, and facilitate better access to education (Meng, Samah, & Omar, 2013). From the literature, it is evident that mobile phone applications can provide a more economical and feasible way to reach millions of people in Africa, who were once excluded from the information super-highway.

E-Europe was setup with the aim of promoting economic activities that improve the quality of life by providing information to disadvantaged and excluded communities such as rural inhabitants (Hanke, 2009). Most rural communities in Kenya now have access to mobile phone networks, which has brought benefits such as employment and improved access to information, and spurred socioeconomic development in the rural areas (Wamuyu & Maharaj, 2011). The Grameen Foundation launched a mobile phone application for poor rural communities in Uganda, which enables knowledge workers to access and disseminate information relating to farming and marketing, and fill other information gaps (Campenhout, 2012). In developed countries, a further innovation is m-participation, which strengthens citizen engagement with government, allowing citizens to connect with each other to share information and determine how government programmes and policies are implemented (Junghoon, Dulal, Hyoung, & Shin., 2012). For example, the proliferation of mobile phones, particularly smartphones in India, allows citizens to access e-government information. In Kelara state, local government has made services – such as checking the voters' roll, licence registrations and renewals and casting ballots – available on mobile phones (Paula, Gregory, & June, 2011).

In rural communities, text messaging on mobile phones is one of the most important tools for communication, although it has limitations, such as the number of words that can be transmitted and a failure to send images. Some top mobile phone applications that have transformed the lives of people in Africa include M-Pesa, Vula mobile, Mixit, Ushahidi, MPedigree, Afrinolly and mFarm, among others, which cover health, agriculture, mobile money and education (Africa.com, 2015).

3.14.1 Mobile phone applications augmenting health delivery

Many people in developing countries are dying from diseases and conditions that are preventable. The reasons include poverty, lack of access to information, lack of a voice to make social services work for them and lack of access to medical facilities (World Bank, 2014; Health Poverty Action, 2016). Hindrances to ICT adoption in rural areas are: lack of ICT infrastructure, poor settlement patterns and low-density living, and poverty in developing countries (World Bank, 2014; Health Poverty Action, 2016). The developing world remains the largest market for mobile phone users, accounting for 64% of the global market, and this appetite for technology can extend to help solve the myriad health problems in developing countries (UN, 2007; Rasner, 2013). Mobile phones have become central to people's lives and are capable of promoting health management, through apps that allow clinical conditions to be monitored from home (Hemavathy, 2014). A 2011 study revealed that more than 30% of medical doctors in the United Kingdom (UK) were using smartphones in their workplace and, by 2012, this number would rise to 83% (Baumgart, 2011). Another study that was carried out in 2015 revealed that 79.3% of the doctors surveyed in the UK were using their smartphones for clinical work (Patel, et al., 2015). In developed countries, smartphones have been used to support healthcare and have functions such as global positioning systems (GPS), video and camera functions, internet and SMS. Some of the apps facilitate the monitoring, by health specialists, of obesity and weight concerns, substance abuse, mental health and HIV/Aids (Gustafson, et al., 2011).These studies buttress the use of mobile apps in improving access to health information and improving health delivery.

Public and private partnerships have been established to drive the use of mobile phone technologies in supporting health care. The WHO has described mHealth as the use of mobile phones, patient monitoring devices, personal digital assistants and other wireless applications to support personal or public health (IICD, 2014). According to a WHO report on mHealth in 2011, mobile phone apps currently being researched globally for health care include medication and treatment compliance, telemedicine, emergency management and health promotion (DeSouza, Rashmi, Vasanthi, Joseph, & Rodrigues, 2014). Research conducted in China in 2015 revealed that mobile phone usage among caregivers for health purposes was very high in Zhao county, with about 98.8% of participants using text messages, although some experienced problems such as running out of airtime credit, batteries dying during operation and phones breaking down (Michelle, et al., 2015). A mobile phone-based diabetes patient coaching system also allows sufferers to enter self-care records, such as carbohydrate, sugar and glucose levels, and details about their general condition into the mobile phone, allowing specialists to provide real-time feedback, and this improves healthcare (Quinn, et al., 2011).

In Vietnam, more than 78% of HIV/Aids patients interviewed for a study revealed that they were willing to use their mobile phones as tools for drug adherence (Tran & Houston, 2012). Nigeria, like many developing countries in Africa, has a high doctor-to-nurse-to-patient ratio and semi-skilled community extension workers assist in the provision of health care, particularly in rural communities. In 2012, a mobile phone-based case management and decision support system was introduced in Nigeria and had a tremendously positive effect (McNabb, et al., 2015).

In sub-Saharan Africa, malaria is one of the main causes of death for children aged under five. In this regard, rural villagers in Mali and Senegal have been given a simple mobile phone, containing an app called Mamma, which allows community health workers to monitor and help prevent diseases (WHO, 2013). The app assists in regularly screening patients for malaria symptoms and sharing this data with health specialists (IICD, 2014). Vula Mobile is a South African based healthcare app that allows healthcare specialists to assist public health care workers in remote and disadvantaged areas through instant messaging or voice call (Appsafrica, 2016). Studies in Kenya noted that the mobile phone was used as a tool to ensure that patients on antiretroviral treatment adhered to their strict treatment regime and this had a positive impact on viral suppression and improved health (Lester, et al., 2010). All of the above health applications would be of great use in the Bulilima district, as many health care centres in rural communities in Zimbabwe are ill-equipped in terms of drugs and medical staff, and diseases such HIV/Aids, malaria and diabetes remain top killers.

In Zimbabwe, Econet’s dial-a-doctor project, launched in February 2015, allows subscribers to instantly seek medical help from participating or registered doctors from the comfort of their homes (Econet, 2015). This means that rural communities, constrained by poor and inaccessible road networks and distant medical facilities in remote parts of the country, can now access top doctors for consultation, just like their urban counterparts (Mudadigwa, 2016). Access to medical information must be backed up with the availability of drugs and health personnel.

Mobile phones, which are becoming more accessible for ordinary people, as the cost of phones and data have considerably declined, provide functions such as alarms and alert systems – used to assist patients to take their medication or respond to a problem – as well as email tools, websites and social media platforms (Gustafson, et al., 2011). Patients can now not only set up reminders and alerts to remind them to take prescribed medication, plus access websites with health-related information, but also use the phone's ordinary functions such as cameras which can take images (Tran & Houston, 2012). It is estimated that mobile phone apps will extend to and cover more than 1.7 billion patients globally, thereby improving healthcare and quality of life (Nguyen & Poo, 2016).

Research in Uganda into the use of mobile phones, in order to improve clinic attendance among antiretroviral treatment groups in rural communities, concluded that the phones could be utilised in the fight against most of the chronic diseases in Africa (Kunutsor, et al., 2010). This was because of the mobile phone's availability and ease of use, along with technological advances in signal strength and the low cost of text and voice messaging, due to strong competition. Studies undertaken elsewhere provided an impetus for this research, which explores how the use of mobile phone apps could be used to increase access to health information in Zimbabwe's rural districts.

3.14.2 Mobile phone applications for financial inclusiveness

Most of the 2.5 billion adults without bank accounts live in developing nations and the mobile phone promises to reduce financial exclusion by providing simple options for the poor with regard to improving their access to financial services (ITU, 2013). It has been difficult for rural people to open bank accounts, as banks have stringent requirements, such constant source of income, formal identification and proof of residence. The telephone has been a major tool for supporting business, with a World Bank study in 1997 revealing that the phone could determine the success or failure of rural businesses in Zimbabwe (Kayani & Dymond, 1997). Mobile money platforms allow the unbanked rural communities to perform transactions that include savings, transferring and receiving money conveniently, airtime top-up and transfer and other services they could not previously access.

Zimbabwe experienced an acute cash shortage in 2017, with cash withdrawals becoming impossible forcing consumers to engage in non-cash transactions (Financial Gazette, 2017; RBZ, 2016). The cash shortages affected rural citizens more deeply, as limited financial institutions serve these communities. However, mobile money and other financial services, accessed through mobile phones, can alleviate such challenges in rural areas. Before the launch of mobile money services, most rural communities in Zimbabwe used bus companies to receive cash sent by relatives in urban centres. In many cases, the money would take days to reach the recipients and, in some cases, bus drivers would retain the cash for their own use, thus depriving the intended recipients (Davidson & McCarty, 2011). The charge for ferrying the cash was generally about 10% of the total amount. The launch of Ecocash in 2012, a mobile phone money service provided by Econet Wireless Zimbabwe, allowed most rural people to harness the power of ICTs. Just 18 months after its launch, about 2.3 million Zimbabweans had registered Ecocash, representing close to 20% of the population (POTRAZ, 2017).

As of 2014, only 24% of the Zimbabwean population had access to banking services, while 76% did not have bank accounts (FinMark Trust, 2015). Most of the unbanked resided in rural areas and this compelled the Zimbabwean government to craft strategies that ensured financial inclusion by regulating the use of mobile money, as highlighted in figure 2.4. The number of Zimbabweans with access to mobile money services reached more than seven million in 2015, about 61% of the population (POTRAZ, 2016). This meant that if the mobile money system was vigorously promoted, it could become a solution for financial inclusiveness in rural communities of Zimbabwe, as shown in the figure 2.3.

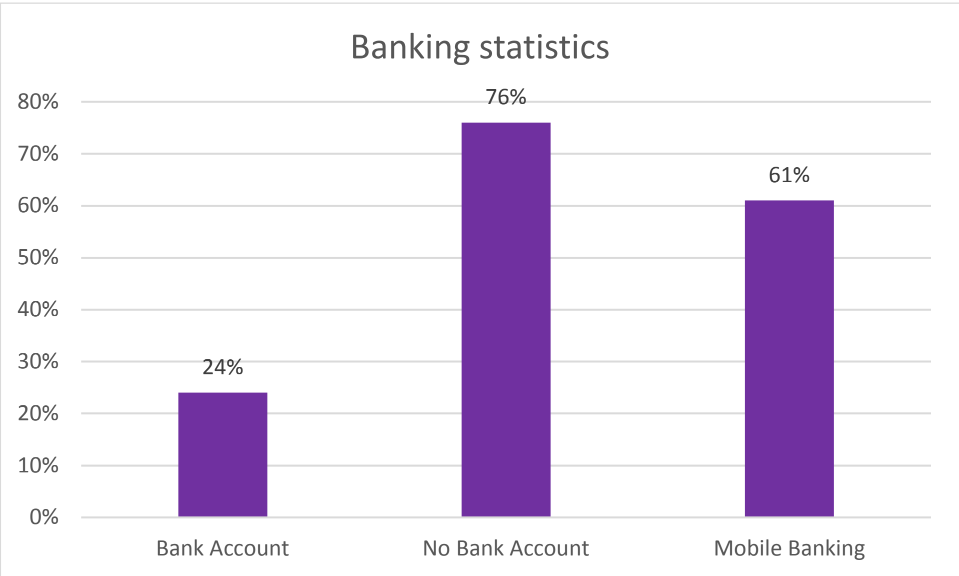

Figure 2.3: Financial inclusion, by Potraz, 2015 and FinMark Trust, 2015

Low economic activity in rural areas means that some household incomes need a boost from remittances sent by relatives and friends who have migrated to urban centres or other countries. In rural communities, traditional banking systems – usually used to pay for these remittances – are mostly unavailable. The traditional means of sending money to rural areas is through bus drivers or people travelling to the same area, but these methods are associated with risks, high costs and delays. Mobile money services eliminate these factors, as sending and receiving money is done instantly and cash can be collected from mobile money agents found in rural areas (Kikulwe, Fischer, & Qaim, 2014).

Mobile finance is being widely adopted in the sub-Saharan region, mainly due to the unprecedented uptake of mobile phones by even the poorest communities, with governments in the region allowing private mobile phone companies to inject more capital into the telecommunications sector (Duncombe, 2012). Mobile phone banking allows consumers to access and interact with their bank accounts anytime, anywhere, thus offering banking convenience (Akturan & Tezcan, 2012). Mobile money apps that are commonly used include, among others, person-to-person (P2P) transactions, government-to-person (g2p) transactions, savings, bill payments and remittances (Meyer, 2015). These mobile money services allow rural communities to keep their money safe, save and earn interest, pay bills and transfer funds locally and across large distances, all of which were impossible in the past. Other mobile money service providers in Zimbabwe include Telecash, by Telecel, and One Wallet, by Netone, which share less than 20% of the mobile money market. In Zimbabwe, elderly people have to travel from rural areas to collect their paltry monthly pensions in urban centres. Since transport costs are prohibitive, this rapidly exhausts their pensions. The Zimbabwean government, however, could use mobile money services for paying out monthly pensions, which would greatly benefit rural communities.

M-Pesa is a mobile money service that has processed over 6 billion transactions, has allowed unbanked rural Kenyans to conduct financial services such as transferring money, making savings, accessing loans, paying for goods and services (CISCO, 2013; Joseph, 2017). Within two years of its launch, M-Pesa had reached over 12 million subscribers and in 2009 accounted for more than 50% of the adult population (Jack & Suri, 2010). M-Pesa has since surpassed 30 million users and has spread to over 10 countries with transactions valued at over $500 million (World Bank, 2012; Monks, 2017). In India, as part of the Grameen Bank's thrust to provide low-interest loans to rural communities, the Grameenphone Company installed village phones in Bangladesh, enabling poor rural communities to apply new technologies, resulting improved levels of productivity and socioeconomic development (Shams, 2009). In Zimbabwe, the Kumusika mobile app allows Zimbabweans to meet in an online market, in order to buy and sell a wide range of products. It allows listings to be viewed and direct engagement between buyer and seller (Google Play, 2017).

3.14.3 Mobile phones and access to national news

The inhabitants of central India's remote jungles of Chhattisgarh can now access a mobile phone network, which allows them to report news on a website. Everyone in the community can read it, so this innovation bridges the digital divide that was once experienced (Acharya, 2010). Almost two decades ago, the mobile phone presented new opportunities in the field of communication, as it provided a new platform for the dissemination of information and news and updates, sports, weather, and market reports could be delivered instantly (Mena report, 2002). In a survey carried out by the *China Daily* newspaper, 93.5% of respondents said that they read the news on their mobile phones, 77.4% check news on their phones daily and 68.4% prefer using a mobile app, rather than a browser, to access news (China Daily, 2016). In contrast, the rural communities of Matabeleland have no other alternative sources of news, except radio and television broadcasts.

To reach out to more people, most television stations have launched the distribution of programmes through mobile phones. Japan's BeeTV now produces programmes for mobile phones, covering news, drama, comedy and music, among others (Madden, 2010). Mobiles have allowed citizens in developing countries such as Mozambique and Nigeria to lodge complaints through an SMS platform, plus report violent crimes to a central server (Aker & Mbiti, 2010). Studies conducted by Semali and Asino (2014) in Namibia revealed the critical role that the mobile phone could play, in allowing news organisations to engage with communities whose members could clarify details about certain issues reported during major newscasts. Sliide is a mobile phone application, operating in Africa, that provides users with personalised news from national and international sources and it uses its advertising revenue to buy mobile data, which is still expensive on the continent (appsafrica, 2017). Sliide's spin-off for users is that they can earn data by completing surveys.

In contrast, most districts in Matabeleland South have limited or no access to radio and television, which means that rural inhabitants are cut off from accessing any national development information (News Day, 2016). This means they remain ignorant of vital information that may concern their socioeconomic development (POTRAZ, 2015). Readership of newspapers has declined 67% in urban centres and 33% in rural areas, and strategies to encourage Zimbabweans to access news on their mobiles will help ensure that the public is well informed (Tech Target, 2013). Mobile phone companies in Zimbabwe, in partnership with national news broadcasters, could be innovative and package the national news for rural communities who live in places that do not have access to radio and television signals. In Zimbabwe, soccer is one of the most followed sports and, due to the lack of radio and television reception, communities in rural areas are often denied access to sport news. Mobile phones, though, could offer live radio commentary and sports updates.

A human rights group in Matabeleland described the failure by the Zimbabwean government to ensure that there was adequate radio and television reception in rural regions as a violation of the constitutional and fundamental rights and freedoms of its citizens – including the right to information, education, health and other freedoms (News Day, 2016). The absence of such reception in most districts of Matabeleland South compounds problems that communities in these districts face, as they cannot access weather forecasts, information on rainfall patterns, markets and disease outbreaks and control (Matsa & Simphiwe, 2014). The mobile app can provide information which is currently not available, and traditionally disseminated through newspapers, radio and television which impacts their day to day living.

3.14.4 Mobile phones and entertainment

Indian farmers and rural villagers in Devarahati, who do not own a television, have been using their mobile phones as a source of entertainment (National Geographic, 2012). They were also benefiting from its other features, including the built-in flashlight, which they used as a torch Today's mobiles have powerful cameras, too, and other features pertaining to entertainment – for example, movie watching – and a radio receiver and MP3 player for music as revealed by the National Geographic in 2012. The mobile phone entertainment industry has grown tremendously, fuelled by close to two billion mobile phone sales in 2013 (ITU, 2014). Afrinolly allows users to download latest movies and watch trailers from the $5 billion movie industry, app downloads have surpassed 4m making it the most popular app developed in Africa (MTN, 2013; reporters, 2015). The mobile phone and its applications allow people to pass the time if, for example, they are waiting at a bus stop or at the clinic. Mobiles, in short, can alleviate boredom. Rural communities in Zimbabwe, with limited access to radio and television, are denied entertainment, so the mobile phone app could also offer an alternative source for this.

3.14.5 Mobile phone applications for agricultural productivity

In rural communities, communication and transport is a hindrance to productivity, with villages situated long distances from market places, so obtaining prices and other related information remains a challenge. However, having a proliferation of mobile phones in rural areas could address this issue. FAO has ascertained that ICTs are providing better access to the information required by farmers to be more productive and ensure effective management of farming activities – this includes inputs, ploughing, managing crops, post-harvest and marketing produce (FAO, 2013). Farmers in rural areas can use mobile money to pay farm labourers, their electricity and other utility bills, buy inputs and access loans. The combination of improved broadband and mobile internet, together with advancements in cloud computing and data mining, offers unlimited options to farmers, with a platform to access support as they grapple with complex value-chain decision-making concerning agricultural marketing information (FAO, 2013). The FAO has defined e-agriculture as an emerging technology, whose primary focus is to support the dissemination of agricultural information, thereby providing access to and use of information, and transforming agriculture from being input- to information-based (Collis, 2003; FAO, 2013). In developed and advanced economies, ICTs have been utilised in agricultural applications, including sensors to ascertain soil fertility and nutrients, and measure moisture content through the use of GIS and GPS; there are also applications for applying fertilizer and pest control, yet they have not been used in developing countries, whose economies are agrarian based (FAO, 2013).

There is a positive correlation between an increase in revenue and mobile phone usage by rural farmers. Studies carried out in Peru confirmed a 13% increase in per capita farm income, due to the use of mobile phones by rural farmers (Chong, Galdo, & Torero, 2005). The Akashganga app makes the production of milk a more viable and profitable venture for rural families, as they can apply ICTs to solve problems, such as weighing milk on electronic scales, testing fat content and producing data on the amounts owed to farmers (Narasimhaiah, 2009). Studies conducted in India among rural farmers and fishing communities support the conclusion that ICTs can improve income and quality of life among the rural poor (Goyal, 2010). There are a number of ICT enabled initiatives in India whose overall objectives have been to provide information and empower rural communities by reducing price disparities and reducing waste in the fish industry (Kannabiran & Banumathi, 2008). These include Gyandoot, E-Seva, Rasi, Lokvani and e-Choupal, among many others. E-Choupal, a supply chain management system that allows farmers to access market related information and contact producers, has boosted their profitability and competitiveness (Shubham, 2014).

Research work undertaken in Pakistan also revealed a positive correlation between mobile phone use by farmers and increased crop productivity (World Bank, 2008). Farmers could contact agricultural experts when their crops were under threat from diseases and easily obtain market-related information to determine prices and improve competitiveness (Naveed, et al., 2014). In countries such as Malaysia, ICTs and mobile phone applications are employed in navigation, with GPS used to locate and mark fishing zones, improving safety and enhance productivity (Zeinah, Samah, Omar, Bolong, & Shaffril, 2014). Also, in India, a new application targets illiterate farmer, allowing them to collaborate and share information relating to their cropping needs – such as fertilisers and pesticides, seeds and crop yield – using the audio-visuals of the application (National Geographic, 2012).

The FAO launched Teca in Uganda in 2010, a project to improve the lives of rural farmers, incorporating a web platform with online resources, discussion forums and query-and-response services that offer practical information on technologies and practices to assist small-scale producers (World Bank, 2011). One study (Adamides & Stylianou, 2013) concurred with a 2002 BBC report, which pointed out that Senegalese farmers using their mobile devices to check market prices before selling their produce earned 15% more profit, compared to those who did not. In Burkina Faso, an innovative project uses computers, solar-powered internet connectivity, digital cameras and projectors to communicate about the hygienic use of water in the district of Bokin (Ndyetabula, 2011). mFarm helps farmers to find buyers and provides information on price trends and farming tips (Mwangi, 2017).

Employing researchers to monitor plant diseases is expensive, but farmers in Tanzania have taken over the monitoring, through a project called The Digital Early Warning Network (Dewn). They are educated about plant disease symptoms and, with their mobile phones, send text messages when necessary to crop researchers. This is a cheaper option than employing experts and allows communities to be involved in issues that affect them (Ndyetabula, 2011). Regarding research carried out in Namibia and Tanzania, it was demonstrated that mobile phones could provide instant information, allowing farmers to market their crops and make critical and effective decisions within a variable value-chain system (Semali & Asino, 2014). A study by Aker and Mbiti (2010) of rural communities in Niger revealed that agricultural information, gathered through mobiles, reduced information search costs by more than 50%.

One mobile application, iCow, voted as one of the best in its field, provides rural farmers with information that helps them track the estrus cycle of their cows and provides tips on animal breeding and nutrition. It has resulted in increased milk production and improved gestation (Africa.com, 2015). In Zimbabwe, Econet wireless launched its Eco-farmer project, an application that allows commercial farmers to access agricultural information (Econet, 2015). The Zimbabwean government deployed agricultural extension workers to aid rural communities, through the provision of advisory services and technical support, although they remain inhibited by transport challenges. To overcome these challenges, mobile apps can be developed to connect extension workers to farmers. Apps can also link suppliers and buyers who live in diverse geographical locations and strengthen the value chain (Bank World, 2012).

3.14.6 SMS-based systems

Mobile phone penetration has grown rapidly over the last decade, with an increased use of SMS services in rural areas in Africa promising to improve healthcare – and more. Mobile phone instant messages were predicted to increase by about 500%, from 1.6 trillion messages in 2011 to about 7.7 trillion in 2016, due to the growth of the mobile phone industry and free SMS messages for users who connect to wireless internet with smartphones (Dickson, 2015). The SMS is one of the most popular mobile phone services, allowing users, especially the younger generation, to send brief messages to other mobile phones (Balakrishnan & Loo, 2012)

Several studies have determined that SMS interventions can assist patients to adhere to medication intake times – and allow health workers to monitor these patients (Zurovac, et al., 2013). SMS applications are useful for rural communities in Africa that are remote and do not have access to faster networks such as 4G. It is here that SMSs are used to send and receive information on topics such as disease control, drug adherence, anti-natal care, crop production and market prices (IICD, 2014; UNICEF, 2015; Kuek, Qiang, Dymond & Esselaar, 2011). In India, a federation of 239 women's self-help groups developed Vidivelli, a group that comprises 320 female goat farmers, who produce audio recordings and daily SMSs, which are sent to farmers on their mobile phones (Balasubramanian, Thamizol, Umar, & Kanwar, 2010). These women cover topics such as goat rearing, disease control and marketing management. The SMS system has been used to in Tanzania to support farmers to get real time information on weather, market prices and techniques on agricultural practice who pay about 100 Tsh (GSMA, 2015).

In Nairobi, Kenya, nurses with the Pumwani antiretroviral therapy management use the SMS platform on mobile phones to check on patients' progress and send messages reminding them to take their drugs (Lester, et al., 2010; IICD, 2014). Another project, Masiluleke, which was launched in South Africa in 2008, uses mobile technologies through an SMS platform to fight and combat the HIV/Aids and TB epidemics, thus it benefits from the popularity of mobile devices (Han, 2012). In the battle against the Ebola virus in Sierra Leone, UNICEF launched an SMS-based mobile reporting platform that utilised cloud-based, multi-language and multi-channel (SMS, voice and Twitter) architecture, allowing information on new admissions and results from tests to be sent to Freetown within seconds. There, medical experts received updates during their fight against the deadly virus, which caused more than 3,000 confirmed deaths in Sierra Leone alone (UNICEF, 2015). In another study, this time carried out in Kenya, it was found that 80.4% of participating patients sent and received text messages, whereas 20% could not, due to low literacy levels. It was also determined that 98.6% of health professionals owned a mobile phone and were using the SMS platform (Zurovac, et al., 2013). Rural communities in Zimbabwe can benefit through using SMS to alert communities on disasters such as disease outbreaks, phenomenal weather conditions and general information which affects their day to day living. The main disadvantage of SMS based systems is the cost per message, limited number of characters per message and its inability to support multimedia.

3.14.7 Mobile learning

At some point in history, the television and the textbook revolutionised learning. Today, mobile phones have begun to transform teaching and learning, more so in rural communities, where students have no access to textbooks or qualified teachers. In 2017, the Zimbabwean minister of primary and secondary education approved a policy that allowed primary and secondary school pupils to use smartphones while at school, for conducting research (Newsdzezimbabwe, 2015). The careful adoption of mobile phones in rural communities in Zimbabwe will promote lifelong learning in isolated communities. Today's youth are born into the digital age and are usually introduced to ICTs early on. One study (Traxler, 2009) noted that mobile phone applications would become a central tool for learning, as most rural communities in developing countries had myriad problems, including limited access to educational material and teachers. Teaching and learning have undergone transformation through innovations and reforms ushered in by mobile phones and associated wireless technologies. These offer endless possibilities and have resulted in the creation of a new generation of learners (Wang, Yu, & Wu, 2013).

The widespread global use of mobile phones and their grand entrance into rural villages of Africa holds promise for new prospects in tackling teaching and learning problems, through this new means of accessing information (Semali & Asino, 2014). The Commonwealth of Learning (COL) has recognised the importance of lifelong learning for farmers and that mobile phone technologies could be utilised to reach out to marginalised sections in rural communities in terms of transfer of knowledge through indigenous knowledge systems (Balasubramanian, Thamizol, Umar, & Kanwar, 2010). Teaching and learning have been greatly affected by the proliferation of mobile and wireless technologies, which provide an interactive, two-way learning experience that engages learners, compared to traditional teaching and learning methods that include PowerPoint presentations, whiteboards and slide projectors (Agbatogun, 2013). In developing countries, access to ICTs has been a challenge. Even schools in a well-resourced emerging nation such as South Africa have computer-to-pupil ratios of 1:33 or more, but the mobile phone revolution has surpassed that ratio within a few years of its adoption (Traxler & Vosloo, 2014). In South Africa, Microsoft unveiled a mobile phone app that makes learning mathematics personal and engaging, by allowing students to practice by taking exercises and tests (Microsoft, 2016). Microsoft unveiled a mobile phone app that makes learning mathematics personal and engaging, by allowing students to practice by taking exercises and tests in South Africa (Microsoft, 2016). Another project, dubbed “Dr Math”, was jointly developed by the Mereka institute and the University of Pretoria and integrated with MXit, enables school-going children to learn maths from anywhere through volunteer tutors (Chaka, 2012).

Advances in mobile phone technology use have affected even the least developed countries and this has led to the widespread use of mobile phones for learning purposes, better known as m-learning (Semali & Asino, 2014). Other research (Javier and Arturo, 2014) has determined that the mobile phone is a technological tool employed by institutions to support teaching and learning, with various emerging applications underpinning these pedagogical endeavours. The mobile phone has revolutionised the field of education by introducing new aspects to learning that are not confined by the teacher, or by space and time, but that allow students to learn 24/7, with the collaboration and sharing of knowledge (Wang, Yu, & Wu, 2013; Norman, Din, Nordin, & Ryberg, 2014).

Research conducted in the UK by Kukulska-Hulme (2010) concluded that mobile phones not only offered communication channels but also provided a platform for learners to engage in the learning process and improve their digital competencies. Another study conducted in a rural school in Mexico concluded that students from rural communities, with limited access to libraries and who lacked exposure to technology, could benefit more than their urban counterparts from their use of mobile phones, as their parents were more interested in their learning activities (Kim, et al., 2011). Many marginalised, poor rural communities lag behind in terms of access to education and mobiles offer expanded and unexpected learning opportunities, with the promise of improved administration and professional development (Traxler & Vosloo, 2014).

A few unresolved issues have been hindering the adoption of mobile phones in the classroom, including privacy, informal use, lack of guidelines for use and overload of information (Kukulska-Hulme, 2010). As their acceptance as a communication medium increases, such issues will be gradually addressed. Their portability allows teaching and learning to reach more students, and their interactive nature allows them to meet students' needs better than traditional teaching methods (Irby & Strong, 2013). Further research also revealed that mobile phones could extend the boundaries of education, by allowing teaching and learning to occur in places with no infrastructure, qualified teaching staff or even resources (Kim, et al., 2011). In Ethiopia, unassisted children who had never even held a book could learn the alphabet and games through a mobile phone application (Talbot, 2012).

Today's youth are at the forefront of the technology revolution and want to experiment with it – and mobile phones provide a platform for learners to engage with and easily master new concepts (Irby & Strong, 2013). Mobile phone technology has many educational and general advantages: it does not need a great deal of infrastructure; uses less electricity; is cheaper; more easily deployed; it is more accessible; it offers more learning opportunities in rural areas; and can be utilised in places where traditional learning may not easily take place (Kim, et al., 2011). Developing this mobile app can help in creating a reading culture which has been diminishing, as pupils and students have limited or no access to textbooks and reading material, thus inhibiting their learning.

3.15 Mobile phone application design using DSR

There is limited literature from developing countries that highlights the steps that are taken to design an artefact such as a mobile phone application. The output of a DSRM driven study is an artefact, developed with a purpose to solve problems affecting organisations and communities, enhancing existing solutions or models and theories (Hevner, March, Park, & Ram, 2004; Iivari, 2007; March and Storey, 2008). DSRM has been applied in designing an application to help in preserving indigenous farming knowledge which is passed through generations, encompassing information on crops and agricultural management knowledge tool in South Africa (van Rensburg & Vermaak, 2017). Mobile health applications for managing chronic diseases targeting underserved ethnic groupings have been successfully developed using DSR, following a user centred approach (Schnall, Rojas, Travers, Brown, & Bakken, 2014). Mobile applications have been designed through DSR to support ubiquitous and collaborative learning in developing countries like Nigeria, evaluation results revealed that students who used MobileEdu had a positive attitude towards learning than traditional methods (Oyelere, Suhonen, Wajiga, & Sutinen, 2018).

3.16 Justification for building the application

The literature covered several ways that have been used to convey information in rural areas such as mobile applications, telecentres, SMS based systems, traditional media such as radio, newspapers and television. Mobile applications are the most economic and effective tools that can be used for information dessimination. Kumar (2012) posited that successful deployment of ICT interventions in rural communities entails customising content to match the needs of the local community. Through the proposed ISDM and the DSR approach, community members were consulted and participated in the design, development and evaluation of the app. The application offers some interactivity by allowing the community to be involved in the creation of some of the content, which positively impacts the app’s usage (Best & Kumar, 2008; Internet.org, 2014). Research that was conducted by the GSMA group in 2016 noted that there was need to strengthen local content ecosystems to ensure that communities’ benefit from digital interventions.

3.17 Identifying research gaps

The studies reviewed reveal that, mobile applications have the potential to connect remote and poor rural communities, and allow them to access information vital to socioeconomic development. Communities using mobile phone applications can improve upon internal communication, fostering better development, and their external engagement with government.

There have been many motivations for this study, the first being that many rural communities in Zimbabwe have limited access to socioeconomic information. Therefore, the development of the mobile application has been tailored specifically to enhance their access to information, in order to improve their livelihood. Another motivating point for conducting this research is that mobile phone penetration rates and the provision of associated services are reaching saturation point in urban areas, but there is the need to capture new potential markets in rural communities marginalised in terms of information access. Previous research has targeted mobile applications for accessing individual categories of information needs in rural areas, including market prices, health and weather information, m-learning and mobile money services, yet few researchers have combined these socioeconomic categories into one place.

A further motivation for this study stemmed from conclusions drawn by Zhao (2008), about the need to carry out micro-level research to determine the impact of ICTs on the livelihoods of rural communities and correlate internet access to improve income generation and better access to education and health. What also prompted this research was the findings by Donner and Escobari (2010) that, in developing countries, mobile phones were most often the telecommunications entry point for poor rural communities, although their economic benefits and usage patterns had yet to be solidly documented.

Most rural communities in Matabeleland have no access to radio, television or fixed telephone landlines, so it is therefore important to maximise mobile phone penetration rates in rural areas and develop applications that allow communities to access contextual information relevant to their needs. A further motivation for this study concerned conclusions made by scholars and practitioners on the need to provide relevant local content that is meaningful to the development needs of the community. Through the development of the mobile phone application, communities in Bulilima will have improved access to local information that directly affects their lives. The application is designed in a way that it addresses low bandwidth and low incomes by supporting offline access. This resonates with the 2014 GSMA report, which highlighted that, for rural communities to adopt mobile phone internet and enjoy its benefits, there was the need for local content and in some cases in an appropriate language that was also mindful of literacy levels (Best & Kumar, 2008; GSMA, 2014). The study was also prompted by the results of research conducted by GSMA, which reported that 58% of respondents identified the lack of local relevant content as a barrier to internet adoption (GSMA, 2016). This mobile phone application will allow rural communities in Zimbabwe's Bulilima district to access local content that addresses the community's socioeconomic information needs. A further research motivation was the high doctor-to-patient ratio at over 1:250,000, with a dire need to promote telemedicine and access to health information (Pindula News, 2016).

A survey conducted by Zimstats in 2014 revealed that the average mobile phone ownership in Zimbabwe was about 90%, while the average literacy rate was 95% (Zimstats, 2014). This means that rural populations in Matabeleland South have the capacity to utilise the proposed mobile phone app. As highlighted in section 1.1 and section 2.14.7 rural Ethiopian children who have never read a book have been able to teach themselves to use preloaded mobile phone applications and, as an extension, the alphabet. Therefore, the populations of Bulilima will be able to adopt and use the proposed app. From the reviewed literature, no studies have been conducted on the use of apps for socioeconomic development in the rural communities of Zimbabwe, in particular those in Matabeleland South.

The mobile application industry in Zimbabwe is in its infancy and, therefore, there is need to create awareness so that more African countries could claim a reasonable share of the $77 billion global mobile app industry revenue, by strengthening national application development (Business 2 Community, 2017). Africa is second in terms of mobile internet traffic, as a percentage of total internet traffic, but has an insignificant share of global mobile phone app revenues. By promoting development and the use of applications, this share may very well increase.

3.18 Summary

From the literature that has been reviewed, it is clear that there is need to address challenges related to information access in rural communities. Telecentres which have been commonly used to enhance access to socioeconomic information such as health, agriculture, education and markets have heavily relied on donor funding which has dwindled. SMS based systems have also been used to propagate socioeconomic information, but have proved to be more expensive, less interactive and have limited text. Literature reviewed supports the role of mobile apps augmenting health delivery, agriculture, access to news, learning and entertainment. Most mobile phone applications reviewed were designed to offer a category of information. For this research, general information which is mainly provided through a telecentre will be provided. The major consideration is that rural communities have no access to traditional media such as radio, newspaper and television. The literature also reviewed some applications which have been developed using DSR methodology.

Chapter 3: Information access challenges faced by rural communities

3.1 Introduction

Some rural communities in Africa – including Ethiopia, Somalia and Mauritania, among others – are under-developed with limited access to basic services and their children have no educational opportunities, people die from preventable diseases as they have limited platforms for information access, such as the telephone, radio and television (Talbot, 2012). The information requirements for people in developed and developing countries, rural and urban barely differ, yet there is a huge disparity in terms of ease of access to information. Rural communities need information relating to their needs – health and social services – and perform financial transactions through government agencies and programs. Information that relates to political and civic choices should be made readily available. It should be easy to access information pertaining to community development, through traditional information sources, such as radio, television and newspapers.

Rural communities in sub-Saharan Africa face many challenges, with less than three percent of the rural population having access to a landline, over 400 million inhabitants have no access to electricity, accounting for about 70% of the population, while less than 29% of the roads are paved (World Bank, 2006; IEA, 2014). Efforts, made on the part of governments and donor organisations to improve upon the livelihoods of rural communities, remain hampered by a lack of access to the right information at the right time, which poses problems for decision-making. Information, which is an important ingredient in development, must be applied with capital, skills and labour. Consequently, rural communities have faced difficulties in selling and marketing their produce at a competitive price, due to lack of access to market prices (ITU, 2009; Nzie, Bidogeza, & Ngum, 2017). The unavailability of telecommunications infrastructure and the poor road network in Africa have remained unchanged, although the advent of mobile phones has allowed people to share and exchange information that is vital for their development (Ngumbuke, 2010). They have remained uncompetitive, as they face difficulties accessing marketplaces to ascertain the prices of commodities. Most rural schools remain inadequately resourced, which negatively affects the standard of education. Research, however, has revealed that mobile phone applications and tablet devices have gained popularity in supplementing the teaching and learning process, and are being employed in both formal and informal environments (Morris, Ramsay, & Chauhan, 2012). As mobile ownership rises even in rural communities, this increase will open new opportunities for learning material to reach more people, thereby improving the quality of education (Pew Research Center, 2017). ICTs can allow farmers to interact with experts and answer many questions, such as how to increase productivity, access markets and weather-related information in simple, more accurate ways (Oyewole, Ige, & Oyetunde, 2013).

3.2 Lack of access to socioeconomic development information

Access to community development information is an important ingredient for progress, yet rural communities, in some instances, cannot obtain such information. A remote village in Mexico with 2,500 inhabitants could not wait any longer, as it partnered with local universities and NGOs, to build its own mobile phone network after major cell phone companies regarded its connection to the grid unprofitable (Wade, 2015). Information access and communication are major attributes for rural development and rural communities must access information that is both current and appropriate to their development; mobile phones promise to provide this platform. Communicating important messages, such as death and burial notices, information on cattle sales, and community meetings has been through word of mouth and other traditional methods that are time-consuming.

The political and economic environment prevailing in Zimbabwe makes it problematic for companies and government agencies to access loans at reasonable rates to fund the expansion and roll-out of ICTs to cover rural communities, due to perceived country risks (Ministry of ICT, 2015). The sanctions imposed on Zimbabwe resulted in the disengagement by many donor organisations and multilateral organisations from socioeconomic development projects that they were working on in the country, this resulted in communities becoming vulnerable, as they struggle with challenges that include lack of access to information and communication technologies. Communities in Bulilima have limited access to local television, radio and newspapers, which are traditional sources for appropriate socioeconomic information. However, they can easily access radio and television signals from Botswana and South Africa which does not address their development needs (Maphosa, 2007; News Day, 2016). Telecommunications infrastructure in Bulilima has been extremely inadequate over the years, yet the improvement in mobile phone coverage is promising to reduce information and communication asymmetries, and improve socioeconomic development in rural communities.

3.2.1 Poor education

According to UNESCO, more than 43 million children in sub-Saharan Africa will not have the opportunity to attend school (UNESCO, 2016). Out of those who get the chance to be schooled, 17 million will learn so little that they will be worse off than those who never attended school (van Fleet, 2012). The BBC reported that over 10 million primary school pupils in sub-Saharan Africa drop out every year, yet those who do finish have deficient literacy and numeracy skills, due to the unavailability of teachers and resources such as textbooks (BBC, 2014). In Uganda, Community Knowledge workers functioned as village-based intermediaries, providing support and information to poor communities through a Grameen Foundation initiative (Qiang, Kuek, Dymond, & Esselaar, 2011). Developed countries make huge investments in new mobile phone and ICT infrastructure, and upgrades to existing infrastructure, enabling the transmission of large amounts of data at speeds that can facilitate the integration of mobile technologies into the classroom. Studies conducted on mobile learning revealed that mobile apps produce learning material anytime, anywhere, thus increasing students' productivity and access to information (Mohamed, Hafedh, & Osama, 2013).

The Zimbabwean government has acknowledged the need to integrate ICTs in its education curriculum and promote the uptake and use of ICTs in its rural communities (Ministry of ICT, 2015). In the country, access to education has always been a top priority, but the prevailing economic environment does not allow the government to channel resources – teachers and textbooks – to these schools. Recently, the government suspended the recruitment of teachers, nurses and university lecturers as a way of containing its wage bill, but this will have catastrophic consequences on its education and health systems (Dailynews, 2018). Limited government funding on education has compromised standards, as schools are inadequately equipped in terms of textbooks, teachers and other materials that support a conducive learning environment. It is here that the use of mobile phone apps could ensure that children have easy access to a quality education and their parents could access medical information. Schools in rural communities are so far away that learners often have to travel more than 10km and some villages are quite distant from each other, making communication through traditional methods difficult, yet m-learning and social media could be utilised for learning and communication purposes (News Day, 2016). One positive thing is that the average rural literacy rate in Zimbabwe is 90%, which means that rural communities can also comfortably use mobile phone apps and other services offered by mobile phone companies.

3.2.2 Poor health

In most rural areas of Zimbabwe, patients often travel more than 20km to the nearest health facility, yet telemedicine – through ICTs and mobile phone apps, where patients can communicate with a doctor remotely – could possibly reduce the number of visits (Mudadigwa, 2016). Zimbabwe's poor economic outlook and political discord has led to reduced healthcare budgets, affecting the provision of healthcare, especially in rural areas, where it has declined by 40% (Hansen, 2011). Through its annual budget in 2016, the Ministry of Health and Child Welfare was allocated $301 million, representing $22 per person, while South Africa allocated $650 per person and Botswana, $390 (Newsday, 2015). The UNDP pledged support to help Zimbabwe launch telemedicine initiatives and e-mobile technologies to help in the delivery of health services and to connect health institutions to communities (World Bank , 2016). In 2015 the World Health Organisation (WHO) reported that almost 500,000 Zimbabweans were being served by less than two doctors and this ratio was higher in rural communities. In 1960, this ratio was less than 1:500 and was higher than the 1:200 prescribed by the United Nations. However, the prevailing socioeconomic environment will drive the current figure even higher, as the government has frozen the recruitment of nurses and doctors (VOA, 2015). Lack of access to health information results in people dying from preventable disease and this is worsened by a high doctor-to-patient ratio which is over 1:250,000 (Pindula News, 2016). This state of affairs requires innovation and measures that can ensure that Zimbabweans have access to health care information through services such as telemedicine.

3.2.3 Unemployment

A survey conducted in 2014 indicated that Zimbabwe's formal employment rate was about 16%, with 84% of Zimbabweans working in the informal sector (Sintha, 2014). The situation in rural communities, where there are few firms and limited capacity for any meaningful economic activities, is much worse. Lack of electricity, the bad road networks and low population density all make it difficult for larger firms or organisations to set-up operation in rural communities. Very few banking institutions in Zimbabwe have opened branches in rural communities and those that have require source of income, proof of residence and a payslip from rural residents. There is not one bank in the Bulilima district. This state of affairs begs the inclusion of mobile phone applications and services, such as mobile money services, which will provide financial inclusion for the 84% Zimbabweans in the informal sector (Zimstats, 2015).

3.2.4 Low population density

Most of the rural districts in Matabeleland South have poor soils that cannot sustain reasonable agricultural activities that can support higher populations. Low population densities, lack of electricity and low and erratic rainfall patterns, resulting in water shortages in Matabeleland South province, have constrained meaningful economic activity and further exposed communities to poverty. Telecommunications companies could never invest in these communities, as there is little potential that they could generate enough revenue to justify the companies' huge initial investments. However, through the Universal Service Fund (USF), mobile phone infrastructure is slowly finding its way into rural communities and this will help to ensure that coverage reaches out to even the most sparsely populated areas.

3.2.5 Poor road network

Zimbabwe's road network has deteriorated over the years. The economic meltdown resulted in a virtual abandonment of periodic maintenance and the network was declared a national disaster (Mutekwa, Matsa, & Kanyati, 2012; Herald, 2017). This negatively affecting communication in rural areas. The national road infrastructure has deteriorated, isolating many rural communities from timely access to markets, thereby limiting their profitability. They are thus becoming poorer, since they cannot access competitive prices. This state of affairs has not spared rural and remote communities, where many places have remained inaccessible, thereby further disadvantaging rural communities who cannot access markets, health facilities and schools (Mudadigwa, 2016). Research conducted by the World Food Programme (WFP) discovered that only 25% of the rural population in Africa could access markets within two hours (WFP, 2010).

The road network in the Bulilima district is hugely inadequate and this situation worsens during the rainy season, when bridges linking remote areas are damaged, cutting off traditional communication links (David & Dube, 2013). With radio and television signals non-existent in some of the wards, the problems are exacerbated. In 2017, Cyclone Dineo displaced over 859 people, destroyed roads and bridges, and about 2,500 homes. More than 100 families were marooned in the floods for over 48 hours due to lack of access to information that provided warnings for evacuation and were rescued by air force helicopters (The Financial Gazette, 2017) Some rural communities in Zimbabwe are so inaccessible that its people may starve or die if food distributed by donor organisations fails to reach them. Rural communities can utilise mobile phone applications to support communication and information access.

3.2.6 Digital divide

A debate has been ongoing as to ways in which the digital divide could be narrowed, in order to allow poor, marginalised rural communities to join the information superhighway. In his address in 2011, UN secretary-general Ban Ki-Moon noted that as the digital divide was bridged, the chasm between the rural poor and the urban rich was being reduced, by opening up opportunities for rural communities that improve their standard of living through ICTs (Dzenowagis, 2011). Mobile phone technology has improved agricultural productivity and market access for rural communities, and reduced socioeconomic inequalities in Bangladesh (Islam & Gronlund, 2011). There is no equitable distribution of services between the developed and developing nations, urban and rural, and rich and poor, yet the mobile phone promises access to information for all, even in the most remote rural areas of the developing nations, and serves to bridge the digital divide (Goodman & Harris, 2010).

ICTs, used in developing countries such as India, Kenya, Uganda, South Africa and many others, help to reduce the digital divide and empower rural communities to access useful information that enhances their businesses, improves their health and education, and fosters development (Meshur, 2012). In countries such as Kenya, before mobile phones reached the masses, most citizens could not take part in the digital world. Most telecommunications products were a preserve for the few who were rich and ordinary people had to travel to towns and cities to make phone calls (Wamuyu & Maharaj, 2011). Lessening the digital divide redefines social interactions and trade and commerce at a global level, resulting in reduced poverty and improved development in rural areas (Junghoon, Dulal, Hyoung, & Shin., 2012).

Although mobile phone penetration rates have surpassed 100%, in Zimbabwe’s urban areas, rural communities mostly connect to base stations that are about five kilometres distant, thus reducing the signal strength they receive, compared to their counterparts in urban centres, who connect to a station about 500 metres away (Zimstats, 2014). In Zimbabwe, the digital divide still existed in both urban and rural populations, when the fixed landline was the sole telecommunications platform available. Rural communities, however, still only have access to 2.6% of total fixed landlines, whereas urban populations have access to 97.4% and this disparity cements the existence of the digital divide in terms of communication and access to information, as shown on figure 3.1 (POTRAZ, 2014). The arrival of the computer also failed to bridge the digital divide in Zimbabwe, as just three percent of the rural population owned one, compared to 24% of urban dwellers (Zimstats, 2014). The Gallup group in 2012 reported that about 90% of urban households had access to television, compared to 34% in rural areas.

The mobile phone promises to bridge the digital divide, as even people on a small income can afford it – a small, powerful communication tool providing many functions that compare to a personal computer, which is not accessible to the poor. As shown in figure 3.1, unlike the fixed landline, whose access was mainly limited to urban areas and only reached about three percent of the rural population, the mobile phone penetration rate was about 110% by mid-2016 in urban areas and stood at 75% in rural areas (Lancaster, 2016).

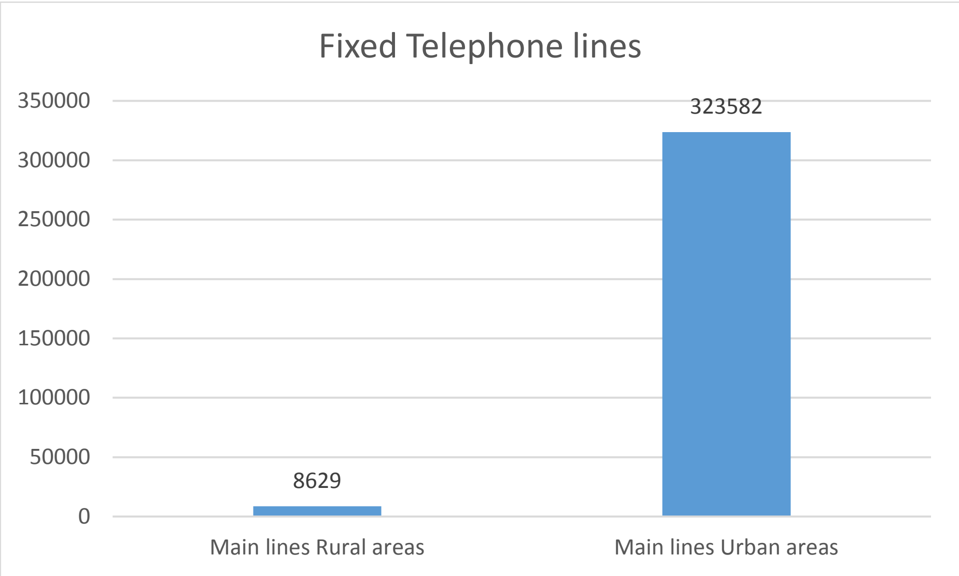

Figure 3.1: Distribution of fixed landlines, by POTRAZ, 2015

Access to the internet through a mobile phone between rural and urban areas is comparative, with 72.8% for rural populations and 84% for urban dwellers, and this helped in bridging the digital divide (ZimVac, 2014). The effect of the mobile phone has surpassed that of the personal computer, as it is offering poor, rich, rural and urban citizens alike an ubiquitous and pervasive way of communicating and accessing information and other applications, thereby bridging the digital divide and promoting socioeconomic development. Mobile phone companies in Zimbabwe are contributing 1.5% of their revenue towards the USF, where the regulator will construct base stations even in areas that are sparsely populated. Research by the GSMA group, however, established that most countries that have set up these funds are not channelling them towards their intended use, as witnessed by continuing low levels of coverage in remote areas (GSMA, 2014; POTRAZ, 2015).

3.3 Overview of Zimbabwe's economy

The Zimbabwean economy crashed in 2008, when inflation reached over 231 million percent, resulting in the collapse of all economic sectors of the economy, including agriculture, health, education, social services and the banking system (World Bank, 2016). The introduction of the multi-currency system stabilised the economy and reduced inflation to an average of 1.02% from 2009 and, during this period, the economy experienced positive growth. The government of Zimbabwe introduced a surrogate currency, with bond notes in denominations of $1, $2 and $5, with the hope of easing cash shortages and curbing externalisation of the US dollar (RBZ, 2016). After a bloodless a coup in November 2017, the Zimbabwean government is still constrained today, as revenue inflows have declined to a level that has seen the domestic and foreign debt balloon (Campbell, 2017). Lack of foreign currency has resulted in the shortage of fuel and basic commodities. This has inevitably resulted in failure to fund social services that support the poor. The poor revenue inflows will inhibit the government from funding most socioeconomic development programmes, thereby leaving most rural communities vulnerable and poor. About 90% of government expenditure is channelled towards civil service salaries and this has resulted in government failure to pay its foreign and national debt (RBZ, 2016). Levels of Foreign Direct Investments (FDI) have fallen to less than three percent of the GDP, negatively affecting investment in the telecommunications infrastructure (UNESCO, 2012). Zimbabwe's food insecurities have risen over the years because of recurrent droughts, low farm productivity due to a chaotic land reform, high unemployment and the HIV/Aids scourge on the population. This prompted relief organisations to help the government feed the population in both urban and rural areas, which has had a further negative effect on economic growth.

The hard-economic conditions experienced in Zimbabwe over the past years have fuelled poverty in rural areas (ZimVac, 2014). Production of crops and cattle has drastically reduced, due to lack of financial resources to support rural and subsistence farmers, coupled with recurrent droughts (Maphosa, 2007). The poor economic fundamentals and economic sanctions have led to many companies and businesses closing down, resulting in an acute decline in formal employment. The net result is a highly informal workforce that is poorly remunerated (UNESCO, 2012). After disputed elections in 2000 and perceived human rights abuses, the international community-imposed sanctions on the country in 2000, resulting in the withdrawal of financial aid, trade, travel restrictions and the freezing of foreign accounts.

These sanctions, coupled with an absence of systems of governance and acute corruption, affected the socioeconomic fabric of Zimbabwe, as it became dependent on many international donor organisations for financial aid. Over the years, donor fatigue has crept in, and a number of developmental agencies could not support the country in terms of education, health, agriculture, transport, regional cooperation and technical support (African Monitor, 2012). This left it isolated, with many donor-funded interventions bypassing the country. There were, however, a few, limited interventions, which meant that there was a paucity of literature in these areas. Initiatives that could improve information access and communication in Zimbabwe were no longer funded by most development agencies, due to sanctions, and this impeded the growth of incubation facilities and innovation hubs that are found in most countries in sub-Saharan Africa for the development of mobile phone applications (Infodev, 2016).

As the Zimbabwean economy has contracted sharply, poverty rates have ballooned to over 72% and the worst-hit provinces, such as Matabeleland, are experiencing rural poverty rates as high as 96%, while health and education systems that were once regional benchmarks have also collapsed (World Bank, 2016). The Zimbabwean economy is agrarian and persistent droughts in the region and a non-performing economy have significantly stalled infrastructure development, leaving a high deficit in the areas of energy, transport and water (AFDB, 2018). With limited or no access to energy, transport and water, rural communities have remained impoverished. Persistent drought, chaotic land reform and poor economic policies have seen Zimbabwe being relegated from its position as the bread basket of Africa to the begging bowl of the continent, and it now relies on food donations to feed its urban and rural populations. Over the years, Zimbabwe has been importing maize to alleviate hunger in both the urban and rural populations and this has resulted in the government suspending most of its social obligations, leaving rural communities exposed to acute poverty (Reuters, 2016).

To become productive, rural communities must access information and farmers must be able to communicate effectively, make decisions on which crops to plant, be aware of rainfall patterns, animal diseases, market information and much more. Rural communities in Zimbabwe could utilise mobile phones to access this information in real time, in order to improve their livelihood and productivity.

3.3.1 Zimbabwe population

Zimbabwe’s population was recorded as 13,062,239 in the last census in 2012, with the rural population accounting for 67% and the urban population 33% (Zimstats, 2014). Zimbabwe has 10 administrative provinces that fall into different agro-ecological areas, known as natural regions, based on rainfall patterns, soil quality and vegetation. In 1998, HIV infection was 40%

and, through various strategies that were undertaken, this figure dropped to 15% in 2014. This decrease in infection rates had a net effect of increasing life expectancy from 43 years in 2003 to 53.3 years in 2012 (World Bank Group, 2016). This research is aimed at addressing information access and communication challenges that are faced by most rural communities in Zimbabwe, which constitute 67% of the population.

3.3.2 Bulilima district facts and figures

The total area covered by the Bulilima district is 6,439.4 square kilometres, and it has a population of about 90,561 – 54% females and 46% males – with 16 wards that have an average of six villages (Zimstats, 2013). The villagers often travel long distances on foot and wealthier families use animal-drawn carts as the main means of transport. There is a high migration rate among young people in the district, who leave Zimbabwe to live in South Africa and Botswana as illegal immigrants (Maphosa, 2007). Communities in the district are dependent on subsistence farming for their livelihoods, the barter trade and remittances from relatives in the diaspora sustain them (Zimstats, 2013; Maphosa, 2007). A constituency report in 2011 revealed that there were five clinics, 11 secondary schools and 39 primary schools in the district. In Bulilima, 89% of households have no electricity, while two percent have a flushing toilet (Zimstats, 2013). Access to schools and clinics remains a challenge, due to inadequate and inaccessible roads. It is also difficult to access electrical power supply. The teachers who staff most rural schools are unqualified, as these institutions fail to attract qualified educators, due to their poor working conditions, inferior accommodation and lack of electricity. A survey conducted by the World Bank, UNICEF and Zimstats revealed that the overall poverty prevalence rate in the district was estimated at 80.2%, with the highest prevalence being 86.3% in ward 11 (Zimstats, 2015). All of these factors require intervention to improve the lives of rural inhabitants as most wards in the district have no access to radio and television signals, which are the primary sources of socioeconomic development information, thereby worsening the digital divide (News Day, 2016). Mobile phone applications, however, have the potential to address some of the issues related to access to information and communication, which is vital for socioeconomic development.

3.3.3 Mobile network operators' landscape in Zimbabwe

Zimbabwe has three Mobile Network Operators (MNOs) – Econet, Telecel and NetOne. Econet's market share in terms of subscriber base is the highest at 53.9%, Netone has a market share of 30.7% and Telecel has the remaining 15.4% (POTRAZ, 2014). Econet wireless is a private company, while Netone and Telecel are wholly owned by the government. The mobile network operators' revenues have dwindled, due to high taxes and other regulatory impediments that have been imposed on the operators by the cash-strapped government, coupled with poor economic fundamentals, yet investments in mobile phone infrastructure have propelled mobile phone penetration to over 110% by mid-2016 (Lancaster, 2016). In 2014, the Zimbabwean government introduced a five-percent tax on airtime and a 25% tax on mobile phones. This, coupled with an enormous 20-year licence fee of $137.5 million on mobile phone operators will result in reduced growth in the telecommunications sector (TechZim, 2014). In his 2017 budget, the minister of finance pointed out that an additional five-percent tax levy on airtime sales would fund the procurement of drugs for hospitals, thus demonstrating a diversion of funds (Pindula, 2017). Zimbabwean mobile phone companies have become highly innovative, introducing extensive services beyond ordinary voice, text and data, including e-learning, mobile money transfer, insurance and broadband services, among others. South Africa's MTN has also been considering acquiring shares through Telecel's parent company, which is based in Egypt, and if this deal goes through, it will provide capital for Telecel to improve its services and compete with the other two service providers (Bulawayo24, 2015).

3.4 Mobile phones and youth

Mobile phones could empower youths, in terms of opportunities broadcast through text messages that encourage positive behaviour, spur an appreciation of financial concepts and result in a positive, lifelong impact (New Report, 2013). A 2013 UNESCO report revealed that most people in sub-Saharan Africa had no access to books, yet many could read material on their mobile devices (UNESCO, 2013). The youth and people in rural areas need to take advantage of mobile phone developments, with apps that are engaging and easy to use (Jensen, 2010). Previous studies have revealed that most young people spend about three hours a day on their mobile phones, accessing applications such as Facebook, WhatsApp, making phone calls and texting SMSs (Mvula & Shambare, 2011). Mobile phones can banish boredom among the youth, especially those who live in rural areas, and act as positive status symbols. Through mobiles, they can watch videos and movies, listen to radio and audio files and take part in social networks. Through smartphones, they can watch digital TV. However, the youth can abuse mobile phone communication, committing crimes such as cyber bullying, watching and disseminating pornography and encouraging prostitution. This has placed pressure on government regulators and concerned parents to act (Assa, 2011). This engagement means that positive educational material could be conveyed to the youth, packaged in an attractive form to foster lifelong learning.

Most young people in Matabeleland cross over Zimbabwean borders as illegal migrants into Botswana and South Africa, and find low-paid employment on farms and elsewhere, due to a paucity of job opportunities in their home country (Maphosa, 2007). Mobile phones could be used in educating the youth on the dangers of illegally migrating to South Africa without passports and permits, and sensitise migrants as to the types of jobs and incomes they would have if they worked without permits. Many of them could consider completing their studies before migrating to South Africa to work as unskilled labour. A study conducted by Maphosa (2007) revealed that about 23% of migrants had not completed their secondary school education. The mobile phone could therefore help rural youths appreciate technology and progress, as well improve their communication skills, positively affecting their confidence, through playing games, watching videos and social media interaction.

3.5 The mobile phone promise

There is a belief that the mobile phone revolution will have more impact than the industrial revolution, especially in developing countries, as people will become dependent on information (Goodworks, 2016). The mobile phone is increasingly penetrating into the lives of many people and, with promises of democratic reforms, poverty alleviation and equality becoming buzzwords in developing nations, there is the prospect of apps helping to provide health information and financial inclusion (Assa, 2011). Mobile phone technology promises to leapfrog all other forms of technological development, due to the relative low cost of its infrastructure, easy access to cheap android mobile devices and their ease of use – and this has resulted in increased usage in the least developed regions of the world (World Bank, 2009; Quadir, 2013). Sub-Saharan Africa has about 829 million inhabitants and its governments, businesses and households are rapidly adopting mobile phones and their apps faster than any other region, as they realise the potential of these gadgets to access information, as well as improve communication (GSMA, 2014).

Mobile phones, by virtue of their role as carriers and conduits of information, will lessen information asymmetries in markets, thereby making rural and undeveloped markets more efficient. The growth of broadband infrastructure and the manufacture of inexpensive mobile phones has made Africa one of the fastest-growing regions globally, in terms of usage. In

Zimbabwe about 10 years ago, the cost of a mobile phone line was equivalent to the cost of a cow, which was almost $400; now the cost is significantly less, at under $1. Some of the design and functional specifications of mobile phones and mobile apps produced for developing regions must cater for low literacy levels, low income, a poor electrical power supply and limited connectivity.

3.6 The Internet of Things

One of the emerging concepts provided by the internet is the Internet of Things (IoT), which promises to deliver solutions to improve socioeconomic development through health, agriculture and education, among other facets of daily life. IoT is an environment that links technology and other intelligent objects, such as machines, through sensors that permit objects to interact and transmit data over the internet, thus improving standards of life for communities and organisations (GSMA, 2014). The IoT can be used in health applications, with intelligent devices implanted into patients to detect temperature and pulse rate, or used to monitor diabetes, HIV/Aids and cancer. In agriculture, the IoT can track animals and monitor disease outbreaks, water pollution and moisture in fields. GPS equipment can also be implanted, with the IoT, in livestock. The IoT is also used in medical applications, to monitor vaccines through IP connected thermometers or sensors (CISCO, 2009). Most communities in Matabeleland rely on livestock production as a source of income, however, this is insecure, due to rampant stock theft and wild animals preying on stray livestock near national park boundaries. However, with the use of the IoT, these animals can be fitted with tracking devices that can minimise both stock theft and attacks. Livestock, including cattle and goats, could be fitted with tracking devices to allow the monitoring of their movements, preventing them from straying into fields. This technology could also solve some transport woes in rural areas, where information on timetables is usually limited. It could be useful in allowing communities to track bus services, with devices, installed in transportation, that have the IoT technology.

Mobiles easily provide the internet to remote rural communities, which could therefore also adopt new technologies, such as the IoT. The rural communities of Bulilima could also use GPS systems to map water points and monitor water levels using the IoT. This means that innovations made in developed countries could have an easy introduction into rural communities that have internet access. The IoT could also provide localised data on temperature, rainfall and weather forecasts, as the current weather forecast system is too broad and the information may not be very useful and irrelevant to local community needs in Bulilima.

In Zimbabwe, the quality of water in both urban and rural communities has remained a challenge, negatively affecting standards of life, yet other developing countries, such as India, are using sensors linked through the IoT to monitor water quality and supply clean water in rural areas (ITU, 2015). In Zimbabwe, some of the issues that may delay the full-scale use of the IoT include the country's unstable electricity supply, high internet costs, limited bandwidth and poor regulation and policies. Further, the IoT's database will store large amounts of personal medical and financial information, and be prone to hackers wanting access to it, thereby raising security concerns (Razzaq, Gill, Ullah, & Qureshi, 2017).

3.7 The internet and social media

Connected rural communities in Bulilima can benefit greatly from social media as they have the opportunity to participate, contribute and broaden news sources. Most districts and wards have no access to radio and television, and rely on foreign broadcasting stations, which don't provide developmental information. Most traditional news agencies in Zimbabwe are government-owned and highly polarised. However, social media promises to offer rural communities an alternative source of news and information, and may play a crucial role in disseminating crucial information on the current situation in the country. In this context, there has been debate around the world and some in Zimbabwe on health concerns regarding genetically modified organisms (GMO) in consumables. Since rural communities are the major recipients of most of these handouts – but have no access to information or debate around GMOs – this is where social media could play a crucial role in education.

The country witnessed widespread demonstrations against the government in late 2017, coordinated by social media platforms, whose news bypassed state-controlled media. Social media in rural areas can keep the community informed about agricultural subjects, such as El Niño weather patterns, the start of the rainy season, when to plant and when to sell livestock. This is where social media in rural areas keeps communities informed. The country is also experiencing acute shortages of basic commodities and citizens are using social media to inform each other where there has been delivery of scarce commodities such as fuel, cooking oil and bread among others.

In developed countries, citizens access news mainly through social media websites that offer readers interactivity and feedback. Social networks, such as Web 2.0 tools – including blogs, wikis, podcasts and social networks – form powerful platforms enabling rural communities to support economic and agricultural activities, through knowledge of market prices and consumer demand, and engage in learning. Mobile phones and applications such as Web 2.0 technologies have the potential to bridge gaps, since they are easily accessible, simple to use and allow users to create their own content. Lessening the digital divide redefines social interactions, and trade and commerce at a global level, resulting in reduced poverty and improved development in rural areas (Junghoon, Dulal, Hyoung, & Shin., 2012). Web 2.0 technologies can allow rural communities to be producers of information and knowledge in their own language and context. By their nature, such technologies group users into social networks and enable users to connect with each other and share information, thus creating a community of users instead of individuals (Georgios, 2012). Web 2.0 and other agricultural websites can assist rural communities to access information that includes crop and livestock prices, weather forecasts and disease outbreaks, thus helping them make informed decisions and enhance their socioeconomic development (Oates, 2005; Beaudreau, Johnson, & Sieber, 2012). For rural communities in Bulilima, social media can provide a platform for the community to produce its own news and share stories of events, such as weddings, funerals and meetings. It could also allow communities to tell their own stories and share farming stories and information. The cost of data remains prohibitive in rural areas and this may inhibit use of social media in Bulilima.

3.8 Conclusion

This chapter provided an overview on the major challenges that affect rural communities in Bulilima district. The chapter also provided facts and figures on Zimbabwe's population and economic performance, IoT and social media influence. The challenges that are affecting the country require deployment of simple but effective solutions which can help in uplifting the standard of life in rural communities.

Chapter 4: Research methodology

4.1 Introduction

Chapter two delved into relevant literature that placed this research into perspective and context. The purpose of this chapter is to provide an overview of the philosophical assumptions that underpin any research in relation to other philosophies, the research methodology and research model. Saunders proposed a research "onion" (figure 4.1) to assist in classifying research in terms of its philosophy, approach and strategies – including its techniques and procedures – for gathering and analysing data. The outer layer of the onion deals with the research philosophies, the research approach is found in the second layer and at the core of the model are the research techniques (Saunders, Lewis, & Thornhill, 2012). The researcher adopted this model as it presents a detailed structure on the broad research philosophies and links them with time horizons as well as the techniques.

The key characteristics of any research are the ontological, epistemological, axiology and methodological assumptions. Ontology is concerned with the independent existence of an object, through human interaction or thought. Epistemology is concerned about perceptions of reality, steps taken to assume that knowledge and their scope, and is premised on the relationship between researchers and the researched (Creswell, 2007).

After the philosophical layer, the next layer on the research onion is making a choice between deductive which is quantitative and inductive choice which is qualitative. The choice between the two is influenced by the philosophical stance that has been taken. In this research a mixed method approach will be undertaken. The following layer determines how the researcher will gather, analyse and interpret data. In this research, the researcher will use design science research which seeks to solve a problem based on a set of objectives. In this case the researcher will gain knowledge through developing the mobile application through consulting the users. This approach leans towards action research. Other approaches include case studies, experiments, grounded theory and others shown in figure 4.1.

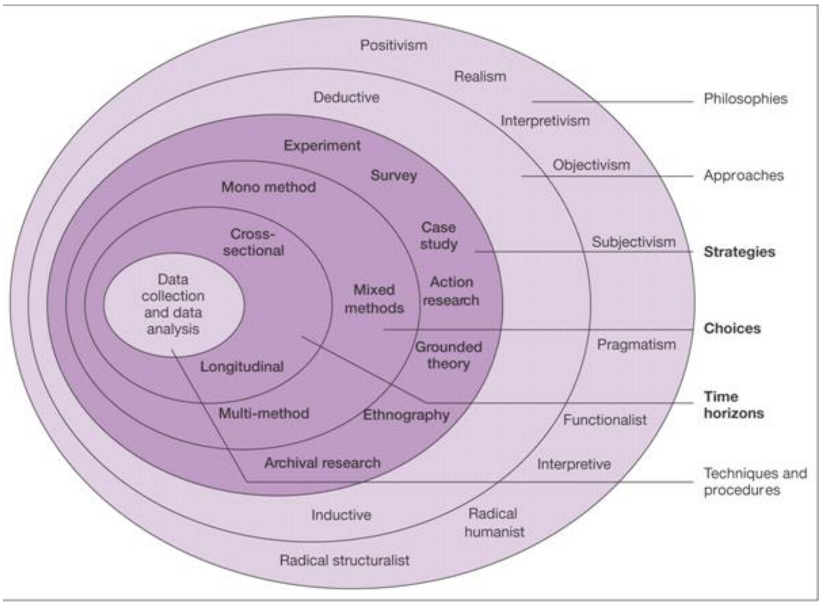

Figure 4.1: The research 'onion' (Saunders, Lewis, & Thornhill, 2012)

The two main methodologies are the quantitative and qualitative research approaches, although in recent years the use of the mixed-methods approach has increased considerably in the field of Information Systems.

This chapter outlines the research philosophy, approach, strategies and procedures that are followed to collect data through questionnaires guided by the research onion. This research utilised the research onion as it clearly shows a detailed structure, links different stages of each chosen paradigm and logical steps taken to complete the research.

Table 4.1: Overview of the four research philosophies (Saunders, Lewis, & Thornhill, 2009; Vaishnavi, Kuechler, & Petter, 2017)

Beliefs	Research paradigms			
	Positivist	Interpretive	Realism	Pragmatism
Ontology	Single reality; knowable	Multiple realities, socially constructed	Socially constructed	External, multiple, adopted.
Epistemology	Objective; Detached	Subjective, derived from researcher-	Suspicious; Observer subjectivity	Objective; subjective or a

	observer truth	participant interaction		combination of both
Methodology	Observation; quantitative; Hypothesis testing	Participation; qualitative	Deconstruction; Textual analysis	Observation; participation; developmental; quantitative and qualitative
Axiology	Truth: Universal; prediction	Understanding: Situated and description	Research is value laden; Researcher biased	Both objective and subjective; create; understand

4.2 Research paradigms

Layer one of the research onion relates to the philosophical stances about the generation of knowledge. A research methodology refers to the entire process and procedures that direct the research process. Any research follows a particular paradigm that defines beliefs and consensus among certain groupings, systems and studies that guide the researcher on selecting key questions for the study and the methods that underpin the study (Morgan, 2007). Three major paradigms have been adopted in most IS research – positivist, interpretivist and critical realism – although other scholars have begun to employ pragmatism as a paradigm (Klein & Myers, 1999; Saunders, Lewis, & Thornhill, 2009). An overview of the research process is presented in table 4.1, where each research perspective is linked paradigm. After considering the research problem at hand, pragmatism was chosen to guide this study's process.

4.2.1 Positivism

The philosophical view of positivism is that knowledge exists independently of the researcher; therefore, factual knowledge is gained through the use of methodologies that promote objectivism. This ontological realism assumes that reality or knowledge exists independently of the enquirer (Cohen, Manion, & Morrison, 2007). In positivism, the relationships existing between individuals and systems in society are reduced to variables and people are often treated as units that have to be observed. Thus, positivists believe that reality is never mediated, discovered through inquiry, or by means of our senses.

The methodological principles of positivism establish strict principles that are followed by identifying a phenomenon, measuring and evaluating identified variables to ascertain causal relationships and providing a generalisable outcome. This paradigm strives for objectivity and acceptability of research outcomes, and uses quantitative techniques including statistical analysis to come up with provable outcomes. The outcome of a positivist inquiry fosters objectivity and external validity that theoretically means that the experiment or inquiry can be repeated with the same results (Creswell, 2009).

4.2.1.1 Weaknesses of positivism

Many scholars have concurred that the following of scientific principles while undertaking research may not enable the researcher to deduce how communities live, the effects of the research or intervention on them and their strategies to adapt after the intervention (Hasan, 2016). Positivists deal with variables and mainly measure relative change and not causes, so this may be a problematic approach when it comes to dealing with communities.

4.2.2 Interpretivism

The ontological orientation of the interpretivist is relativism, whose philosophical stance is that reality is experienced subjectively, mediated by our senses and, therefore, varies depending on the individual (Guba & Lincoln, 1994). The epistemological assumption of interpretivism is subjectivism, which is an account of how knowledge is constructed, captured and communicated. The subjectivist approach is based on real-world phenomena, premised on the understanding that our world does not exist independently of our knowledge of it (Grix, 2004). Interpretivists believe reality to be a social construct, built by people, and claim that the natural world would not exist without the researcher’s intervention.

Over the years, the positivist paradigm has dominated Information Systems (IS) research, however, new research problems emerged which required in-depth study of organisations and management information systems, and this has led to the emergence of the interpretivist paradigm (Silva, Ferreira, Ramos, & Amaral, 2014). This relies upon the fact that our knowledge of certainty is shaped by our view of our surroundings, that reality is socially constructed and that the researcher is the instrument that interprets this reality through the understanding of people (Collis, 2003; Andrade, 2009). Interpretive research allows the researcher to go into the community and talk to participants who will respond to questions and in the process provide answers to the what, why, how and when questions that are evident in qualitative studies (Collis, 2003; Saunders, Lewis, & Thornhill, 2009). With regard to the application of technology in rural communities, the interpretivist viewpoint is that different interpretations and meanings that can be associated with a particular community are dependent on both a particular community and researcher.

4.2.2.1 Weaknesses of interpretivism

Individual subjective constructions are employed to produce knowledge in interpretive research, meaning that it will be difficult to generalise the data since it is contextual, while the privacy of the participant is never guaranteed (Scotland, 2012).

4.2.3 Pragmatism

The pragmatists support an ontological position that compels research to be supported by actions that result in change. Pragmatics do not take a solitary view but recognise that there are many different worldviews when it comes to undertaking research and, therefore, at times, no single point of view can reveal hidden knowledge that can only be obtained through multiple realities (Saunders, Lewis, & Thornhill, 2009). Pragmatism often circumvents debatable concepts, such as the absolute truth and reality, by philosophically stating that reality can be observed through an angle that leans towards solving practical problems affecting communities (Martina, 2010).

Pragmatism is a paradigm generally associated with mixed-methods research, which offers an alternative view between the two main traditional paradigms. Debates between positivists and interpretivists about worldviews regarding the truth and reality are embraced by pragmatists, who believe there are both multiple and singular views, and therefore the researcher can both make an inquiry and solve real-life problems that affect communities (Feilzer, 2010). Pragmatism merges two traditional philosophical viewpoints – that knowledge exists independently of the researcher and that our senses mediate reality. Pragmatists conclude that truth or knowledge is not ready-made – it is created through us, as we explore its independent existence (Mastin, 2008). Pragmatism frees the researcher from the forced dichotomy between the warring opposing paradigms of positivism and constructivism, by seeking a compromise position, thus freeing researchers from becoming the slaves of either paradigm (Creswell, 2007).

Philosophically, positivism asserts that the world exists independent of our knowledge or comprehension of it, while interpretivists claim that the world is created by our conception of it (Guba & Lincoln, 1994). The assertion that no single viewpoint can provide a definite picture of reality strengthens the ideas of the pragmatist, who concludes that the world is comprised of multiple realities and, therefore, to discover knowledge requires multiple viewpoints. The pragmatists view the relevance and importance of any theory or idea through both its operation and the real practical consequences derived from its application. Mastin posits that a theory or concept is true, as much as it works, and pragmatists argue that any meaning associated with a concept or theory is equivalent to its perceived practical operation output (Mastin, 2008).

4.3 Choice of method research

Quantitative purists have long undermined interpretivism, arguing that it is subjective, while qualitative purists have rejected positivism, saying its objectivity should be contextualised and be free of time constraints (Onwuegbuzie & Johnson, 2004). In a study, the researcher can choose a single data collection procedure known as mono method or use both quantitative and qualitative methods known as mixed methods (Saunders, Lewis, & Thornhill, 2009). The goal of mixed research methods is not to replace any of the two traditional paradigms, but to use the strengths of either method in one research study. Many researchers have combined qualitative and quantitative research elements over the last 10 years, with their focus on broad areas such as human sciences, social sciences and information systems (Heyvaert, Hannes, Maes, & Onghena, 2013).

Two main research methods have been generally used and accepted, these being quantitative and qualitative, with mixed-methods research the third methodological movement that tries to neutralise the false dichotomy between the positivist and interpretivist schools of thought. Before mixed-methods was designated as a research paradigm, some scholars began to deliberately integrate both qualitative and quantitative approaches, even before the terms were distinguished as two main paradigms (Doyle, Brady, & Byrne, 2009). Scholars began to use mixed methods in the 1990s, when it became a thriving and well-formulated research paradigm that could combine different and complementary types of data sources, such as questionnaires, to sieve potential participants for semi-structured interviews (Denscombe, 2008).

This study will adopt pragmatism as its research paradigm. The initial stage involves use of questionnaires to gather information on general use of ICTs in the community and then using the results to help in developing a mobile app. Semi-structured interviews will be used to refine the requirements and the design. There is no accepted set of mixed-methods options and, therefore, scholars argue that such an approach is characterised by concurrent data collection, with sequential analysis design and must ultimately answer the general research question (Denscombe, 2008; Onwuegbuzie & Johnson, 2004).

4.4 Design Science Research

Design science research has been associated with pragmatism as a philosophical orientation that attempts to bridge science and practical action, resulting in the creation of an artefact that can solve real-world problems (Simon, 1996; Cole, Purao, Rossi, & Sein, 2005). The design science approach, as posited by Saunders et al. (2009), aims to develop valid knowledge that solves business and societal problems through use of tools or concepts. Design science research is premised on solving real-world problems through the building of an artefact (Orlikowski & Iacono, 2001). A design science research study could start with identifying a problem, or in a formal setup having a request from a client or even with an existing system that may require improvements or adaptation (Peffers, Tuunanen, & Niehaves, 2018).

Design science research enables the researcher to go beyond understanding nature, but enables the researcher, through human creativity and development, to construct artefacts that address real-world problems (Hevner & Chattejee, 2010). Such a research approach supports a practical research model, which facilitates the building of innovative artefacts and uses a mixed-method approach. This research employed design science research, which uses mixed methods. Mixed-methods uses both qualitative and quantitative methods, and its advantages include triangulation, complementarity and aiding interpretation among others.

At the core of any design science research is the production of an artefact, which will solve societal and organisational problems, and an artefact could be defined as constructs, models, methods and instantiations of a system or prototype (Hevner, March, Park & Ram, 2004). In DSRM, artefacts are developed through ideas similar to other products and services, following traditional IS steps, such as conception, analysis and design, in order to deliver services to organisations and communities (Helfert, Donnellan & Ostrowski, 2012). There has been debate on what constitutes an artefact – whether the executing code of a program is a genuine artefact, or rather the concepts that result in the execution of the code (Baskerville, 2008). Orlikowski and Iacono (2001) defined IT artefacts as “bundles of material and cultural properties packaged in some socially recognisable form, such as hardware and/or software”.

The central aim of DSRM in Information Systems is to solve important social, organisational and business problems that affect humanity through appropriate designs and inventions that result in the creation of technologies that solve generic problems and are reusable (Venable, 2009). The central aim of this methodology is the creation and evaluation of IT artefacts that are designed and developed to solve specific social and organisational challenges, which have hitherto remained unsolved (Hevner, March, Park, & Ram, 2004). Both the positivist and the interpretivist's approach to research is to interpret reality, while design science focuses on creating objects that will serve the needs of humanity (Peffers, Tuunanen, Rothenberger, & Chatterje, 2008). The process of creating these artefacts goes through rigorous processes to ensure that the artefacts solve the intended real-world problems, contribute to the new body of knowledge and pronounce or communicate the research output to relevant communities (Hevner, March, Park, & Ram, 2004). The artefact must be verified to ensure it meets the requirements and expectations of the target population. Efficacy, appropriateness and efficiency are some of the measurable verifiers used in design science research.

Hevner et al. (2004) produced seven guidelines that direct the conducting of design science research in IS, while Peffers et al. (2008) and March and Storey (2008) provided six activities to act as guidelines or steps in the conducting of design science research. The fundamental theme of these steps is the production of an artefact that addresses societal and organisational problems. The changing operational environment requires researchers in the field of computing to come up with inventions and new ideas to improve livelihoods and enable organisations to be innovative as they face new challenges (Hevner & Chattejee, 2010).

The primary output of a DSR methodology is the development of an artefact that could be in the form of methods, constructs, instantiations and models whose main purpose is to address the challenges affecting an organisation or society (Peffers, Tuunanen, Rothenberger, & Chatterje, 2008). The development of the artefact must go through a rigorous process, whose output must be well communicated to relevant communities. The artefact that will be developed in this research is not a full-grown system that will be deployed in the community immediately, but encompass ideas, and technical capabilities of the application through following systems development methodologies (Hevner, March, Park, & Ram, 2004). Further improvements will be required for commercial deployment of the application.

4.4.1 Justification for Design Science Research Methodology

The aim of this research is to develop a mobile phone app, that enhances access to information that supports socioeconomic development in rural communities. This resonates with the views of March and Smith 1995; Hevner, March, Park, & Ram, 2004; Gregor and Hevner 2013 who concluded that design science research's main objective is to develop artefacts which can solve practical problems as well as contributing new knowledge to the field of Information Systems. From literature, other scholars Vaishnavi and Kuechler 2004; Hevner & Chattejee, 2010, concurred that design science research must innovate and develop artefacts which can solve particular existing problems and must be evaluated for usefulness. In the Information Systems discipline, design science research's contribution to new knowledge is through developing artefacts which solve practical problems as well as evaluating the utility of the artefact (Niederman & March, 2012).

The output of this design science research is a mobile phone application which can be deployed in practice as well as the knowledge that is gained from its development. After developing the mobile phone app, new knowledge will be generated through evaluation feedback from potential users as outlined by (Weber, 2010). TAM2 will be used to evaluate the utility of the mobile phone app, the results will provide new insight into the problem and can provide guidelines for developing similar artefacts.

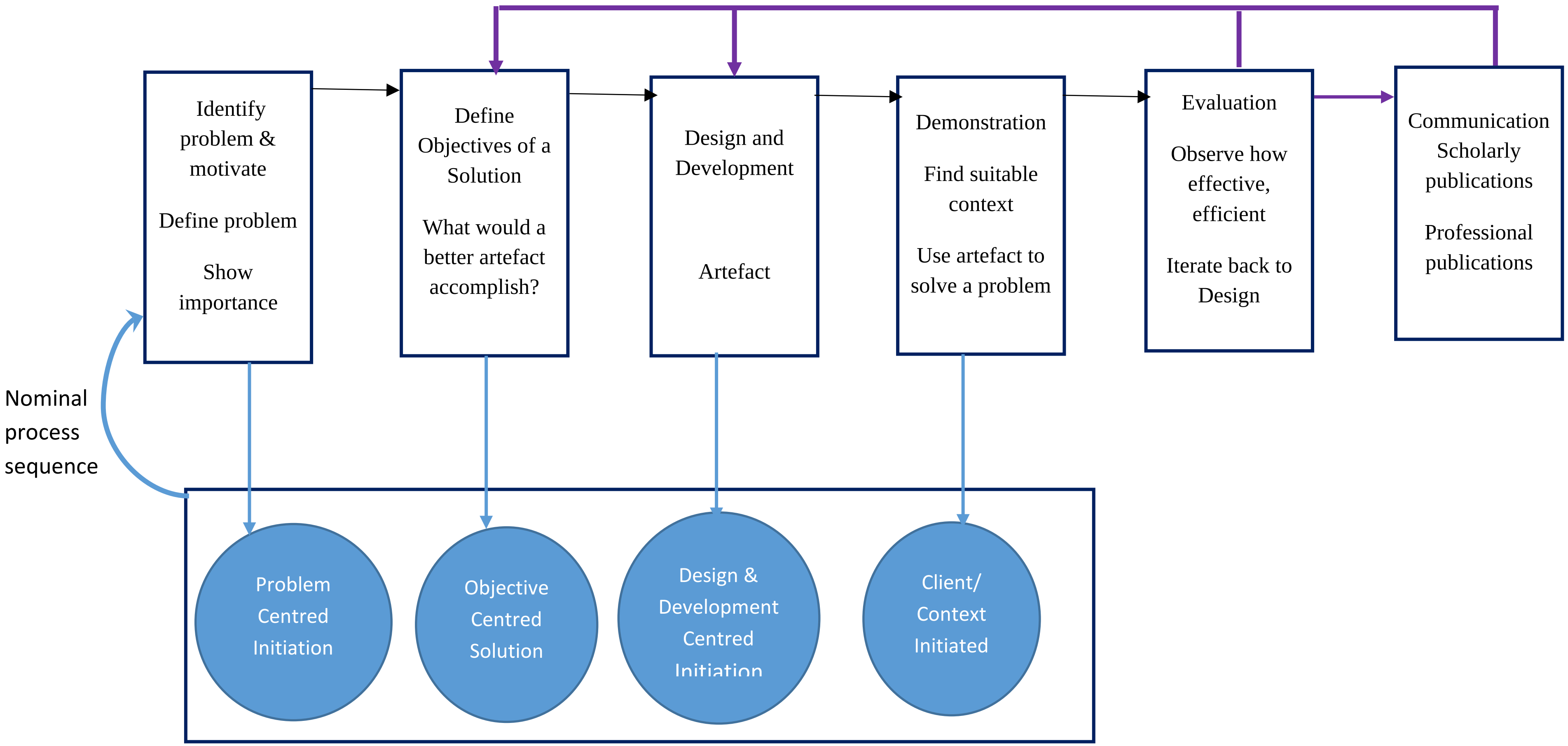

Figure 4.2: Design Science Research Methodology (Peffers, Tuunanen, Rothenberger, & Chatterje, 2008)

The design science research methodology is problem-solving oriented, where the researcher carefully studies the problem at hand and recommends a solution that subsequently results in an artefact being developed (Hevner & Chattejee, 2010). A design science research model must provide an explanation or a prediction about how a specific target population will use the artefact (intention to use some technology) and how the population will find the artefact useful (perceived usefulness).

Such a research model aligns well and provides a clear relationship with the chosen research model (adapted TAM2), as the two have similar constructs and variables. Design science research focuses on the usefulness of the artefact, which is one of the most important constructs in the TAM model. Design science research also seeks to explain the overall impact of the artefact on the community or organisation, while TAM2 seeks to evaluate the usage of a system by individuals or organisations. For the prototype to make any contribution to a new body of knowledge, the artefact must be new or show some improvements when compared with existing artefacts.

Design science research methodology activities are shown in figure 4.2 and each is explained below, as adapted from Peffers et al. (2008). Other researchers, such as March and Storey (2008) and Hevner and Chattejee (2010) also developed similar activities to guide design science research activities. The output of the design science research can be a method, instatiation, constructs and models (Hevner, March, & Park, 2004; March & Smith, 1995). Table 4.2 shows the link between the research process and the DSRM.

4.4.2 Activity 1: Problem identification and motivation

The main aim of a design science research methodology is to develop technology-based solutions to address clearly articulated organisational and societal problems. The initial steps involve identifying the problem and spelling out the motivation to come up with a solution. During this phase, the researcher must have skills to conceptualise the problem and provide reasoning for the intentions to implement the solution. There was need to assess the state of information access in rural communities of Bulilima, a baseline survey was conducted to ascertain the problem which has been generally highlighted in the literature review. Access to relevant, current and up-to-date information that is essential for socioeconomic development has remained a challenge in most rural communities.

Rural communities of Bulilima district have limited access to information that impacts on their socioeconomic development. This is due to lack of access to radio and television signals, while roads make it impossible to reach these communities, making access to socioeconomic information a challenge. The unavailability of information hinders the community from making decisions that impact upon their social, political and economic well-being. The situation worsens during the rainy season, when road conditions degrade further, making these communities inaccessible and sources of news, such as newspapers, undeliverable. Rural mobile phone penetration in Zimbabwe has increased to more than 80%, while the national broadband penetration average is about 47.5%, with rural literacy levels at about 90% (POTRAZ, 2015). These high literacy levels, coupled with high mobile and broadband penetration rates, provide a platform to develop mobile phone applications to help improve access to socioeconomic information in rural areas.

4.4.3 Activity 2: Artefact objectives definition

During this stage, the researcher must define the objectives for the solution, as outlined from the problem definition. In this phase, justification is spelled out, clearly and precisely, as to how the artefact will address the problem specified in activity one. This involves examining the feasibility of the proposed solution or artefact and comparing the proposed solution to existing ones. The researcher must demonstrate that he has investigated the domain of all possible solutions and has chosen the best and most ideal one. After determining that mobile phone penetration was high in rural areas, with most community members owning cheap smartphones, the idea of developing an app was finalised. The results of the baseline survey conducted by the researcher revealed that mobile ownership was more than 95% in the Bulilima district. The baseline survey results noted that the community has challenges in accessing radio, television and newspapers which are the traditional tools for information dissemination. The major objective was to build a mobile phone application that would enhance access to socioeconomic information in rural communities in Zimbabwe. Currently, most of them cannot access this information, due to lack of access to radio and television signals. This means that they cannot easily access agricultural, market and educational information. In addition, sources of national and international news are limited. Other primary objectives included coordinating with the local community to determine the type of information that was to be provided through the mobile phone application. Further, there was the need to design a website for hosting the app so that members of the community could download the mobile phone application, as well as provide a platform for creating articles for the application. Most available mobile phone applications do not provide a wide range of socioeconomic information, as they focus on specific areas, such as health or education. The mobile phone application that was developed enhances access to general socioeconomic information relevant to the needs of rural communities in Zimbabwe's Bulilima district.

4.4.4 Activity 3: Design and development

This stage involves the actual design and development of the artefact. The main objective, as outlined in activity two, is to develop an app that will enhance access to socioeconomic information. Once there is an understanding of the artefact's desired functionality, the researcher's objectives are met through its development (Peffers et al., 2008). This creation serves to improve a social or technical system. This could be an object; whose architectural design and functionality serves as the design research. The prototype design was based on the findings of the baseline survey and the literature review.

The development of the prototype followed a user-centred approach, where the app's intended users were consulted during the entire development process. The researcher developed and presented a paper sketch prototype to guide the design with a sample of users deemed to be intense users of mobile phone applications. The purpose of the team is to help refine the requirements from paper-based prototypes to testing the application. This culminated in an iterative process, whereby the prototype was redesigned through feedback from users, until an agreement was reached between the researcher and the potential users on the final application.

This phase involves building the model and instantiating, through adhering to software engineering fundamentals and principles for effectiveness (Cole, Purao, Rossi, & Sein, 2005). The researcher must exhibit knowledge that allows them to convert theoretical objectives into a real-world artefact. To develop the artefact, the researcher will search the domain for existing theories and knowledge that will help to construct the artefact that must solve some of the information access and communication problems that are being experienced by rural communities in the Bulilima District.

The mobile application's back-end tasks include designing the database for data storage, user management, server-side logic and security and data integration. The front-end tasks include user interface designs and development. The mobile phone application's back end was developed using Java/Android, PHP (Hypertext Pre-processor), JavaScript and SQL (Muir, 2015). The front end runs on the Android Mobile Phone Operating System and interacts with the backend using RESTful web services/API. The server side is powered by the Apache web server. RSS feeds from accredited sites can be used to obtain the latest information, such as weather updates and news. The researcher had borrowed concepts from reviewed literature and aggregated categories of socioeconomic information in order to provide a wholesome package of developmental information. Communities could access local information; for example, if the community was to repair a borehole on a particular day, this information could be made available without a meeting having to be held that would reduce productivity, with members in some cases having to travel more than 10 kilometres in order to attend.

4.4.5 Activity 4: Demonstration

After the mobile phone application was developed, the prototype was tested to ensure that all its utility could be demonstrated. This involves the real application of the artefact to address the problem, or parts of it. This is achieved through an activity, such as a demonstration, where the artefact is loaded with real information to solve one or more instances of a problem. This may involve its use in experimentation, simulation, case study, proof or other appropriate activity. Resources required for the demonstration include effective knowledge of how to use the artefact to solve the problem. The researcher recruited 15 participants and installed the mobile phone application into their phones, so that he could demonstrate the efficacy and functionality of the app. From the feedback obtained, the participants felt that it had great potential to improve access to socioeconomic information in most rural communities in Zimbabwe.

4.4.6 Activity 5: Evaluation

This involves evaluating the artefact on the extent to which it can solve the problem. The researcher must possess the necessary skills and techniques to measure how well the artefact meets the original, set objectives. Evaluation could involve comparing set objectives to functionality, or through surveys and feedback from users (African Monitor, 2012). During this activity, the artefact is evaluated over the extent to which it can solve the stated problem through its utility and efficacy (Venable, Pries-Heje, & Baskerville, 2012). The researcher must have the necessary techniques to measure how well it meets the original, set objectives. Resources required for the demonstration include effective knowledge of how to use the artefact to solve the problem. Evaluation is achieved through the comparison of set objectives with functionality, or through surveys and feedback from users. The output of this phase results

in the researcher deciding on whether to go back to the design phase to further improve functionality, or continue on to the last phase.
After the artefact was designed, a sample composed of community members will be employed to evaluate it according to Hevner et al.'s (2004) guidelines, which include functionality, reliability and usability. Members from the community would be asked to use the app to test its utility, efficacy and usefulness. The field test results help the researcher to determine if the artefact met the objectives stated in activity two; if they did not, the problem identification activity would be revisited. One scholar referred to evaluation in the natural environment as" the proof of the pudding" (Venable, 2009).

The activities in this stage involve an evaluation of the artefact, regarding the practical benefits of the app and its impact, and substantiation of its claimed benefits. The goal of the evaluation was to test if the application could address known gaps in information access. The application will be compared to other similar existing mobile apps.

Appropriate evaluation metrics must be utilised to evaluate the artefact. According to Hevner and Chattejee (2010), some of the relevant metrics could include functionality, completeness, accuracy, usability and reliability. Other appropriate metrics include quality, utility and efficacy, which reasonate with the proposed model built on the foundations of TAM2. Other scholars proposed an evaluation of the artefact in terms of its usefulness and capability in transforming an organisation and how it was fit for its purpose (Gacenga, Cater-Steel, Toleman, & Tan, 2012).

The mobile phone application will be evaluated on how it has met the perceived needs of the rural communities that are related to information access and communication as shown in figure 4.3. The app will be evaluated using TAM2 which has been adapted to include constructs of a social nature which are more applicable to rural communities. As highlighted before the main challenges that rural communities face is lack of access to information among others. These rural communities are remote, inaccessible by road, have no access to traditional media such as radio and television. The app allows creation of information by the community and this ensures that information is relevant and appropriate (Carlsson, Henningsson, Hrastinski, & Kelle, 2011).

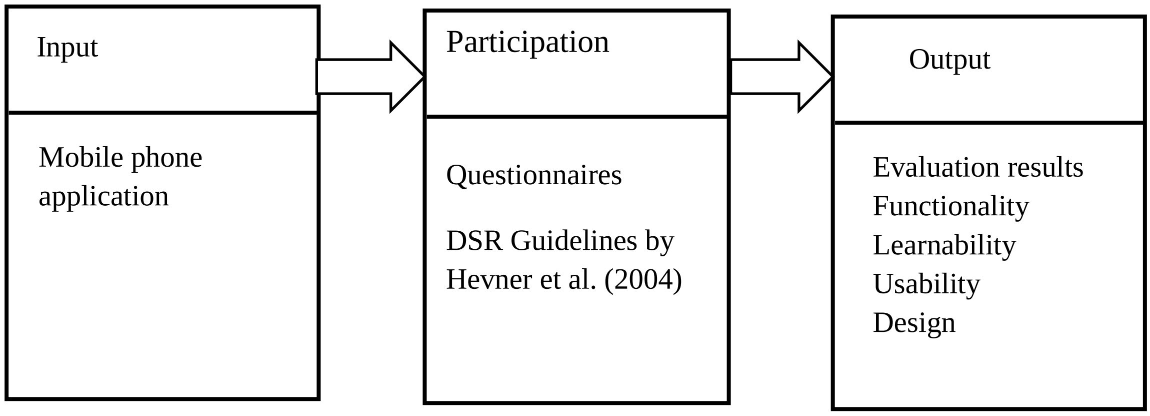

Figure 4.3: Evaluating the mobile phone application

4.4.7 Activity 6: Communication

This activity involves the researcher communicating the significance of the problem and its effects on the target population, the effectiveness and appropriateness of the artefact and its novelty to other professional bodies, and descriptions of the community that the research is intended to reach (Hevner, March, Park, & Ram, 2004). The development of the artefact results in the creation of new knowledge, which must be communicated (Baskerville, 2008). Design science research should provide distinct and verifiable contributions to new knowledge in areas such as design methodologies and artefact design.

The results of this research will be communicated to rural communities, local government and other development agencies, as well professional bodies, through chosen publications and/or conference presentations. The research will also provide useful information to mobile phone companies, particularly on mobile phone usage and trends in rural areas as their next potential market. The researcher attended two international conferences, at which he presented papers on the development of the mobile phone app to improve access to information. The first was the Africa Internet Summit in Nairobi, Kenya, in May 2017, the presentation entitled "Narrowing the digital divide through mobile phone applications". The title of the second presentation was "Mobile phone applications: A corridor for information access in rural Zimbabwe", delivered at the second Artem organisational creativity and sustainability conference in Nancy, France in September 2017.

Table 4.2: Linking the research process and activities used in DSRM

Main activities	Research techniques	Research objectives
Design as an artefact	Literature review Semi-structured interviews	**Objective One** Design a mobile phone application that allows rural communities to access information that is important for their socioeconomic development needs.
Problem relevance	Literature review Questionnaire Semi-structured interviews	**Objective two** Assess opportunities offered by improved mobile phone coverage in rural areas and how this correlate to socioeconomic development, **Objective three** Investigate factors that influence the uptake and use of mobile phone applications in rural communities for socioeconomic development,
Design evaluation	Literature review Questionnaire	**Objective One** Design a mobile phone application that allows rural communities to access information that is important for their socioeconomic development needs.
Research contributions	Literature review	**All the objectives**
Research rigour	Literature review Analysing tools that have been used elsewhere to enhance access to information	**Objective two** Assess opportunities offered by improved mobile phone coverage in rural areas and how this correlate to socioeconomic development, **Objective three** Investigate factors that influence the uptake and use of mobile phone applications in rural communities for socioeconomic development,

Design as a search process	Literature review	**Objective two** Investigate factors that influence the uptake and use of mobile phone applications in rural communities for socioeconomic development **Objective four** Evaluate the impact of the developed prototype
Communication of research		**All the objectives**

4.4.8 Research Contributions

The design science research contributions include the designed mobile phone application and its claimed benefits, allowing us to extend knowledge in the area of mobile apps and rural development. The contributions made could be new constructs, models, and methods and these are evaluated with respect to their ability to improve performance in the development and use of information systems (March & Storey, 2008). The design science research iterations provide valuable knowledge that can be applied to build similar applications. A number of such apps have been developed and many have narrowed to provide access to agricultural or health information alone, in communities with general access to information, yet this app will be the sole provider of the general 'expected' information by the community. One other contribution of this app is its ability to allow automatic download of content into the phone's local storage for offline use. Niederman and March (2012) noted that knowledge generation in Information Systems was through the building of the artefact as well as evaluating its utility. The research contributions will be ascertained through the rigorous evaluation of the artefact and by answering the question posed in 1995 by March and Smith: "How well does the artefact perform?". This researcher presented a paper at an international conference organised by the Africa Internet Summit '17, in Nairobi, Kenya, in May 2017, as well as at the second Artem organisational creativity and sustainability conference in Nancy, France, in September 2017.

4.5 Shortcomings of DSR

The DSR methodology is still in its infancy and some critical aspects – such as the origin of the concept or proposed solution to address the problem – have not been finalised, including the steps that will guide the transformation of the concepts into the development of the artefact. Other scholars such as Gacenga et al. (2012) highlighted a glaring lack of guidance on designing and developing an artefact, despite extensive research in other aspects of the DSR methodology, such as justification of the problem, evaluation of the artefact and demonstration of the artefact.

4.6 Theoretical framework

This is a scientific theory which is central to interpreting the results of any research, as it guides the study process. The model provides a visual narrative of how the variables are interrelated, based on the objectives and the research question. The most important aspects of a study are data gathering, analysis and interpretation of the key findings, which are a product of the research model.

The study of technology adoption behaviour and acceptance is considered one of the most mature research areas in Information Systems, with theories borrowed from sociology, psychology and business management, for example, the Theory of Reasoned Action, Social Cognitive Theory, Technology Acceptance Model and others (Jaffee, 1998). As research problems became diversified, these theories were adapted and modified to address deficiencies with the original theory. For example, TAM was modified by Venkatesh and Morris (2000), to become TAM2, with the inclusion of constructs, such as gender and subjective norms.

4.6.1 Theory of Reasoned Action

The Theory of Reasoned Action (TRA) was modelled by the scholars Fishbein and Ajzen in 1975, to explain how attitudes and perceived social pressures – known as subjective norms – could predict human actions through the examination of the relationship between attitude and behaviour, thus focusing on factors that may cause an individual to behave in a certain way. An individual's intention to perform a particular type of behaviour is determined by factors such as his or her attitudes and subjective norms (Davis, Bagozzi, & Warshaw, 1989). The basis of the theory is that the intention of an individual to perform a particular behaviour is a consequence of his or her behaviour in a given situation. Ultimately, individuals would first consider the consequences of their actions before they acted and used a certain behaviour.

4.6.2 Social Cognitive Theory (SCT)

In 1986, Bandura established the Social Cognitive Theory (SCT), which centred on cognitive, behavioural, personal and environmental factors, which, if jointly used, could predict and govern motivation and behaviour (Crothers, Hughes, & Morine, 2008). In this theory, the core factors of environment, people and behaviour consistently interact to influence each other. These factors, in turn, affect one's ability to use technology or influence the motivation for one to use technology, with constructs such as outcome expectation performance, outcome expectation personal and self-efficacy, judgements that effect motivation and behaviour (Venkatesh, Morris, & Davis, 2003). Self-efficacy helps individuals to overcome obstacles and failures, and move forward towards achieving a specific challenge, with higher efficacy levels that result in increased effort, vigour and persistence in achieving a task (Pajares, 2002).

4.6.3 Technology Acceptance Model

In 1989, Davis began to study how attitudes could affect the intention to use a system, with the evaluation of some constructs (Davis, 1989). The focus of the study was to determine factors that would compel individuals or a group to use a system. The TAM was adapted from the TRA, where the individual's beliefs, attitudes and behaviours were strong proponents when determining an individual's acceptance of a technology (Davis, Bagozzi, & Warshaw, 1989).

The TAM by Davis in 1989 has been widely used in research that focuses on the use and acceptance of a broad range of end-user computing technologies by a target population. Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) are two beliefs used in the model, where PU is the degree "to which a person believes that using a particular system would enhance his or her job performance" and PEOU the degree "to which a person believes that using a particular system would be free of effort" (Davis, 1989). PEOU is the belief that using a system would take less mental and physical effort, while PU is the belief that the system would be less cumbersome (Davis, 1989). The two important individual constructs of the TAM, PU and PEOU support attitudes (AT) that determine the utilisation of a certain information system or technology. When users perceive that the system is easy to use, this positively affects their usage of the system. PU and PEOU have a positive influence on attitudes, behavioural intention to use the system and usage.

The reviewed models focus on how attitudes, beliefs, behaviours and other antecedents can influence the behavioural intention to use technology or a system. Over the years, these models have formed the basis for investigating information technology acceptance and usage, and for this research, adapted TAM2 was used.

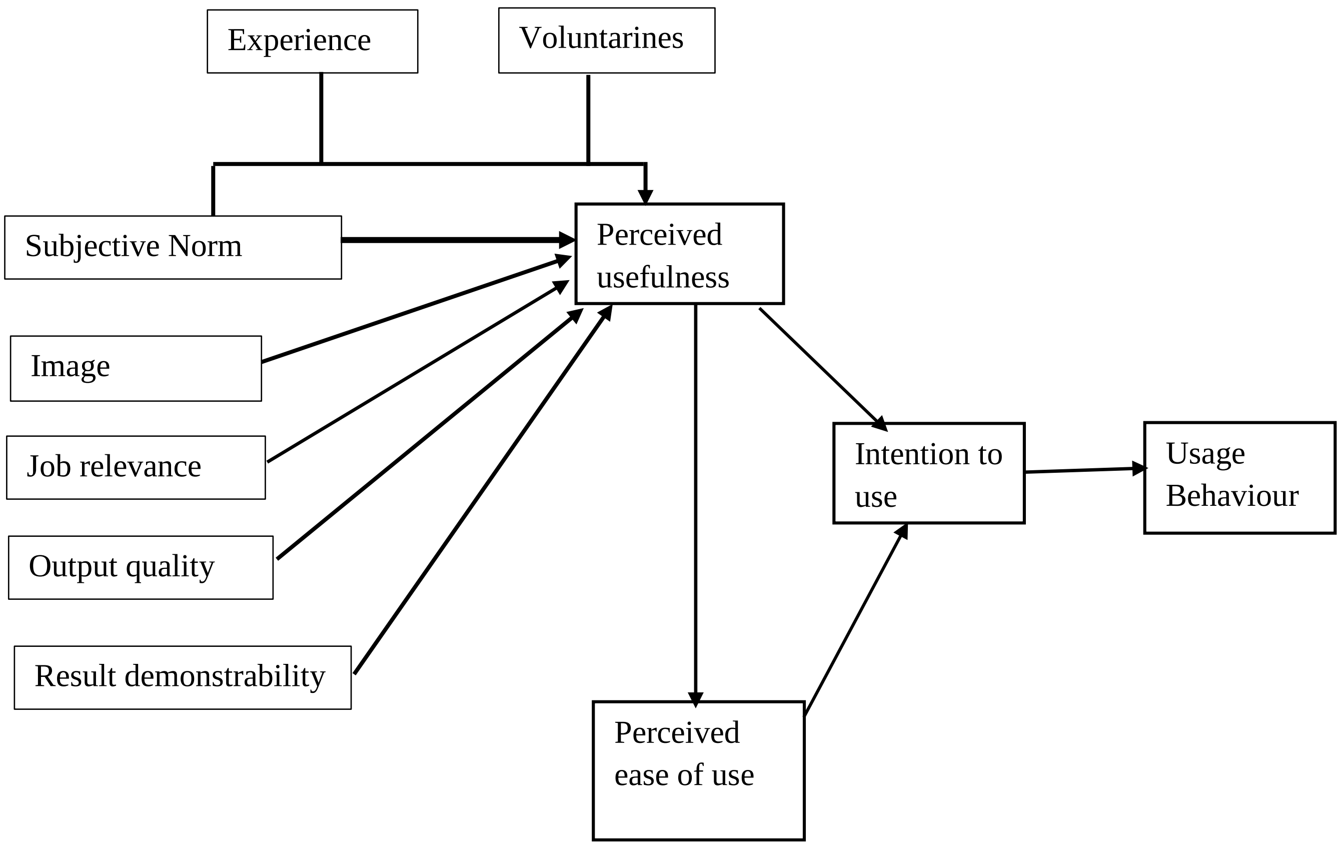

Figure 4.4: TAM2 by Venkatesh and Davis (2000)

This 1989 TAM by Davis has been widely used in research that focused on the use and acceptance of a broad range of end-user computing technologies by a target population, as shown in figure 4.4. Social factors that affect the adoption of technology – such as the subjective norm, image and others – were not included in the original TAM, but were incorporated later to improve the model (Venkatesh; Davis, 2000). The behavioural intention to use a mobile phone application is described as a person's willingness or measure of his or her determination to engage in a particular behaviour (Fishbein & Ajzen, 1975).

4.6.4 TAM2

Over the past years, TAM has proved to be a reliable and robust model for predicting user acceptance of an information system in a work environment. Venkatesh and Davis (2001) proposed a new version of TAM, which they called TAM2, after they investigated additional variables and determinants that could affect technology adoption and use, as shown in figure 4.5. Research revealed that TAM could probably predict only 40% of the variance in system adoption and, therefore, other variables have been included to help improve the percentage of predicting the acceptance of information systems and technology (Legris, Ingham, & Collerette, 2003). One of the major flaws of the original TAM is that it did not consider prior experience and individual attributes – such as age and gender – that could influence an attitude towards using a particular system, invariably influencing the intention to use the system or technology (Venkatesh, Morris, & Davis, 2003). Additional variables of a social nature that impacted upon PEOU were added to TAM2; these could affect technology adoption and were identified as the subjective norm, voluntariness and image that could impact the system or technology adoption. TAM2 was developed primary to refine determinants of PEOU and PU, and identify other variables that had a moderating impact on other constructs.

4.6.5 Adapted TAM2

For purposes of this study, TAM2 was adapted to include other variables that could affect the adoption and use of mobile phone applications in a rural setting. In this adapted TAM2, there was a deliberate choice of constructs that influence the adoption of technology in an informal environment, such as the use of mobile phone applications by rural communities. Variables that are a product of PEOU have been grouped under a thematic heading, referred to as suitability. The main reason is that these variables tend to determine if a system or technology is suitable for use. According to Davis (1989), the functionality of a system is the main driver that influences adoption and, thereafter, users may consider how hard or easy is to use a system. PU and Suitability are the two main factors that will either positively or negatively affect the intention to use the mobile phone application in the Bulilima district, thereby affecting the behavioural intention to use the app.

The main constructs of suitability are language, experience, simplicity, effectiveness and gender issues, which are important determinants in predicting acceptance of a mobile phone application for socioeconomic development. On PU, the researcher added cost to the other traditional factors proposed by Venkatesh and Davis (2001) as the cost of air time and the phone is very relevant in a rural community. In a rural set-up, a subjective norm is critical, as most people will begin to use a system or some technology if others or their peers are using it.

Information system usage or adoption, by an individual or community, is determined by behavioural intentions that are a product of attitudes towards using a particular information system. These are determined by PU and Suitability. TAM2 and its variants have been widely used in Western cultures and been rigorously tested while few studies have been published on TAM2's application in other cultures like the African culture to enhance our understanding and verify cultural validity (Teo, 2013). In recent years, other scholars such as Cheng San and Lee added other constructs onto the original TAM2 – education and the cost to their model to refine factors that affected technology acceptance and usage (Cheng-San & Yee, 2013).

The DSR methodology use theories that must predict how the target population will use the developed artefact, its impact and the perceived usefulness and these requirements make TAM2 one of the most appropriate models (Hevner, March, Park, & Ram, 2004). Table 4.3 shows the relationship between TAM2 constructs, baseline survey questionnaire and artefact evaluation questionnaire. The adapted TAM2 is highly appropriate to this research, as it provides a means to measure how rural communities perceive and respond to the use of mobile phone applications and related technologies for socioeconomic development. The factors of job relevance, image and output quality were afforded less weight, as they appealed more to a formal organisational setup than a rural community.

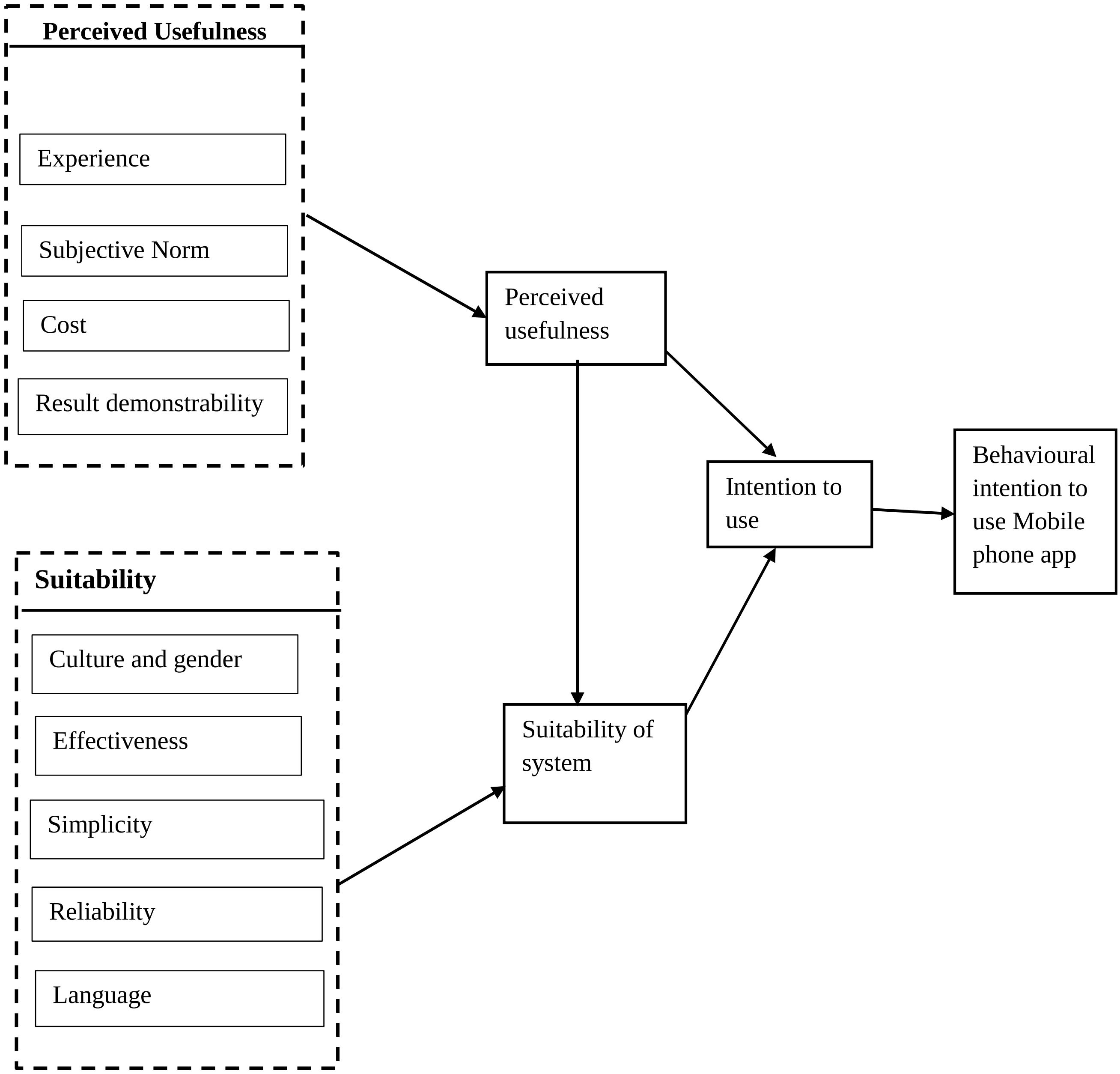

Figure 4.5: TAM2 (Adapted from Venkatesh and Davis 2000)

Knowing the perceptions of rural communities with regard to the use of mobile phone applications and related technologies can help local government, development agents and rural community leaders to come up with strategies for rolling out such technologies to other rural communities in Zimbabwe. Suitability will be viewed as the degree to which rural community members believe that these apps and related technologies will enhance access to information that will help to improve socioeconomic development. The added variables are very important when determining the adoption and use of mobile phone applications in rural areas, as shown in figure 4.5.

i. Effectiveness: This is a measure of the accuracy of users in achieving certain goals.
ii. Simplicity: This is a measure of the effort made by users in order to accomplish tasks.
iii. Suitability: This is a measure of how the community considers the mobile application appropriate for their needs.
iv. Culture and gender: These are roles, assigned to men and women, that are defined by the community.
v. Language: The English language can be a barrier and, therefore, this application used simple language and, in the future, a local language option to enhance usability and comprehension will be provided.
vi. Reliability: This is a measure determining how dependable the mobile application will be to the community.

Meanwhile, PU is the degree to which an individual or community believes that using mobile phone applications and related technologies will be less cumbersome. One added variable evaluates the impact of the cost of this technology upon technology adoption. There is limited literature on the potential of mobile phone applications and related technologies to enhance socioeconomic development in rural communities in Zimbabwe – and that on issues such as knowledge, culture and gender dynamics, appropriateness and affordability.

Table 4.3: Linking adapted TAM2 and DSR varaibles to the questionnaire

Relationship between TAM2 constructs, baseline and artefact evaluation questionnaire		
TAM2	Baseline questionnaire	DSR evaluation questionnaire
Result demonstrability	Question 3.1, 3.41	Question 2, 3, 5, 12, 14
Cost	Question 4.3.4	Question 12
Experience	Question 2.4, 2.6.6	Question 1
Effectiveness	Question	Question 1, 3
Simplicity	Question 2.1, 3.4.3	Question 4
Suitability	Question 3.4	Question 1, 3, 5, 12
Culture and gender	Question 4.3.1	
Language	Question 4.3.2	
Reliability	Question 2.6	Question 1, 5, 13

4.7 Mobile phone application design

The proposed mobile phone application will enable rural communities to access relevant and current information that impacts upon their day-to-day living. The broad categories of information that the app will provide were gathered through the baseline survey. The app will allow communities to access general content which has been highlighted by several scholars as important to support socioeconomic development in rural communities (Kasusse, 2005; Best & Kumar, 2008; Kivunike, Ekenberg, Danielson, & Tusubira, 2011; Mtega & Benard, 2013; Breitenbach, 2013). Some of this information has been provided through telecentres.

i. Local and national news – Get current local and national news and provide a link to sources of news. Local news stories within the community from local sources and key informants.
ii. Market information – Get updated prices for local commodities, e.g. the price of crops and fresh produce, poultry products and animals. Provide dates for cattle sales, dipping dates and vaccination information.

iii. Health information – Provide basic health tips and information on common diseases and conditions, such as diarrhoea, HIV/Aids, pregnancy tips, postnatal care, TB and malaria, etc.
iv. Agriculture information – Provide information on topics such as planting season dates, seed information, crop varieties, rainfall predictions and patterns, plant and animal diseases, and conservation techniques.
v. Community-related activities – Provide information on community activities, such as meetings, weddings, parties, sporting fixtures and funerals. Also provide a schedule on available transport, including buses and taxis, and reports on the condition of roads and bridges (whether a particular road is closed or a bridge has been destroyed).
vi. Educational activities – Allow communities to access educational material and career information and advice through appropriate websites.
vii. Political information – Allow communities to access local government information, access to information related to rights,

4.8 Triangulation

When conducting research, it is important to use a process called triangulation, where one uses multiple methods to explore one research problem (Given, 2006). The use of more than one method in data collection, multiple data sources, analysis of previous work and comparison of other generalisations within the same domain helps to ensure that the results drawn from a study are consistent and can be applied in general (Costello, 2003). The use of quantitative and qualitative techniques in a single study also aids triangulation (Dawson, 2009). Saunders, Lewis and Thornhill (2009) noted that peer debriefing is a technique where a researcher allows peers who are not pursuing a similar study to probe the researcher’s line of thinking on parts or the rest of the research, in a process called triangulation. In this study, this process was achieved through asking the same questions to different respondents and also through utilising different data gathering techniques for data solicitation, such as questionnaires and semi-structured interviews.

4.9 Study population

The research will focus on Zimbabwe, a land locked country found in Southern Africa as shown in figure 3.6. The study will focus on rural communities, with special focus on Matabeleland South province, encompassing an area of 54,172 square km, with seven districts, as shown in figure 4.6. The focus will be on Bulilima district, which is shown in figure 4.7. It has a population of about 64,540, with 16 wards and 11 secondary schools (Zimstats, 2013).

Figure 4.6: Southern Africa map showing Zimbabwe's Matabeleland South Province

The study population for this research includes all adults in Bulilima district and pupils in secondary schools. Learners, the next generation, have a great potential to use mobile phones and have been described as digital natives, whose native language is the Internet, video games and the language of computers (Prensky, 2001). Communities in these districts have remained marginalised, with limited or no access to television and radio services, poor road networks and restricted agricultural and economic opportunities, due to low rainfall.

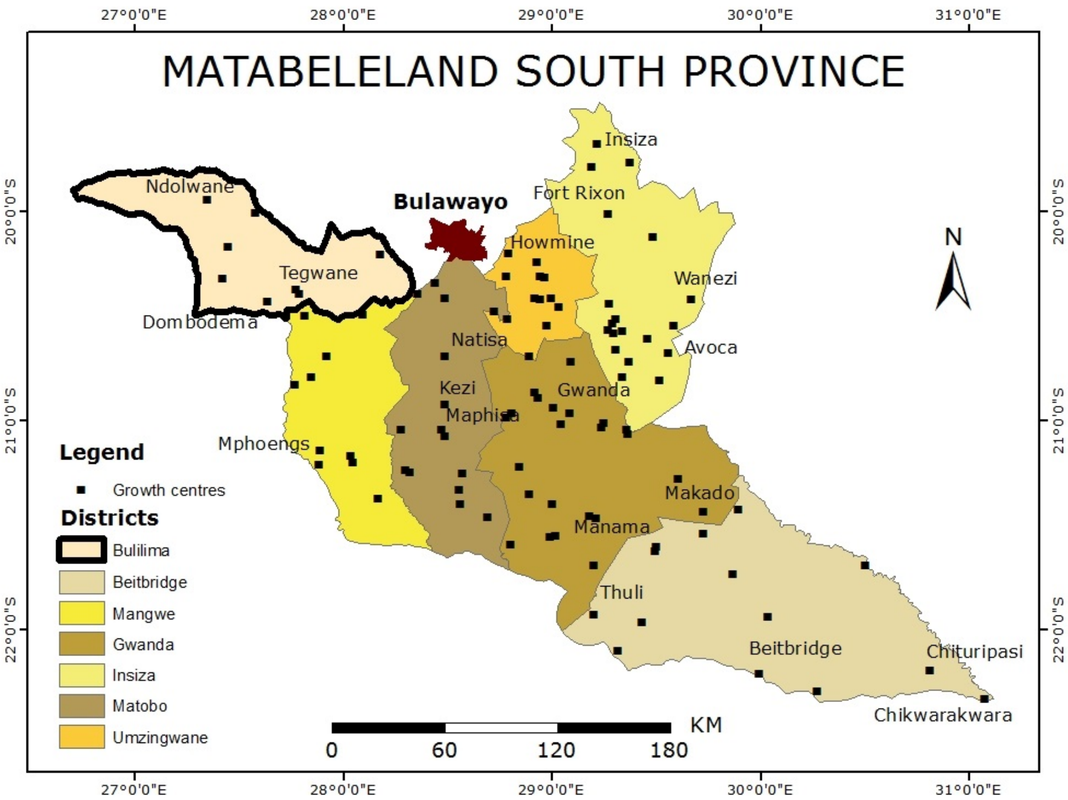

Figure 4.7: Matabeleland South Province map

4.10 Study Sample

The population under study forms the universe of all possible participants for the research and is the basis from which the study sample is constructed, through methodological assumptions (Given, 2008). Time, accessibility and financial resources may not permit studying the entire population of Zimbabwe and even that of Matabeleland South province, therefore, Bulilima district will be the focus of the research as shown in figure 4.8. Two wards in the district were sampled and two villages per ward were used for the study, through cluster sampling. Employees of the arms of government related to socioeconomic development that covers the selected wards had questionnaires sent to them, including Agricultural Extension workers (Arex), the Social Welfare ministry, traditional leaders, NGOs, health practitioners, secondary level pupils and school teachers. Through cluster sampling, two secondary schools were sampled in the district and questionnaires given to senior pupils from forms four through to six. Through the questionnaire responses, intensive users of mobile phone applications were identified and this helped in the selection of another sample group that was used to help in the design of the artefact. Semi-structured interviews will be conducted, with selected intensive users of mobile phone applications. A series of semi-structured interviews were conducted to solicit information that will be used to design the mobile phone application.

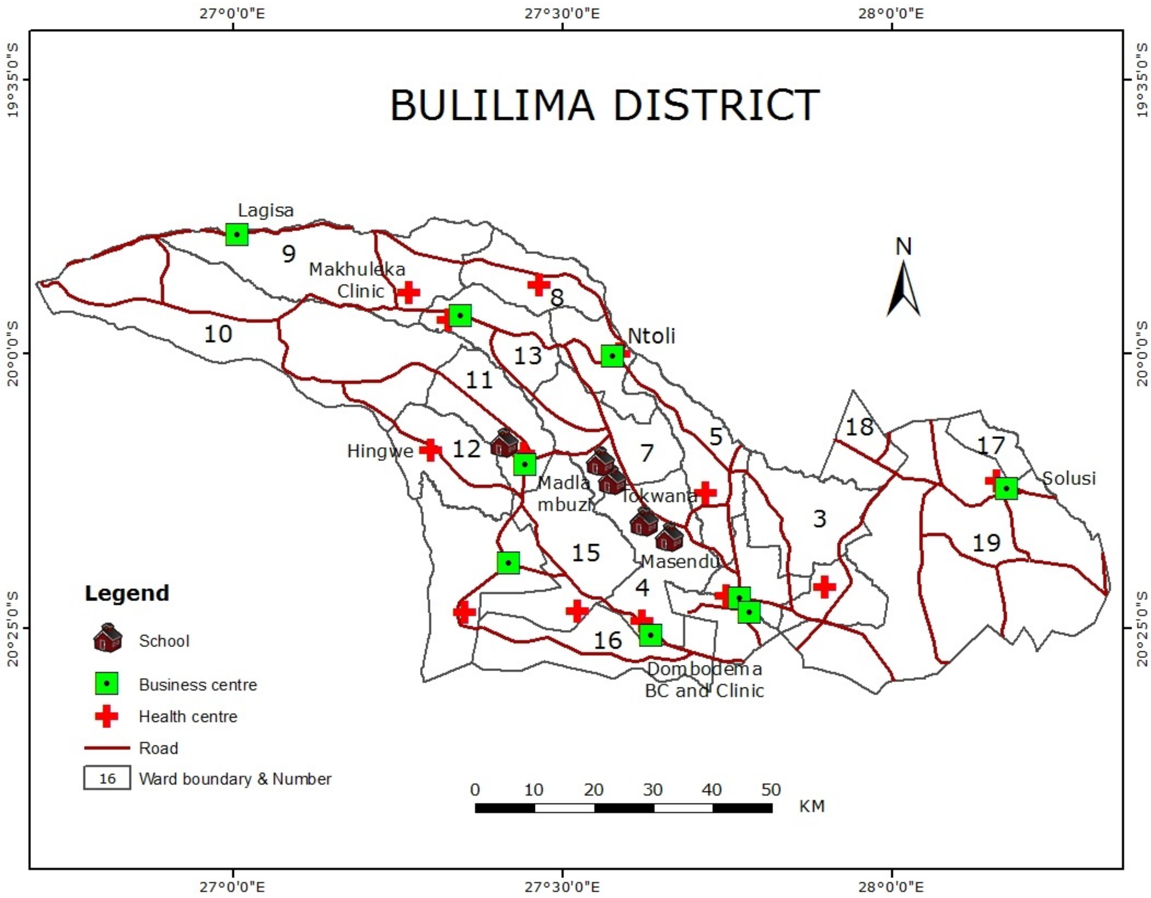

Figure 4.8: Bulilima district map

4.11 Sampling frame and sample

A sampling frame is a complete list of all possible cases within the study population and, for this research, it will be all of the rural districts of Matabeleland South province. The sample frame for this study is all the wards within the rural districts of Matabeleland South province, while the sample unit comprises the villagers.

4.12 Sampling techniques

Kothari, (2004) posits that probability sampling includes random sampling, systematic sampling, stratified and cluster sampling, while non-probability samples are premised on judgment sampling and quota sampling techniques. Cluster sampling allows the researcher to select broad interest groups, such as government officials (Arex) and social welfare workers, NGO agents, health workers, key informants and secondary school children. Each selected cluster must be heterogeneous and non-overlapping, and each element within the population can only be assigned to one cluster group. Where completeness and accuracy of the sampling frame are not guaranteed, cluster sampling is preferred, as it allows the stratification of information-rich samples that may describe or explain key themes. The drawback of this technique is that the sample may not be representative of the entire population.

Random sampling was employed to select respondents from villages, schools and special interest groups to gather information that is not gender, position or ward biased. The selection of sample strata and respondents follows some iterative steps until samples are selected using random sampling techniques. Table 4.4 provides an overview of the activity, plus associated sampling techniques with appropriate justification. From the table, the choice of districts and wards was achieved through purposive sampling, based on gaps in information and the communication services available in the district. Cluster sampling helped select the wards, clinics, secondary schools and other key informants. Random sampling was used to select the participants for questionnaire distribution and semi-structured interviews.

Table 4.4: Activity, sampling technique and justification

Activity	Sampling technique	Justification
Choice of province	Purposive sampling	Matabeleland South province was chosen because it lies in region 5, with low rainfall, poor soils, low economic activities and many minority communities such as the Tonga, Venda, Suthu and Kalanga. Radio and television signals are found in just a few districts in the province.
Choice of district	Purposive sampling	Communities in Bulilima district lack access to information, since there is limited access to telephone, radio or TV signals. The districts lie in region 5, which suffers from low rainfall and perennial droughts.
Choice of wards per district	Cluster sampling	The district is divided into wards. Two wards were chosen per district.

Choice of village(s) per ward	Cluster sampling	Wards are made up of several villages. Two villages out of an average of six per ward were selected.
Choice of Secondary school	Cluster sampling	The district has about 8 Secondary schools and two schools were selected
Choice of clinic	Cluster sampling	From the 6 clinics in the district, 2 were be selected.
Distribution of questionnaires	Random sampling	Questionnaires were distributed to villagers, secondary school children and special groups.
Choice of interviewees from the questionnaire respondents	Random sampling	Members who seem to be heavily using mobile phone applications were selected to be part of the mobile phone application development process.
Semi-structured interviews	Random sampling	From the questionnaire analysis results, intensive mobile phone application users were selected.

As shown in table 4.5, cluster sampling was used to group all of the secondary schools in the Bulilima district, while random sample was used to select the secondary schools that would participate in the study.

Table 4.5: Using cluster sampling to select secondary schools

Population	All Secondary schools in Bulilima district.
Group (Cluster)	Seven different Secondary schools in Bulilima district.
Random Sample	Two Secondary schools from the list of all schools in Bulilima district.
Sample	Every senior student in the school.

The participating wards were selected from the list in table 4.6 through the use of purposive sampling. The factors that were considered were accessibility of the ward as those that were close to each other.

Table 4.6: Using random sampling to select wards

Number	Name of ward	Selected
000	Madlambudzi	✓
001	Hingwe	
002	Nswazi	
003	Tokwana	✓
004	Dombodema	
005	Wuwana	
006	Masendu	✓

As shown in table 4.7, cluster sampling was used to select the participating secondary schools in the district. The schools are listed in the table and uniquely numbered and then selected using random sampling.

Table 4.7: Using random sampling to select Secondary schools

Number	Name of Secondary School	Selected
000	Madlambudzi	✓
001	Zimnyama	
002	Malalume	
003	Dombodema	✓
005	Bambadzi	
006	Zenzele	
007	Tokwana	✓
008	Siyaphambili	

Similarly, cluster sampling was used to select the participating clinics, as shown in table 4.5 and table 4.8. Through simple random sampling, participating clinics were selected from the list of all of the clinics in the district, as shown in table 4.9.

Table 4.8: Using cluster and random sampling in clinics

Population	All clinics in Bulilima district.
Group (Cluster)	Eight different clinics in Bulilima district
Random Sample	Two clinics from the list of all schools in Bulilima district
Sample	Health workers in the clinic

Table 4.9: Using random sampling to select clinics

Number	Name of clinic	Selected
000	Madlambudzi	✓
001	Hingwe	
002	Nswazi	
003	Tokwana	✓
004	Dombodema	
005	Ndiweni	
006	Masendu	✓
007	Village 13	

4.13 Research instrument

Research methods determine how data is solicited from the target population and the researcher must to choose specific methods, based on the type of questions to be asked and the perceived answers. Yin (1994) recognised five popular ways of collecting and analysing empirical data in research, which included experiments, surveys and analysis of archival information, histories and case studies.

4.14 Data Collection methods

Several methods can be used to collect primary data when conducting mixed-methods research; among them are observations, interviews, focus group discussions, questionnaires and content analysis. Survey researchers tend to generate large amounts of statistical data, which is easy to interpret through the use of questionnaires or structured interviews (Dawson, 2009).

In this survey, self-completion questionnaires with closed and open questions were developed. According to Bryman and Bell (2003), closed questions have some advantages: they are easy to process answers; they enhance the comparability of answers and make them easier to show the relationship between variables. For this research, it was better to pose closed questions than open ones, as the latter tend to encompass qualitative information that can only be reduced into coding, therefore, the answers tend to lose some of their initial meaning. Another drawback of open questions is that respondents use their own words, which makes it difficult to compare the meanings of the responses (Dillman, 2000).

4.15 Questionnaire

Questionnaires are versatile and are better at handling time constraints and a more cost-effective tool for data collection compared to other data gathering techniques (Leedy & Ormrod, 2008). A questionnaire is a formalised schedule for collecting data from respondents and consists of a series of questions that respondents must answer in order to capture unpublished data. Questionnaires are research instruments that: are easy to follow; inexpensive; often measure attitudes, values and intentions; and that must be completed by the respondents themselves (Bryman, 2004). Their general limitations are that respondents may not complete all the questions and the information supplied may be biased. A questionnaire has been utilised as one of the data collection instruments for this research. The purpose of the questionnaire for this study was two-fold – firstly to attend to the initial research questions and, secondly, to use its results to identify participants deemed to be intensive mobile phone application users, in order that they participate in semi-structured interviews to assist in designing the artefact (Creswell, 2009). The questionnaire enables researchers to examine and explain relationships between constructs (Saunders, Lewis, & Thornhill, 2009). In questionnaires, closed questions have advantages: it is easy to process the answers; it enhances the comparability of answers; and easily demonstrates the relationship between variables (Dawson, 2009). Dillman (2000) defines a questionnaire as a pre-determined, written list of questions that is to be answered by the interviewee. In this light, copies of a pilot questionnaire were distributed to staff at the

Bulilima Rural District Council offices for pre-testing, in order that issues concerning the clarity of questions and answerability could be ascertained. Participants who were selected for the pilot survey were excluded from the final survey. The questions were, in general, easy to answer but many participants found question 12.3, which asked what type of mobile data they were accessing, difficult to answer.

4.15.1 Questionnaire Design

The first part of the questionnaire captures demographic data, i.e. age, gender and educational level, among others. The second section evaluates mobile phone efficacy and usage, while the third evaluates how participants use the mobile phone to achieve their work or activity. The other remaining sections of the questionnaire assess the participants on using mobile phones for financial inclusion, community mobilisation, access to news and health information, mobile phone infrastructure and connectivity to the internet.

4.16 Semi-structured interviews

Lee (2010) equates structured interviews to verbally administered questionnaires, with set response options within a rigid structured schedule that directs the process. Semi-structured interviews utilise a constructed a list of questions that may be asked during an interview session. According to one study (Saunders, Lewis, & Thornhill, 2009), during an interview, some questions may be omitted or varied, depending on the response of the interviewee and the flow of the questions. Additional questions may be asked as follow-up questions. For this study, the researcher used semi-structured interviews to probe intensive mobile phone users to gather the required specifications for the mobile phone artefact. Three sets of semi-structured interviews were undertaken, during the development of the artefact. The first set of interview questions gathered broad information needs questions. During these sessions, paper sketches of designs and information flow diagrams were developed. Respondents played a central role, with the output of this process transformed into a functional prototype.

During the second set of the development iterations involved agreeing on the design specifications and the type of content the respondents thought could form the core of the design of the mobile phone application. The second set of interview questions involved the presentation of a prototype of the app for user acceptance and a solicitation for contributions on further improvements. The objective of this stage was to evaluate the prototype, by comparing objectives and requirements set by participants as to its functionality. The output of this stage helped the researcher to decide about either returning to the design phase or making further improvements on the functionality of the prototype. Finally, participants were asked to evaluate the mobile phone application through a questionnaire, to ensure that the artefact met the needs of target users.

4.16.1 Overview of interview questions

Phase one of the interviews canvassed mobile application design principles, as well as the content that the app had to contain. In some cases, participants had to describe their ideas on the aesthetic design of the application, in terms of background colours to be utilised. During these sessions, participants described how they thought information in the mobile application should be organised, in the context of enhancing its functionality.

During the second part of the interviews, participants were presented with a prototype, so that they could evaluate whether the general design principles agreed upon in phase one had been implemented. This was loaded with test information that facilitated functionality evaluation. All of the concerns raised by the participants were noted.

4.16.2 Prototype evaluation

Evaluation of the prototype was through the appropriate metrics for functionality, completeness, accuracy, usability and reliability (Hevner & Chattejee, 2010). Meetings were then held with key stakeholders – schools, health institutions and villages – that were included in the assessment of the prototype presented to the community in Bulilima. The app was loaded into Android-based phones and tablets, and the prototype was evaluated according to its usability, simplicity, design elements, flow of information, appropriateness and the relevance of its information.

4.16.3 Usability

This stage involved the users examining the app to test whether all of the elements, menus and links were functional. Participants could point to usability issues that required redesign, such as: navigation, clarity and relevance of information, ease of scanning for information through the eye, and comprehension through language options.

4.16.4 Simplicity

Participants were asked to rate the mobile phone application, by navigating through it to search for relevant information. They would then assess it as either simple or complex to use.

4.16.5 Design elements

Participants assessed the mobile phone application, by evaluating the placing of elements, organisation and flow of information, visual appeal of the icons used, and navigation options. They further evaluated and rated the flow of events and actions required to ensure that the application was usable.

4.16.6 Functionality

Participants evaluated the artefact on whether it worked, the time it took to load and if its response times were acceptable. They also compared its set objectives against functionality.

4.17 Data analysis

The research project had two phases. The first concerned the collection of data through questionnaires and its analysis through the technology acceptance model. From the questionnaire, respondents deemed as intensive users of mobile phone applications formed the sample for the second part of the research project. Data collected from participants through semi-structured interviews helped to design and develop the app. This phase of the project followed the DSR methodology in building and developing the artefact.

The purpose of this study was to determine how mobile phone access and the use of mobile apps could enhance the socioeconomic development of rural communities in Zimbabwe. The data gathered measured constructs, such as suitability of the mobile phone application, which determines PEOU, PU and the actual usage of the artefact, among other constructs. The analysis of the raw data involves its manipulation to reveal hidden relationships and occurrences between these constructs through statistical operations. Data produced by this research was subject to statistical analysis by available commercial statistical software packages, such as Excel and SPSS. Some of the data was qualitative and "quantified" into numerical codes for further analysis through statistical methods, including descriptive statistics that assessed responses and the meaning of the extracts through measurement of variance, mean, mode and standard deviation. Other data analysis techniques – such as cross-tabulations, chi-square and correlation tests – were conducted to generate insight into relationships between constructs and their level of significance. Data produced in semi-structured interviews was quantified, based on key thematic areas of the model. Correlations then revealed relationships between constructs, based on the coefficient value. If the coefficient value was zero, this implied that no linear relationship existed between the variables, but if the coefficient value was one, this pointed to a perfect linear relationship. This analysis concerned key themes derived from the proposed model, in addition to respondents' comments on perceived usefulness, ease of use and attitude towards the usage of mobile phones. Multi-linear regression analysis tested the proposed constructs of the adapted TAM2 and provided insight into the relationships between variables.

4.18 Conclusion

This chapter gave an insight in broad research themes, such as the paradigm and key characteristics of any research, including its ontology, epistemology and methodology. The main methodologies were highlighted – the quantitative, qualitative and the mixed-methods approaches. The chapter also provided an overview of the DSRM as the selected methodology and the adapted TAM2 as the research model that underpins the study. The chapter also provided a detailed description of instruments employed to guide data capture and the design of the mobile phone application for use rural by communities in the Bulilima district. From the reviewed literature, constructs and variables that determined the adoption of mobile phone applications in rural communities were adapted and developed. The adapted TAM2 had additional constructs added so that it could be utilised in an informal setup like rural community setup. The study population, sampling frame and sampling techniques were adequately covered. Data collection was by means of questionnaires and semi-structured interviews. The next chapter provides an overview of the development of the app and data analysis.

Chapter 5: Baseline and data analysis

5.1 Introduction

Following the DSRM guidelines outlined by Hevner, March, Park, & Ram, (2004), there is need to fully understand the problem by building awareness through exploring literature as well as conducting a baseline survey. It is crucial to conduct a baseline survey to gather information on the current challenges affecting the community as well as establishing their context in terms of availability, affordability and access to mobile services (Qiang, Kuek, Dymond, & Esselaar, 2011). Other scholars have pointed out that before implementing any community-based projects, there is need to investigate real needs of the community before implementing any interventions (Wayi & Huisman, 2010; Agunga, 1998). The output of this chapter helps in confirming the percieved problem.

The results of this data analysis provide clear contextual factors that help in the development of the application. The baseline survey was meant to show the evidence on the ground in line with the ISDM. Designing successful systems for rural communities require the researcher to fully understand the socio-technical factors affecting the community, and this was achieved through gathering information through a baseline survey. To design an effective mobile phone application for the community of Bulilima it was important to establish literacy levels, mobile phone reception, market saturation and availability of other services (Boekestijn, Schwarz, Venselaar, & de Vries, 2017). The baseline survey provided positive feedback on the potential of mobile phone applications in rural development as well as revealing how the community has started to use the phone as a tool for information access.

The previous chapter articulated the methodology that was used to guide the development of the mobile phone application. In this chapter, the researcher will present and analyse data collected using research tools discussed in chapter four. Descriptive data gathered through the questionnaire concerned: demographics and challenges addressed by mobile phones; main issues hindering the uptake and use of ICTs in rural areas; mobile network infrastructure usage; and major mobile apps used by rural communities. The purpose of the study was to develop a mobile phone application that would enhance access to socioeconomic development information. The study also sought to explore issues that affected ICT uptake and usage in rural areas, as well as establish the extent to which members of rural communities utilise ICTs for socioeconomic development. The data presented in tables and graphs was recorded by means of SPSS, and was followed by data analysis combining theories and empirical data.

5.2 Research objectives

The following objectives guided the research:

i. Assess how improvements in mobile phone coverage in rural areas correlate to improvement in rural socioeconomic development;
ii. Investigate factors that influence the uptake and use of mobile phone applications in rural communities for socioeconomic development;
iii. Determine the mobile phone usage trajectory and mobile phone application usage trends in rural areas;
iv. Establish the extent to which rural communities are aware of the potential that mobile phone applications have on their socioeconomic development; and
v. Design a mobile phone application that allows rural communities to access information important to their socioeconomic development needs.

5.3 Questionnaire Response Rate

A total of 150 questionnaires were distributed to residents of Bulilima district, which is mainly comprised of two secondary schools, three clinics, district offices, a police station, a Women and Gender Affairs Ministry, a Social Welfare Ministry, an Agritex department, a traditional leadership body, churches and selected wards. A total of 103 questionnaires were returned, with two not included in the study, as they contained incomplete sections. Therefore, there was a return rate of 67.3%, as shown in table 5.1.

Table 5.1: Questionnaire response rate

Questionnaire Distributed	Questionnaire Returned	Valid Response	Valid Response Rate
150	103	101	67.3%

The research assistants were undergraduates who were studying towards their BSc Honours degree in Development Studies at Lupane State University. They assured respondents that the data collected would be employed only for academic purposes, in light of the volatile political landscape as the nation approached elections. To obtain a high rate of return, members of the research team temporarily relocated to the area and distributed questionnaires that they collected two days later. Studies by Leedy (1993) on questionnaire response rates concluded that 50% or more was adequate, while 60% and above was satisfactory. This researcher was therefore satisfied that the rate of questionnaire return was adequate and gave a true reflection of the sample under investigation.

5.4 Reliability of the instrument

Reliability is fundamentally concerned with issues of consistency of measurement, or to what extent the results of a study remain consistent over time, even if the same study is repeated, but with a different data sample. Internal consistency assesses the consistency of results across items within a test and is important in ensuring that all constructs relate to each other. The reliability test ensures that survey results can be generalisable, that the instrument is reusable across different samples and measures consistently. Cronbach's alpha was measured and observed across all of the constructs in this survey and an initial value of 0.651 was observed, which was lower that the accepted threshold. However, after removing two questions related to the utility of the mobile phone, the Cronbach alpha value increased to 0.839, as shown in table 5.2. This was considered appropriate and acceptable, as reported by the scholars George and Mallery (2003), who indicated in their study that a value greater than 0.7 was acceptable.

Table 5.2: Cronbalch alpha measurement

Variable	Number of questions	Cronbach alpha value (α)
Usage of mobile phone to access information	8	0.765
Access to media	5	0.734
Utility of the mobile phone	7	0.839
Challenges faced before mobile phone usage	6	0.702
Solutions provided by mobile phones	8	0.780

5.5 Data analysis technique

An overview of data analysis procedures that were utilised in this study are presented here. Descriptive and inferential statistical applications provided an overview of the collected data. Data analysis was achieved by means of two software programs – the Statistical Package for

Social Sciences (SPSS), version 22, which computed descriptive statistics, and measured central tendency and dispersion of the data, and Microsoft Excel 2013, used to produce graphs on data distribution. Other tests utilised included the Pearson and Spearman correlation, and Cronbach's alpha. The charts and graphs produced provided a visual and graphical presentation of data. The results from the data analysis fulfilled the objectives of the study and answered the research questions raised in chapter one.

5.5.1 Respondents by Gender

Of the 101 respondents who completed the questionnaire survey, 51 (50.5%) were male and 50 (49.5%) were female. This is encouraging, as most research revealed that ICTs also increased disparities between male and female. Table 5.3 shows the respondents' distribution by gender. This was satisfactory, as it did not discriminate against women.

Table 5.3: Respondents' distribution by gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	51	50.5	50.5	50.5
	Female	50	49.5	49.5	100.0
	Total	101	100.0	100.0	

5.5.2 Respondents' Ages

The distribution of respondents' ages, shown in table 5.4, is: 35.6% between 15 to 18 years, 25.7% between 19 and 25, 25.7% between 26 and 49 years and 12.9%. aged over 50. Since the majority of mobile phone owners are younger people, who are known as "digital natives", the probability of using the proposed application increases, as ICTs are an intrinsic way of life to this generation. Other scholars have noted that the use of ICTs is heavily dependent, on age with younger people having a relative advantage (Selwyn, Potter, & Cranmer, 2010). Earlier studies have revealed that elderly people often excluded themselves from using ICTs (Haddon, 2000). Previous research also determined a causal relationship between an increase in age and decrease in access to and use of ICTs (Olsson, Samuelsson, & Viscovi, 2016).

Table 5.4: Respondents by age distribution

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	15-18	36	35.6	35.6	35.6
	19-25	26	25.7	25.7	61.4
	26-49	26	25.7	25.7	87.1
	Over 50	13	12.9	12.9	100.0
	Total	101	100.0	100.0	

5.5.3 Level of education

Research revealed that 75% of respondents had attained a secondary school education, 16.8% a college or university education and 8.9% just a primary school education, as shown in table 5.5. This is consistent with earlier research that determined that rural literacy levels in Zimbabwe were very high, at more than 90%, with English the official language of instruction (Lancaster, 2016). Low literacy levels, however, have been identified as one of the major barriers to ICT uptake and use, as the dominant language on the internet is English.

Table 5.5: Level of education

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Primary	9	8.9	8.9	8.9
	Secondary	75	74.3	74.3	83.2
	College/University	17	16.8	16.8	100.0
	Total	101	100.0	100.0	

5.5.4 Ownership of ICTs

The respondents indicated which ICT devices that they owned and, for 95%, it was a mobile phone, as shown in table 4.6. This resonated well with research undertaken by Potraz (2014), which indicated that rural mobile phone ownership was about 80%, revealing a steady increase in ownership.

Fixed landline ownership was recorded as 0%, consistent with publications by Potraz (2014) indicating that rural fixed landline phone ownership in Zimbabwe was less than the national average of three percent (Lancaster, 2016). The lack of fixed landline telephones in Bulilima was also consistent with the views of one study (Rey-Moreno, Blignaut, Tucker, & May, 2016), which revealed a lack of incentive for telecommunication companies to set up infrastructure in rural areas. From the survey, 17 people (16.8%) owned a radio and received a signal and this was consistent with literature showing that most rural districts in Matabeleland South had no access to radio or television signals (Matsa & Simphiwe, 2014). This was in contrast, however, to findings by Mtega (2012), with 97% of respondents revealing that they had access to or owned radios in rural Morogoro, Tanzania, and used radio to access agricultural information. Kenny's further findings (2000), however, were that that radio coverage in Africa stood at 75% of the population, while 40% could access television. The survey revealed that 11 (10.89%) of the participants who owned a television set mainly subscribed to DSTV, while some had free to-air decoders. The FAO (2001) also reported that radio and television were the most effective media for communication and dissemination of information, yet 80% of rural communities in Bulilima, as revealed by this study, had no access to either. A study by the World Bank in 1997 revealed that a fixed landline was a major tool, determining the success or failure of rural businesses in Zimbabwe. Surprisingly, it determined that fixed telephone penetration was almost zero percent (Kayani & Dymond, 1997). As shown in table 5.6, only 10.89% of the participants owned a computer or laptop.

Table 5.6: ICT ownership

		Mobile phone	Land line	Radio	Television	Laptop/Computer
Valid	Yes	96	0	17	11	11
	No	5	101	84	90	90
	Total	101	101	101	101	101

5.5.5 Respondents' Ability to use a mobile phone

As reflected in table 5.7, 95% of respondents indicated that they found it simple to operate a mobile phone. This supports studies conducted elsewhere, which discovered that semi-literate communities could easily operate a mobile. Research by Knoche and Huang (2012) revealed that illiterate people could easily manipulate complex phones, such as the iPhone.

Table 5.7: Mobile phones' ease of use

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	96	95.0	95.0	95.0
	No	5	5.0	5.0	100.0
	Total	101	100.0	100.0	

5.6 Accessing socioeconomic information

Improved interaction and communication can assist rural communities to share ideas and information, and foster unity – thus helping them to develop. More than a decade ago, scholars argued that, for ICTs to contribute to socioeconomic development, there was a need for communities to access, assess, apply and act upon information (Heeks & Duncombe, 2001). The mobile phone application developed for this study will allow rural communities to achieve all three aspects. The app will therefore benefit their socioeconomic development.

5.6.1 Health information

Many people in rural communities die from preventable diseases because access to healthcare and health-related information is not readily available (Mudadigwa, 2016). Most people in rural areas end up in hospital for, preventable conditions compared to their counterparts in urban areas due to lack of health-related information (DoHA, 2012). In the global south, the number of people seeking information on health issues continues to rise and this enhances their ability to experience healthier lives. Medical centres are scattered in rural areas and, with a poor public transport system, many people have to walk great distances to access health information and healthcare services.

The respondents were asked to rate their access to health information on their mobile phone, through SMS, website or a mobile phone application. They could select one answer out of the five provided, which ranged from "never" to "always". Of the 101 responses, seven were missing, as shown in table 5.9. Fifty (49.5%) respondents indicated that they "never" accessed health information, 11 (10.9%) "rarely", 11 (10.9%) "occasionally", nine (8.9%) "frequently" and 13 (12.9%) "always", as shown in table 4.8. The statistics recorded in this study were contrary to those reflected in earlier research, revealing that about 44% of patients globally had experienced the use of mobile devices for health provision (Nguyen & Poo, 2016). There is thus the need to educate rural communities, health caregivers, local government and traditional leadership on the potential to access health information through mobile phones. The results of these findings address research question number four, which established the extent of the utilisation of mobile phones by rural communities, and it became evident that access to health information was one of the areas could be improved through the deployment of the mobile application, among other strategies.

Table 5.8: Access to health information

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	50	49.5	53.2	53.2
	Rarely	11	10.9	11.7	64.9
	Occasionally	11	10.9	11.7	76.6
	Frequently	9	8.9	9.6	86.2
	Always	13	12.9	13.8	100.0
	Total	94	93.1	100.0	
Missing	System	7	6.9		
Total		101	100.0		

5.6.2 Community-related activities

Participants were provided with five response choices, from never to always, to rate how they used mobile phones for community-based activities. As shown in table 5.9, 43 (42.6%) indicated that they had never used a mobile phone for community-based activities, nine (8.9%) said rarely, nine (8.9%) occasionally, 11 (10.9%) frequently and 23 (22.8%) always. There is thus the need to engage and educate local government, development agencies and community leadership on the various ways that mobile phones could be utilised for community-based activities. To ensure the sustainability of these interventions, there is the need to engage and utilise local structures and leadership hierarchies, and ensure that these interventions are community centred. The figure of 42.6% of respondents who had never used a mobile phone for community-related activities showed that there was the need to create awareness of its advantage regarding such activities. Local government and development agencies could also create strategies to encourage communities to utilise mobile phones for community development related activities. Studies in Tanzania also concluded that the use of mobile phones resulted in greater societal cohesion, which helped communities to overcome vulnerability and social exclusion (Mtega, 2012). These findings answer research question number four, which sought to establish the extent to which rural communities utilised mobile phones and apps for socioeconomic development.

Table 5.9: Community activities

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	43	42.6	45.3	45.3
	Rarely	9	8.9	9.5	54.7
	Occasionally	9	8.9	9.5	64.2
	Frequently	11	10.9	11.6	75.8
	Always	23	22.8	24.2	100.0
	Total	95	94.1	100.0	
Missing	System	6	5.9		
Total		101	100.0		

5.6.3 Accessing news

The mobile phone allows people to access news anytime, anywhere, whereas other technologies are location constrained. In some rural areas, there are no other alternative sources for news access, besides the mobile phone. Respondents were asked to rate their frequency of accessing news from their mobile phones, as shown in table 5.10. Twenty-eight percent (27.7%) of respondents indicated that they had never accessed news on their mobile phones, 17 (16.8%) said they had rarely done so, 13 (12.9%) selected occasionally, eight (7.9%) frequently and 31 (30.7%) always. There were four missing responses. There is thus the need to educate those who are not accessing news through their mobiles and for a partnership with news organisations, to cover such respondents' digital education and investigate the packaging of news aimed at them. The time spent accessing news and digital media accounts for over 51% of the total time that users spend on the phone, surpassing all other media platforms (Bosomworth, 2015). The above responses were to research question number four, which sought to measure the extent to which rural communities utilised mobile phones and related applications to access socioeconomic information for development. It has been determined that Mobile Network Operators (MNOs) could be approached to offer subsidies on data used for community development processes.

Table 5.10: Access to news

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	28	27.7	28.9	28.9
	Rarely	17	16.8	17.5	46.4
	Occasionally	13	12.9	13.4	59.8
	Frequently	8	7.9	8.2	68.0
	Always	31	30.7	32.0	100.0
	Total	97	96.0	100.0	
Missing	System	4	4.0		
Total		101	100.0		

5.6.4 Accessing national or current news

In the global north, research revealed that more than 68% of smartphone users acknowledged that they frequently use their phone to read the latest news, due to its relative low cost and well-developed infrastructure (Smith, 2015). News consumption on mobiles could take place at anytime, anywhere of up-to-date information. It has been determined that national news and current affairs access is critical to the development of a nation or community and inherently overcome poverty and inequality (Garrido & Wyber, 2017).

4.7.1.1 How are you accessing the news?

The mobile phone has evolved from being a simple to a multimedia communication device that enables users to access the news as text, video and audio. News websites were common sources for accessing national news and current affairs, with 19% of participants in this study, while video access on the mobile phone accounted for 16.8% and podcasts for 15.8%, as shown in table 5.11. There is need to educate people on the ability of the mobile phone to be used as a source of news from anywhere, as events unfold.

Table 5.11: How are you accessing the news?

		Website	Podcast	Video
Valid	Yes	20	16	17
	No	81	85	84
	Total	101	101	101

5.6.5 Accessing agricultural information

According to the survey data, 44 respondents (43.6%) indicated that they never used a mobile phone for accessing agricultural information, nine chose rarely (8.9%), 13 occasionally (12.9%), seven frequently (6.9%) and 26 always (25.7%), as shown in table 5.12. There is the need to create awareness in order that the rural communities of Bulilima can benefit – like farmers in Bangladesh (who use a mobile phone-based information system called Pallinet) – from direct access to markets, thereby disrupting the power of middlemen so that they can earn more profit (Islam & Gronlund, 2010). Econet has a programme that offers insurance to farmers, agricultural tips and weather information. However, it mainly targets commercial famers (Econet, n.d.). Agriculture extension workers and development-based organisations need to be educated on the use of mobile phones to disseminate agricultural information. In Peru, rural villagers' improved access to market information resulted in increased bargaining power with traders (Beuermann, McKelvey, & Vakis, 2012). The mobile phone has also been used in Kenya by farmers exchanging information on animal diseases. This results in the acquisition of knowledge to help them look after their animals and reduce mortality in the long run, thus improving the farmers' welfare (Duncombe, 2012). These findings helped the researcher to answer research question number four, which sought to measure the extent of use of mobile phones and their apps for socio-economic development by rural communities.

Table 5.12: Accessing agriculture information

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	44	43.6	44.4	44.4
	Rarely	9	8.9	9.1	53.5
	Occasionally	13	12.9	13.1	66.7
	Frequently	7	6.9	7.1	73.7
	Always	26	25.7	26.3	100.0
	Total	99	98.0	100.0	
Missing	System	2	2.0		
Total		101	100.0		

5.6.6 Mobile money transfer

The mobile phone is not only providing a communications platform but has transformed the financial landscape of Africa's rural communities (Demombynes & Thegeya, 2012). As shown in table 5.13, 58.4% of participants indicated they were utilising mobile money services, consistent with research that determined that more than 83% Kenyans made use of M-Pesa and, in Africa, more than 70% of the adult population, although unbanked, engaged mobile money services (Corkin, 2016; Munyegera & Matsumoto, 2017). During the second quarter of 2017, Zimbabwe had 3,352,476 active mobile money subscribers, shared by the three MNOs, with Econet claiming 98% of subscribers, Telecel 1.6% and Netone 0.4% (POTRAZ, 2017).

There is the potential to reach the 41.6% of the rural population that is still not using mobile money services by marketing products, conducting outreaches and educating them on the concept and benefits of paperless, mobile money. Zimbabwe is facing an acute cash crisis, where banks are failing to provide cash to depositors and, therefore, mobile money services present themselves as an interim solution (Studio D, 2017). These findings attempt to answer research question number three, which sought to establish the projected growth pattern in mobile phone usage in rural areas.

Table 5.13: Mobile money transfer

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	59	58.4	58.4	58.4
	No	42	41.6	41.6	100.0
	Total	101	100.0	100.0	

5.6.7 Difficulties faced by rural communities before mobile phones

The participants were asked to rate the level of difficulty that they had faced before a mobile phone signal became available in their ward. There were five categories, with a scale of one to five – one indicating strongly disagree and five strongly agreeing. With relation to contacting family and friends, 79 of the respondents (78.2%) strongly agreed that they had faced difficulties contacting family and friends, while 12 (11.9%) strongly disagreed. This is consistent with research describing this generation as “millennials” who use the mobile phone on a daily basis to communicate with family and friends (Lenart, Smith, Purcell, & Zickurh, 2010). This is also consistent with research in Nigeria by Baro and Endouware (2013), which revealed that 84.5% of respondents used their mobile phones to communicate with distant relatives. Another question related to communication costs and 68 (67.3%) of the participants strongly agreed that the mobile phone reduced communication costs, while 15 (14.9%) strongly disagreed with the assertion. More than half of the participants 56 (55.4%) strongly agreed that they had difficulty accessing educational material, while 23 (22.8%) strongly disagreed. This resonates with findings by Rasmus (2013), who highlighted that mobile phones were opening new avenues in the area of education delivery, also allowing citizens to access educational material that helped them solve problems affecting their communities.

Fifty participants strongly agreed that they had difficulties accessing agricultural information (49.5%), while 29 (28.7%) strongly disagreed. From the survey, 49 (48.5%) strongly agreed that they could not access current affairs and news, while 25 (24.8%) strongly disagreed. Regarding mobile money services, the research revealed that 40 (39.6%) participants strongly agreed that they had difficulty in securing money, while 38 (37.6%) strongly disagreed. It is clear that the impact of the mobile phone on rural communities has been enormous, as most of the respondents recognise its role in their day-to-day living, as shown in table 5.14. There is a need to ensure that rural communities are exposed to other functions and capabilities, which mobile phone applications can provide.

Table 5.14: Difficulties faced before mobile phones

	Could not secure money	Difficulty to contact family and friends	Costs incurred to communicate	Could not access current affairs and news	Could not access educational material	Could not access agricultural information
Strongly disagree	38	12	15	25	23	29
Disagree	7	2	3	2	4	6
Neutral	5	0	1	13	5	8
Agree	4	5	11	7	7	5
Strongly Agree	40	79	68	49	56	50
Total	94	98	98	96	95	98
Missing	7	3	3	5	6	3
Total	101	101	101	101	101	101

5.6.8 Challenges addressed by the mobile phone

ICTs have the potential to transform rural communities if they are adapted to serve their specific needs through the provision of relevant and reliable information (Glendenning & Ficarelli, 2012). Results from the survey demonstrated the challenges that the mobile phone addressed, with figure 5.1 and table 5.15 indicating that 79 (78.2%) of participants strongly agreed that it provided a sense of safety, since it allowed individuals to contact family and friends in times of trouble. However, six respondents (5.9%) strongly disagreed with the statement. This was also indicated by a Spearman's correlation value of 0.853, which showed a strong relationship between the availability of a mobile phone signal in the community and villagers feeling safer. Respondents who strongly agreed that the mobile phone had addressed communication challenges between families and friends were 83 (82.2%), while six (5.9%) strongly disagreed. This is in line with conclusions made by, Pandian, Prasad and Rao (2013) that individuals feel safer and consider it important to be touch with family and friends, when planning events and activities, and to talk and gossip. On the same note, research conducted in

Nigeria by Baro and Endouware (2013) established that 61% of participants concurred that the use of the mobile phone in their community had enhanced their security.

In rural areas, inadequate infrastructure and poor road networks increase communication and transaction costs, yet mobile phones can improve communication and provide access to market-related information. The respondents who strongly agreed that the mobile phone had reduced transport costs through easy communication constituted 77 (76.2%), while nine (8.9%) strongly disagreed with the statement. Spearman's rank-order correlation between the introduction of the mobile phone and reduced transport costs was weak, at 0.214, indicating there was no direct relationship between the two, as shown in table 4.16. This resonates with Goggin and Clark (2009), who noted that volunteers often had to travel 20 to 30 kilometres each way by bicycle to convey messages, usually taking a whole day. This was also consistent with a survey conducted in rural Nigeria, which revealed that 94.7% of participants agreed that mobile phones had reduced travel costs (Baro & Endouware, 2013). The results are consistent with research conducted in Niger, where labourers could use a mobile phone to find out if there were casual job opportunities, without having to pay US$40 for a trip to a town or city (Aker & Mbiti, 2010).

When participants were asked to rate if the mobile phone had addressed the challenge of accessing agricultural information, 58 (57.4%) strongly agreed, while 20 (19.8%) strongly disagreed, as shown in table 5.16. Limited banking services are available in rural areas, due to lack of infrastructure and economic activity to sustain such operations. The mobile phone provides access to some financial services, as highlighted by 54 participants (53.5%) who strongly agreed. However, 19 (18.8%) strongly disagreed. Sixty-three (62.4%) volunteers strongly agreed, while 22 (21.5%) strongly disagreed, that the mobile phone provided access to educational information. These findings are consistent with discussions by Kim, et al. (2011), in their study, which concluded that mobile phones had demonstrated their capability as an appropriate tool to expand access to education and literacy in rural communities in Mexico. The Spearman correlation between the availability of a mobile signal in the community and improved financial services was also high, at 0.789. These findings answered research question number one: How have improvements in mobile phone coverage translated into socioeconomic development in rural communities?

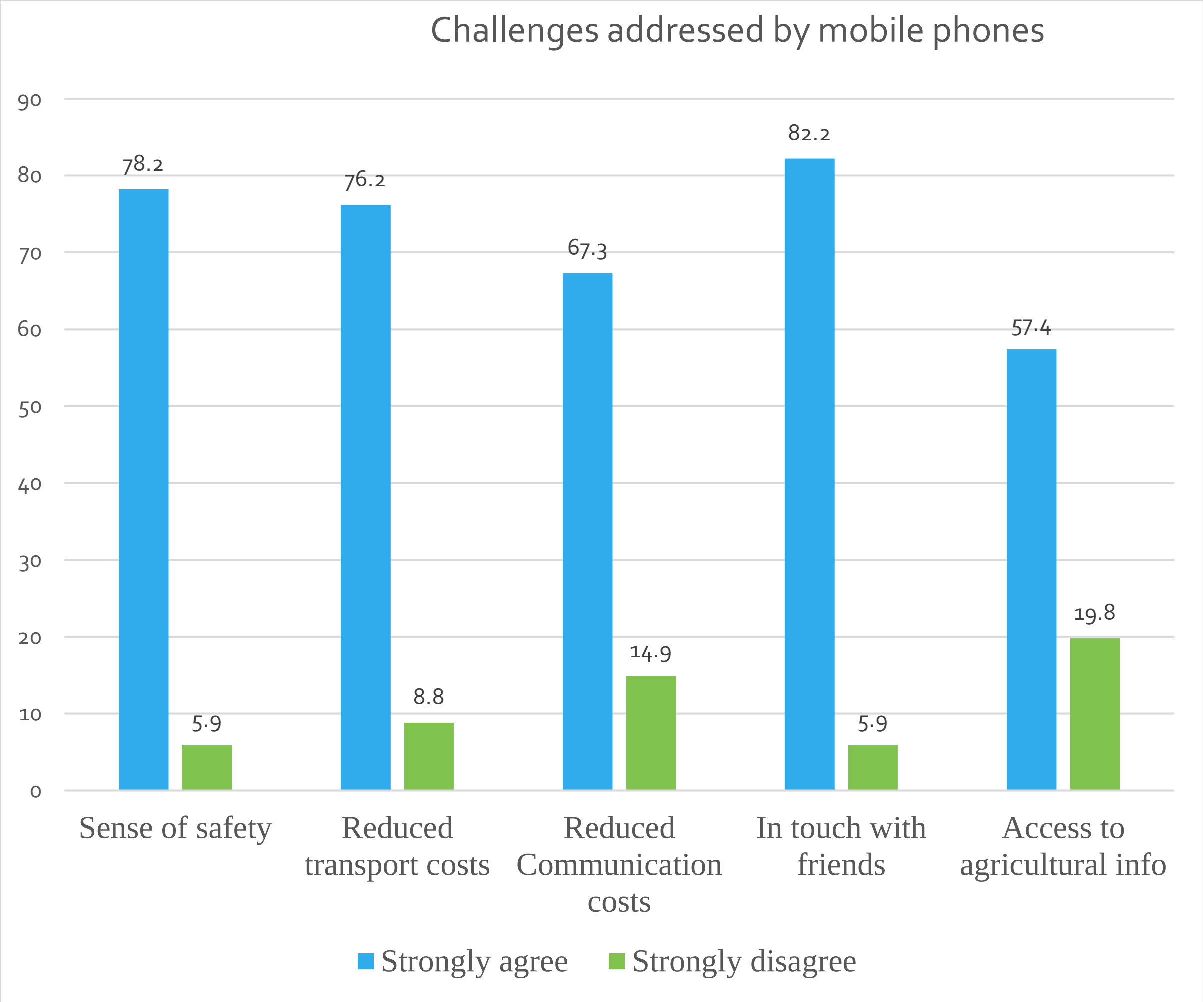

Figure 5.1: Issues addressed by mobile phones

Table 5.15: Correlations

Mobile phone allows me to conduct financial services	Value	Asymp. Std Error[a]	Approx. T[b]	Approx. Sig.
Interval by interval Pearson's R	-.064	.125	-.614	.541[c]
Ordinal by ordinal Spearman Correlation	-.028	.119	-.268	.789[c]
N of Valid Cases	95			
Mobile phone allows me to feel a sense of security	Value	Asymp. Std Error[a]	Approx. T[b]	Approx. Sig.
Interval by interval Pearson's R	-.073	.146	-.719	.474[c]
Ordinal by ordinal Spearman Correlation	-.019	.114	-.186	.853[c]
N of Valid Cases	98			
Mobile phone allows me to join the Global village	Value	Asymp. Std Error[a]	Approx. T[b]	Approx. Sig.
Interval by interval Pearson's R	-.070	.123	-.675	.501[c]
Ordinal by ordinal Spearman Correlation	-.046	.118	-.438	.663[c]
N of Valid Cases				
Mobile phone and reduced transport costs	Value	Asymp. Std Error[a]	Approx. T[b]	Approx. Sig.
Interval by interval Pearson's R	-.165	.141	-1.604	.112[c]
Ordinal by ordinal Spearman Correlation	-.129	.130	-1.250	.214[c]
N of Valid Cases	94			

Table 5.16: Challenges addressed by the mobile phone

	Safety since I can call my family when in trouble	Reduced transport costs	Easy access agriculture information	Can access banking services	In touch with my family	Can access social media	Access educational information	Joined global village
Strongly Disagree	6	9	20	19	6	14	22	19
Disagree	1	0	1	4	0	3	0	4
Neutral	6	4	6	5	3	4	7	5
Agree	6	7	10	13	3	6	4	7
Strongly Agree	79	77	58	54	83	67	63	59
Total	98	97	95	95	95	94	96	94
System	3	4	6	6	6	7	5	7
	101	101	101	101	101	101	101	101

5.6.9 Utility of the mobile phone

Respondents were asked to rate the mobile phone as a tool that helped them to do more work. A total of (N = 101) of the Bulilima community members responded to this survey question, with 81 (80.2%) agreeing that it has helped them improve upon their work, while 20 (19.8%) disagreed, as shown in table 5.17. This is consistent with research undertaken in Nigeria's rural communities, where participants agreed that the mobile phone helped them in terms of reducing transport costs, saving time, finding employment and often substituting some journeys (Ebikabowei & Benake-ebide, 2013).

Table 5.17: Utility of the mobile phone

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	81	80.2	80.2	80.2
	No	20	19.8	19.8	100.0
	Total	101	100.0	100.0	

Respondents were asked to explain how the mobile phone helped them achieve a greater amount of work; 41.6% of the participants highlighted that, due to improved communication and collaboration, they could achieve more, while 21.8% indicated that they could easily access information and research when they were engaged in a task. About seven percent of participants noted that they relied upon the clock and alarm while performing some of their tasks; two percent noted reduced travel; and the same percentage chose multi-tasking and agreed that they could plan better. Those who did not provide any explanation (23.8%) on how the mobile phone was helping them do more work, did agree that it helped them in their work. This is consistent with Baboo, Pandian, Prasad and Rao (2013), whose research concluded that the mobile phone was an important tool for everyday living. These findings also help in answering research question number one, which sought to establish how improvements in mobile phone coverage had translated into socioeconomic development in rural communities. This is consistent with other findings about mobile phones helping rural communities to save time, as a cattle herder no longer needed to travel back to a village to report a sick animal – he could take and send images of a sick animal instead (Kithuka, Mutemi, & Mohamed, 2007).

5.6.10 Issues that hinder uptake and use of ICTs in rural areas

Participants were asked to rate issues that hindered the use and uptake of ICTs in rural areas, as shown in table 5.18: 46 (45.4%) agreed that the use of ICTs in rural areas could result in cultural decadence, whereby children could be exposed to indecent content, while 55 (54.2%) disagreed. Only 29 (28.7%) of the participants noted that language was a hindrance to ICT uptake, in contrast to 72 (71.3%), who disagreed. This is consistent with high literacy levels in Zimbabwe's rural areas of about 90% (Lancaster, 2016). This is contrary to research conducted by Jiyane and Mostert (2010), who noted that the dominant use of English language on mobile phone platforms was a barrier for some. Eighty percent of participants in Bangladesh, when asked which mobile phone features made them feel uncomfortable, indicated it was the use of the English language (Islam & Gronlund, 2010).

Most of the volunteers – 77 (76.2%) – disagreed that digital communication costs were a factor that determined ICT uptake. Those who agreed constituted 23.8% of participants. Since such communication is now a requirement, communities afford it by forgoing other essential needs. This resonates with research concluded by Rey-Moreno, Blignaut, Tucker and May (2016) in South Africa, whereby 41.2% reported sacrificing some food items in order to buy the airtime with which to communicate.

The World Bank (2012) reported that most farmers, depending on their income and education, were willing to pay for services provided by mobile applications if they were good. This is contrary to findings by Bidwell et al. (2011), who revealed that data and voice communication were unaffordable to many in South Africa. However, a survey undertaken in Nigeria revealed that 93.4% of the population did not consider cost as a hindrance to mobile phone usage (Baro & Endouware, 2013). Communities adapt to costs, with some using solar-powered systems to recharge phones. This was confirmed by 76.2% of participants in this study, who disagreed that access to power to recharge devices was a hindrance, with 23.8% agreeing that access to electricity to recharge their mobile phones was a challenge.

A Spearman's rank-order correlation determined the relationship between mobile phone adoption and cultural degradation at 0.025, as shown in table 5.19. This is an insignificant correlation and, therefore, the adoption and use of mobile phones is not hindered by the use of the English language. These findings help to answer research question number two, which sought to establish the main challenges faced by rural communities in the uptake and use of ICTs in Zimbabwe.

Table 5.18: Issues that hinder uptake and use of ICTs in rural areas

		Cultural degradation	Language	Lack of privacy	Expensive to use	No power for the device
Valid	Yes	46	29	24	33	24
	No	55	72	77	68	77
	Total	101	101	101	101	101

Table 5.19: Spearman's correlation between mobile phone adoption and the English language as a hindrance

			Cultural degradation/ Pornography	Device Owned: mobile
Spearman's rho	Cultural degradation/Pornography	Correlation Coefficient	1.000	.025
		Sig. (2-tailed)	.	.801
		N	101	101
	Device Owned mobile	Correlation Coefficient	.025	1.000
		Sig. (2-tailed)	.801	.
		N	101	101

5.6.11 Frequency of mobile internet usage

Mobile internet use in rural areas is experiencing an upward trend, with results from this survey revealing that usage trends were comparable to national levels of approximately 47.6% (Lancaster, 2016). From this study, 33 (32.7%) of participants always use the internet, while 21 (20.8%) regularly used it and 17 (16.8%) periodically did so on their mobile phones, as shown in table 5.20. Only 28 (27.7%) revealed that they never used mobile phone internet.

There is the need to create awareness on the importance of the internet, as its availability and access is no longer an option. Other scholars have concluded that the internet has become a core infrastructure that supports all other services, such as banking, transport, shopping, government-related and health information (Olsson, Samuelsson, & Viscovi, 2016).

Table 5.20: Frequency of mobile internet usage

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not at all	28	27.7	28.3	28.3
	Periodically	17	16.8	17.2	45.5
	Regularly	21	20.8	21.2	66.7
	Always	33	32.7	33.3	100.0
	Total	99	98.0	100.0	
Missing	System	2	2.0		
Total		101	100.0		

5.6.12 Applications downloaded

Mobile applications have become a part of everyday life and, in rural areas where communities have limited entertainment options, such apps could play an important role in this regard and may further stimulate usage. Results of the survey demonstrate that 76 (75.2%) of participants are using WhatsApp, as depicted in figure 5.2. The findings are in line with research carried out by Shambare, Rugimbana and Zhowa (2012), who concluded that WhatsApp addressed a technological poverty crisis in developing countries. Those who downloaded games constituted 59.4% of the sample. From the survey, 43 (42.5%) had downloaded and were using Facebook, consistent with the findings of studies conducted by Mvula and Shambare (2011), who revealed that Facebook was a favourite application, with young people spending about three hours a day on it. A survey carried out in the rural areas of Niger, Nigeria, by Baro and Endouware (2013), revealed that 60% of participants used Facebook. Twenty-five had downloaded and used Google Earth (24.7%), while 12 (11.9%) had downloaded Skype. Other applications and aspects that participants felt were important included a mood scanner, a blood testing device, video calling and movie downloads.

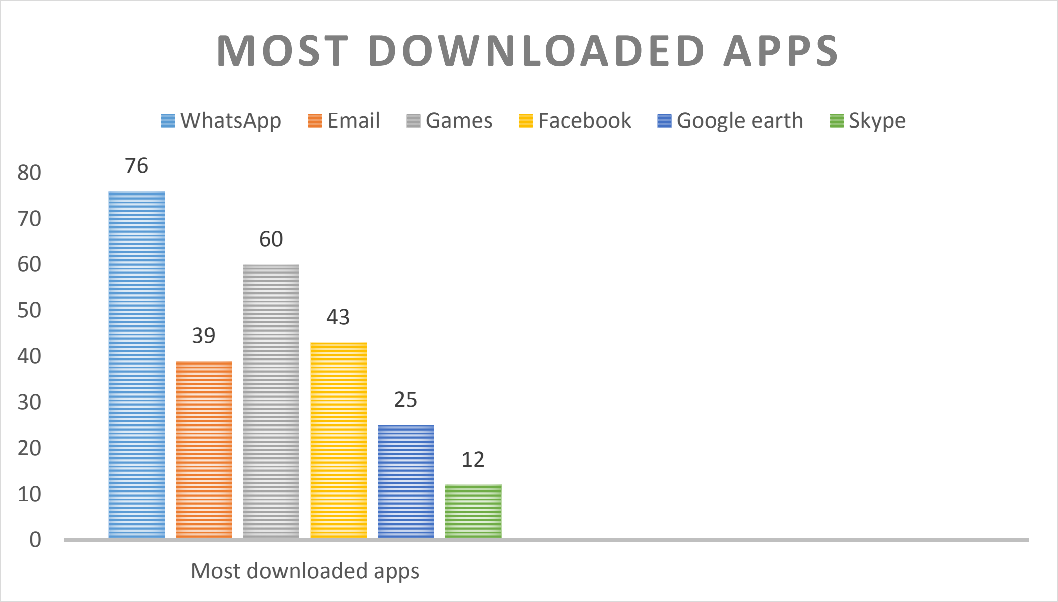

Figure 5.2: Most downloaded mobile applications

5.6.13 Infrastructure adequacy

Connectivity must be universally available, even in the most remote rural regions, however, this is where the provision of such infrastructure may be deemed unprofitable (Clement & Shade, 2000). From the research, it appears that participants are not satisfied with the level of infrastructure, with 64 (63.3%) of participants indicating that the network is inadequate and 37 (36.6%) pointing out that it is adequate, as shown in table 5.21. This is consistent with research by Porter, et al. (2012), which observed that participants often walked long distances and climbed hilltops to access a signal. Similarly, studies conducted by Baro and Endouware (2013) in the Niger Delta region revealed that 57% of the participants highlighted network failure and congestion as a major hindrance to mobile phone usage. A government minister also revealed that communities situated 10 kilometres from Plumtree town using Mascom and Orange MNO from Botswana, due to the unavailability of signals from Zimbabwean MNOs (TechZim, 2017). This is also consistent with the Zimbabwean national ICT policy report, which indicated that most rural communities were not connected to the high-speed network, due to mismanagemnt of USF funds, therefore increasing the digital divide (TechZim, 2015). These findings answer research question number three, as it is evident that there is a need to expand infrastructure and coverage in rural areas, which will become the next budding market for mobile network operators (MNOs).

Table 5.21: Do you think infrastructure is adequate?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	37	36.6	36.6	36.6
	No	64	63.4	63.4	100.0
	Total	101	100.0	100.0	

5.6.14 Infrastructure's main use

While voice revenues are declining in urban centres, it is interesting to discover that, in Bulilima, voice is still regarded as the main use of the mobile network infrastructure at 72%, followed by SMS at 58%, data at 50% and mobile money at 28%, as shown in table 5.22. This means that the rural market is still ripe for MNOs to introduce more services and consolidate revenues, as most services have almost reached saturation points in urban centres. These findings indicate that the mobile money market has huge potential for growth and, therefore, MNOs can significantly grow this potential market. As most rural communities do not have access to banking facilities, coupled with the acute liquidity crisis affecting the country, the use of mobile money in rural areas has the potential to grow significantly.

Table 5.22: Infrastructure's major use

		Voice	SMS	Mobile money	Data
Valid	Yes	73	59	29	51
	No	28	42	72	50
	Total	101	101	101	101

5.6.15 Type of data connection

Rural communities are beginning to access fast mobile broadband networks, although the signal is not yet stable. From the respondents, 54 (53.5%) indicated that they could access 3G, 26 (25.7%) could get 2G and seven (6.9%) could access 4G, as shown in table 5.23. The results reveal an improvement in the deployment of 3G base stations, as previous reports indicated that about 72% of base stations in rural areas were 2G (ITU, 2014; PORTRAZ, 2014). From these findings, it is evident that 4G networks are still not very popular in rural areas and this will be the next growth area. This answers research question number three, which sought to establish the mobile phone usage trajectory in rural areas.

Table 5.23: Type of mobile network

		2G	3G	4G
Valid	Yes	26	54	7
	No	75	47	94
	Total	101	101	101

5.6.16 Choosing a MNO

Mobile phones now cover 80% of the rural population, promising to improve communication and provide services not available in rural areas (POTRAZ, 2014). In some rural areas, the service provided by a MNO is relatively poor, as customers cannot make choices if a provider has a monopoly in the area. Previous studies discovered that several factors influenced customers when they chose a particular MNO, such wide network coverage, charges per call, faster internet and other offered services (Hasan, Yeasmin, & Dey, 2013).

5.6.16.1 MNOs subscribed to

Survey results revealed that 94 (93%) participants used Econet, 13 (12.8%) Netone, 10 (9.9%) Telecel and 4 (3.96%) Mascom (Botswana), as shown in table 5.24. A Zimbabwean government minister bemoaned revenue leaking to neighbouring countries, as most rural communities in Matabeleland South, who lived along the national borders, utilised mobile networks from South Africa and Botswana, due to inadequate infrastructure in Zimbabwe (Technomag, 2017). In order for the rural communities of Bulilima to fully enjoy the benefits of this mobile revolution, there is the need to have adequate connectivity across all network providers, so its members can choose and subscribe to a network offering a good signal strength, reasonable price and other services.

Table 5.24: MNO landscape

		Econet	Netone	Telecel	Mascom Botswana
Valid	Yes	94	13	10	4
	No	6	88	91	97
	Total	100	101	101	101
Missing	System	1	0	0	0
Total		101	101	101	101

5.6.16.2 MNO influence

A mobile network signal from one MNO, Econet, began to penetrate the rural communities of Bulilima a few years ago, and its market share is now more than 94%. MNOs must continually improve upon their service quality, reduce costs and offer other services to retain customers (Hasan, Yeasmin, & Dey, 2013). Rural communities do not have the luxury of choosing between subscribers, as signal availability usually determines this. From the survey, 67 respondents (66.3%) said the choice of network relied upon signal strength. When a mobile phone signal from a particular network service provider was available, this also influenced the availability of airtime, as indicated by 58 (57.4%) of respondents. When there was one MNO, communication costs had the least effect, as 76 participants (77%) disagreed that cost was a factor when choosing a network, as shown in table 5.25.

Table 5.25: Factors influencing choice of MNO

		Signal	Price	Air time
Valid	Yes	67	23	58
	No	33	76	42
	Total	100	99	100
Missing	System	1	2	1
Total		101	101	101

5.6.17 Importance of news sources

The mobile phone is the most important device for accessing news, as shown in table 5.26, where 87 (86.13%) of the population indicated that accessing news through a mobile phone was very important, with only three (2.9%) indicating that this was not important. The internet was rated as the second-most important news source by 73 (72.3%) of participants, while seven (6.9%) indicated it was not important. With regard to television, 52 (51.48%) agreed that it was a very important news source, while 20 (19.8%) did not agree. Forty-nine (48.5%) agreed that radio was a very important source of news, while 13 (12.87%) did not agree. Only 42 (41.58%) agreed that access to newspapers was very important, while 25 (24.75%) did not agree. This shows that the mobile phone and internet are the top media used for news access and, therefore, developing infrastructure to improve access to these is critical. This also answers research question number three, which sought to establish mobile phone usage trends. It is clear that traditional communication channels, such as newspaper, radio and television are no longer viewed as important in rural communities like Bulilima.

Table 5.26: How do you view access to the following media?

		Newspaper	Television	Radio	Mobile phone	Internet
Valid	Not important	25	20	13	3	7
	Quite important	28	20	35	6	14
	Very important	42	52	49	87	73
	Total	95	92	97	96	94
Missing	System	6	9	4	5	7
Total		101	101	101	101	101

5.6.18 Accessibility and availability of media

Participants were asked to rate the accessibility and availability of communication media in their ward, as shown in table 5.27. The mobile phone was the most accessible communication medium in most wards, with 79 respondents (78.2%) having indicated that it was very accessible and available, 14 (13.4%) saying it was sometimes available and accessible, while just four (3.9%) volunteers said it was not accessible. From the survey, 60 participants (59.4%) revealed that the internet was very accessible and available, while 23 (22.7%) said it was sometimes accessible and available, and eight (7.8%) indicated that the internet was not accessible and available. Close to half of the respondents – 48 (47.5%) – indicated that newspapers were not accessible and available, while 23.7% indicated they were sometimes accessible and available, and 22.8% that they were accessible and available. During data collection, the research team noted some homes with satellite dishes, which indicated that they were accessing DSTV or free over-the-air television services. Almost a third of respondents confirmed that television was accessible and available in their ward. A percentage of 32.6 confirmed it was sometimes accessible and available, while 33.5% said TV signals were not accessible. Radio access has greatly improved, with 30.6% of participants indicating that radio was very accessible and available, 36.6% saying it was sometimes so, with 31.7% highlighting that radio signals were not accessible.

Table 5.27: Rate accessibility and availability of media

		Newspaper	Radio	Television	Mobile phone	Internet
Valid	Not accessible and available	48	32	34	4	8
	Sometimes accessible and available	24	37	33	14	23
	Very accessible and available	23	31	27	79	60
	Total	95	96	94	97	91
Missing	System	6	5	7	4	10
Total		101	101	101	101	101

5.6.19 Hindrance to ICT uptake

A Spearman's correlation test of 0.853, 0.789, 0.663 and 0.214 was recorded regarding the main issues that hinder ICT uptake in rural areas. Research question number two wanted to establish the main issues that communities faced in the uptake and use of ICTs in rural areas of Zimbabwe. The major hindrance to ICT uptake was the availability of these ICTs and, surprising, other economic and social factors such as the cost, language and cultural decadence were not major hindrances. A Spearman correlation test between factors that could hinder mobile phone adoption, such as language, was insignificant and this meant that the use of the English language was not a hindrance to ICT adoption. Arising from the study, the only factor that proved a hindrance to mobile phone adoption was lack of access to or a weak mobile phone signal. Research question number three sought to establish the mobile phone usage trajectory in rural areas by determining the main uses of mobile phone infrastructure. The results of Pearson tests performed on associated variables revealed that voice and SMS still dominated mobile phone infrastructure utilisation, as data signals were not always available. Communities were therefore obliged to use available services, paying more than data for voice and text messages. Research question number four set out to determine the extent to which rural communities utilised mobile phone internet and related technologies to support socioeconomic development. They have begun to use the mobile phone for internet access and, surprisingly, in a short space of time, the mobile phone and the internet now rate more highly than other traditional media, including radio and television. There is the need to educate rural communities about the services provided by mobile phones, so that they can enjoy the utilities offered and utilise their capabilities to improve access to information and foster improved socioeconomic development.

5.6.20 Guiding the application's development

The results of this analysis clearly cemented and validated the mobile application idea, as it was clear that communities in the Bulilima district had limited access to traditional information sources. Most of the participants revealed that they could not access the socioeconomic information necessary for their development. The results show that about 91% of the population attained Secondary education and higher, meaning that the community is literate and would utilise the mobile app. Ownership of mobile phones was high as 96% of the participants owned a mobile phone, again this implies that users will utilise the application. Only 20.8% of the population sometimes access health information, 39% percent sometimes access news on their mobile phones, 33% sometimes access agricultural information. This is a potential area to develop an app that will improve information access. The mobile app has positively affected the community through reduction of communication costs (67.3%), sense of security (78.2%), reduced transport costs (76.2%) and being in touch with friends (82.2%). Based on this sociotechnical environment prevailing in the community, the mobile phone application will be developed to improve access to socioeconomic information in Bulilima.

The mobile phone application is likely to have high adoption rates, as the community is already using other mobile applications such as WhatsApp, Facebook and games as shown by the baseline study results. The language employed in the application will be English, as more than 90% of the participants are literate and use it as a language of instruction. Most of the respondents are novice users, with little experience of using apps and, therefore, the researcher will design a simple informative app. A sample of potential users will be engaged during the application development, which will be through paper sketches and user feedback, refined until accurate prototypes are presented to the users. The researcher will use a flexible model that can work with DSRM to adapt to changes in requirements through a series of iterations.

5.7 Summary

The collected data was analysed using descriptive and inferential statistics targeting the stated research questions and these are some of the key findings:

a) There is limited access to socioeconomic information related to agriculture, markets, news, education, healthcare and local activities;
b) ownership of mobile phones is high, participants are highly literate;
c) the utility of the mobile phone in enhancing communication and access to the internet will be high, though costs were still prohibitive and
d) unavailability of other media such as radio and television.

The baseline survey findings are consistent with Mtega and Benard (2013), who revealed that rural communities in Tanzania faced challenges such as poor infrastructure, low income and limited access to information. Rural communities face challenges in accessing information, it is critical for the government to establish rural information centres that will be responsible for overseeing the gathering, packaging and dissemination of information input into the mobile application for the community. News organisations could also be encouraged to package their news for rural communities, to be conveyed through mobile phone applications or SMS text messages. Other service providers can also be encouraged to assist developing countries, especially rural and remote communities, to offer free services such as Facebook, which provides free access across 50 countries (even if the user has no airtime they can still access the service) (Facebook Zero, 2010). There must be engagement with MNOs and other development agencies in order to subsidise the cost of data, especially for rural areas, where it is still high. Some rural communities are still accessing MNOs from neighbouring countries, therefore, there is the need to engage government to raise funds through the USF to be used to expand the infrastructure in rural areas. These findings led to the formulation of the design requirements for the mobile phone application, whose aim is to enhance access to information.

Chapter 6: Mobile application design

6.1 Introduction

The previous chapter provided an overview of the research methodology and research model. The chosen methodology, DSRM, was articulated in detail, together with the research instrument used, population sampling and data analysis techniques. This chapter provides an overview of concepts employed in the analysis and design of the mobile phone application to be used by rural communities in Zimbabwe to enhance access to socioeconomic information. The baseline survey results provided empirical evidence on some of the information access challenges faced by the rural communities as highlighted in section 5.6.1 to 5.6.7. The identified problem was pre-evaluated based on the results of the baseline survey results to affirm the suitability of the proposed solution.

To develop the application, the researcher employed agile development techniques. Designing the mobile application includes determining the type of data or information that must be stored in the app, designing the database and coding for backend and frontend functions. The researcher designed a website for entering articles into the app, as well as user interfaces for the application. A user-centred design approach was adopted to provide a platform for involvement in the entire development of the mobile phone application, in line with DSRM requirements. This approach results in a better understanding of user requirements and ensures that the application meets their expectations and that they feel a sense of ownership. This chapter also demonstrates how the use of DSR methodology guided the design of the app. Other design tools, such as the use of case and class diagrams, were utilised in the development of the application.

6.2 Statement of the problem

Most rural communities in Zimbabwe have limited or no access to traditional means of information dissemination, such as radio, television and newspapers. This results in communities failing to maximise their agricultural productivity, access up-to-date market information and becoming alienated from national development activities and inclusion, thereby fueling underdevelopment and poverty. The proposed mobile phone application will provide the community with a better way to communicate, improve access to information affecting day-to-day life and link its people to better markets. To progress, information access is vital and there is the need for the government and other stakeholders to provide a means for communities to access information to improve their livelihood.

The proliferation of smartphones and improved signal strength in most rural areas presents opportunities to use these devices for more meaningful tasks, such as the provision of socioeconomic information. As the price of smartphones drops and their demand increases, the developing world will witness an additional 2.9 billion smartphones by 2020 (Android, 2016). In this digital age, it is important to create new opportunities for marginalised communities to access the right information, from the right source at the right time to satisfy their socioeconomic needs (Jones, 2008). As mobile phone signals have begun to penetrate almost every village in Zimbabwe, the question is, how can the use of improved network availability enhance access to socioeconomic information in Zimbabwe's rural districts? This is consistent with conclusions made by Stratigea, (2011) that there is need to develop content which is specific to a region's needs.

6.3 Software Development Methodologies

To successfully implement a software project and replicate that success, the right methodology must be utilised. Different methodologies or processes can be followed, with the choice dependent on the size and type of project, as well the capabilities of the development team (Somerville, 2007). The app was developed through the use of agile development processes, where development was iterative, involved potential users throughout, employed user feedback to refine designs and, finally, involved potential users in the testing and evaluation of the application. Agile development processes align well with the DSRM chosen to guide this research. Delivery of the mobile phone application was through prototype releases (increments), with each subsequent release providing additional features and performance. The next increment was dependent on feedback from the evaluation of the previous increment. The first activity in DSRM is to clearly identify and articulate the problem and motivation. The second stage involves defining the objectives of the solution and implementation, and then the production of a prototype. Participants are then presented with the prototype, for further refinement of requirements. This results in the next increment. The iterative nature of this methodology allows the mobile phone application to be refined during each step of the development process, until a satisfactory product is delivered to communities in the Bulilima district.

6.4 Design Science Research Methodology

The DSRM results in the creation of new knowledge through the development of artefacts that must solve persistent problems in society or organisations. The output of the DSRM can be in the form of an artefact, instantiation, constructs or design theories (Vaishnavi & Kuechler, 2015). DSR research can be naturalistic or artificial. The naturalistic develops an artefact to evaluate its utility within a real environment, whereas the artificial aims at theory building (Sun & Kantor, 2006). For this research, the naturalistic viewpoint has been adopted. The DSRM is comprised of six activities that are used to guide the development of the mobile phone application, which were clearly defined in section 4.4.2.

6.5 Overview of the data gathering, design and development of the Bulilima mobile application

Figure 6.1 provides a framework for the development of the mobile phone application. The process began by defining the problem and examining the impact of the mobile phone application and providing an overview of the existing applications. The next phase was the development of the mobile phone application prototype, guided by DSRM and based on UCD, where the user was involved throughout the development process. Low-fidelity prototypes were produced and continually refined until the final prototype was presented to potential users.

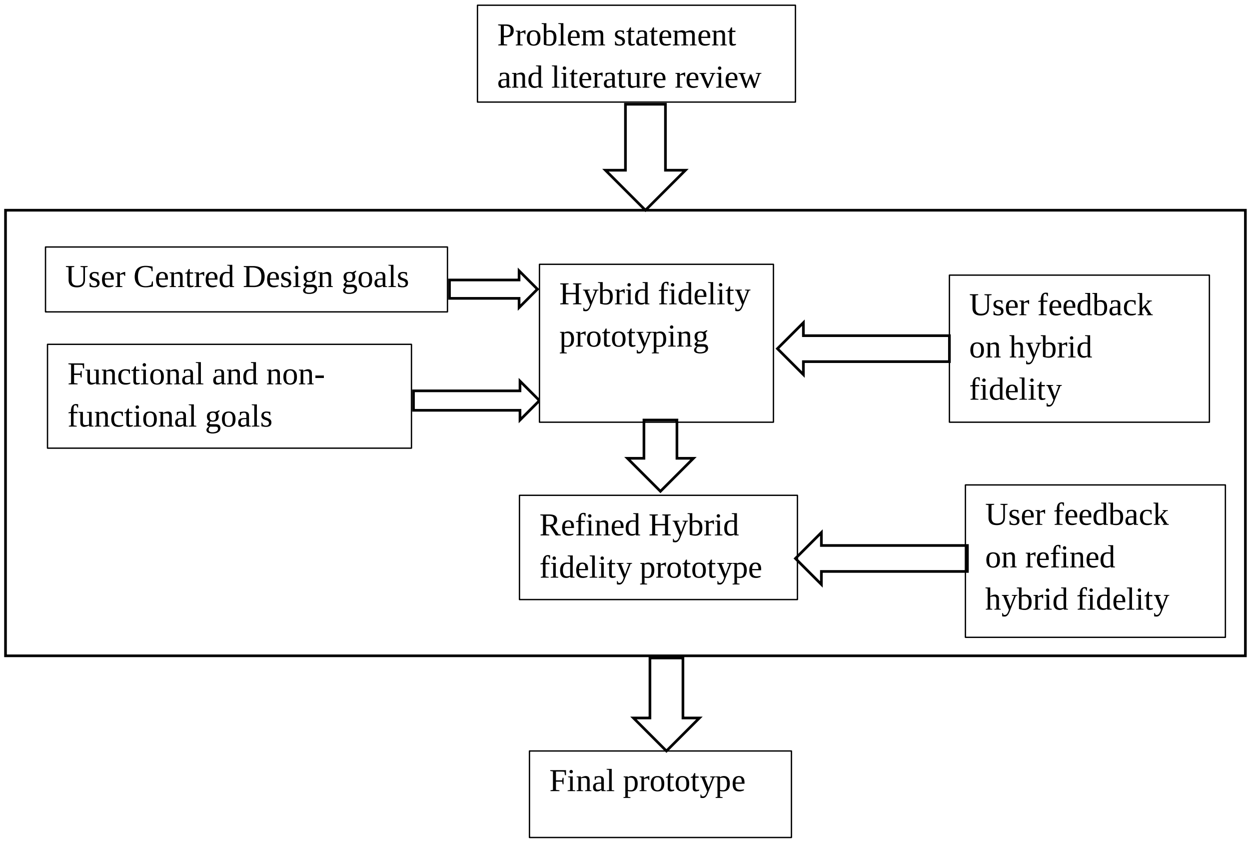

Figure 6.1: Overview of the data gathering, design and development of the application

6.6 Mobile phone application development framework for rural communities

Development of information systems for rural communities is different from developing commercial systems. One of the most important attributes for effective system design is to understand the sociotechnical factors affecting a community. User involvement in developing systems helps in designing systems that suit the needs of the users. Mobile phone applications are a great tool for socioeconomic development in rural areas as they can improve access to information related to social services, education and markets. To guide the development of the application, an Information systems development methodology (ISDM) framework that was muted by Wayi and Huisman, (2010) was adapted. This framework was constructed based on systems design principles that were suggested by several scholars (van Reijswoud, 2009; Pscheidt, van Reijswoud, Weide, & T, 2009; Islam & Alawadhi, 2008) and aligned to specific contextual factors of a rural community (Avgerou & Walsham, 2000). The framework considers the socio-technical pillars that characterise the community, which are the major inputs to successfully implement the mobile phone application. This methodology provides an opportunity for rural communities to participate in the building of an information system which will serve their needs (Oyelere, Suhonen, Wajiga, & Sutinen, 2018). Other scholars have concluded that rural development requires incorporation of traditional knowledge and structures, and in this application community knowledge workers will be used for information gathering (Jhunjhunwala, Ramachandran, & Ramachander, 2006).

Other scholars have applied this concept during the development of a telecentre through evaluating the socioeconomic environment of the community and using this information to plan and initiate the project (Breitenbach, 2013). Information systems for rural communities must be developed to offer content which directly relates to their local needs through engaging users to develop the system. To develop an application that addresses the needs of the user community, it is important to establish the problem, the socio-technical factors within the community and propose a process for developing the proposed solution as shown in figure 6.2. The community of Bulilima has limited access to newspapers, radio and television and the proposed mobile phone application will be developed to close this gap and provide access to information normally provided by this media. Following this framework, users were involved in formulating the system requirements from the early stages of the application development. This information will include news, market and agricultural information. The design of the application was iterative, incorporating user feedback to refine the requirements as well as the final product. The mobile phone app will be designed in a way that addresses low bandwidth and low income attributes found in this community. The design of the application will use simple graphics, text and clear navigation systems since the community has low digital skills. The mobile phone application will allow content to be automatically downloaded onto the mobile phone's internal storage for offline access. When a connection has been established, the application will synchronise with the server based content. Section 5.11 provides a comprehensive explanation on the features of the mobile phone application that address the identified problem based on the socio-technological attributes of the community.

Other scholars have highlighted that most systems fail because they do not contain expected features, cannot meet the desired functionality as well as being difficult to use (Ode, 2010). The ISDM approach support research done by Stratigea, (2011) who posited that there is need to develop content which is region-oriented inline with the needs of the community. Researchers have concluded that for ICT interventions to be successful in rural communities, there is need to offer services that are location-specific through delivering local content and recognising community dynamics (Best & Kumar, 2008; Gorla, 2009; Aker & Mbiti, 2010;

Beuermann, McKelvey, & Vakis, 2012; Internet.org, 2014). The socio-technical factors affecting the community have been fully discussed in chapter 3. Following the ISDM framework, a baseline survey was conducted and the results were presented in chapter 5, where section 5.6.1 to 5.6.7 consolidates the information access problem. The development of the mobile phone application through continous iterations is detailed in section 5.19.

The ISDM framework fits well with the DSRM which guided the development of the mobile phone application. In both the ISDM and DSR problem identification is crucial. After establishing the problem, both the ISDM and DSR engage in the build and evaluate iterations until the prototype can be demonstrated. The goal of this research is to develop a mobile phone application and this development is composed of iterative design sessions involving the users which which are part of the ISDM.

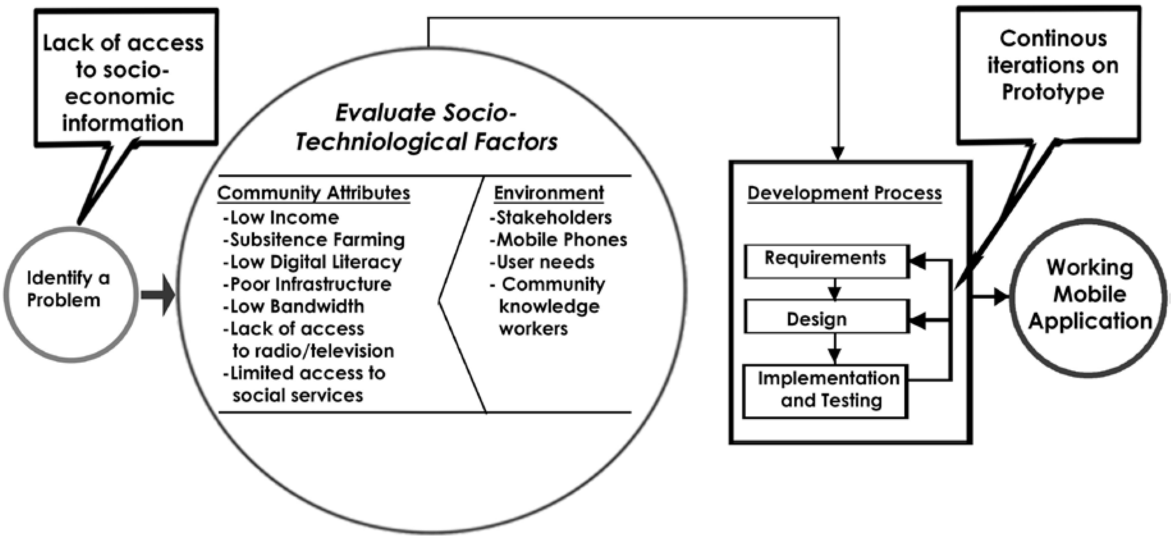

Figure 6.2: A rural community Information systems development methodology (ISDM) framework (adapted from Wayi and Huisman 2010)

6.6.1 Participatory design process in ISDM

When following the ISDM to develop information systems for rural communities it is important to involve the potential users (Wayi & Huisman, 2010). The results of the questionnaire analysis identified users deemed to be intense users of mobile phone applications and these participants were selected to form the next sample to take part in a participatory design process of the mobile phone application. This was an attempt to attend to objective four, as indicated in chapter one, to "Design a mobile phone application that allows rural communities to access information that is important for their socioeconomic development needs". During three sets of interviews, users were engaged on the development and evaluation of the mobile phone application prototypes. Design sessions took place at Madlambuzi Secondary school, involving iterations of the design process until the final product became acceptable to the user community, following the guidelines of the DSR methodology. The content and layout of the app were discussed during these sessions.

Involving the user in the entire development process, having some of the content locally produced and offering interactivity cultivates a sense of ownership and increases usability. The focus of these interviews was to understand the concerns of users relating to the application's interfaces, flow of information and colour schemes. Conducting these interviews was critical, as they served to gather user requirements and gain consensus with users during the development phase. Other advantages of involving the user at every stage of developing the artefact were that users informed design choices and produced a mobile phone application that was suited to them – they would not have to adapt to the application. The initial interviews involved brain-storming, putting down ideas on a flipchart, coming up with screen layouts, colour schemes and agreeing on information that was to be posted on the app.

6.6.2 User Centred Design

ISDM encompasses all the processes that support the recognition of the community in such as UCD, where the design processes focus on goals and motivations of the user. The interfaces that re developed must support the goals, tasks and needs of the user community (Endsley, 2016). Adopting this approach for the design of the mobile phone application means that the inhabitants of Bulilima district were involved in the prototype's design and development. Involvement of the user results in developing products with greater value. The users were involved from formulating requirements, specifying the content which must be included in the application. The application's navigation, icons and graphics were also finalised through consulting the users. This results in more usable systems.

6.7 Overview of existing applications

During the development of the mobile application, it became clear that other existing mobile phone applications had to be evaluated in line with what Hevner, (2004) posited, that the design should be a searching process. After this process, if the design was unique, it could add to new knowledge. Most mobile phone applications provide domain specific information, including that on education, markets and agriculture. Mobile phone apps such as Manobi, Ovi Life Tools and Reuters Market Light are popular in rural communities in Ghana, Nigeria and Senegal, helping people to access both general and more specific village information, including the weather, market information and health related services (Kuek, Qiang, Dymond, & Esselaar, 2011). A mobile phone application called Mamma is being used in Mali and Senegal, and allows community health workers to monitor and screen patients for malarial symptoms (IICD, 2014). Another mobile application was developed in Kenya to reduce elephant-human conflict with GPS-enabled phones monitoring elephant movement (Maximilian, William, & Gabriel, 2011). Another app, M-farm, allows farmers to access agricultural information and meet with buyers and sellers (Lopez, 2014). Dr Math was launched in South Africa to help school going children to learn mathematics and interact with volunteer tutors (Chaka, 2012). Ushahidi was developed as a crowd-sourcing application to allow citizens to report violence, such as post-election disturbances in various areas. Uber is also used to connect commuting clients to freelance cabs (Africa.com, 2015).

Most of these apps target specific information and the proposed application will provide rural communities with general socioeconomic information that they are currently failing to access. This information has been conveyed through telecentres in many developing countries as highlighted in section 2.3. The drawback of this approach is that it may be difficult to offer comprehensive information per each category of information. If there are limited or no other sources of socioeconomic information in these rural communities it will be ideal to offer them basic information that impacts on their day to day living. In my view this information is interrelated and therefore strategies to avail this information are worth pursuing. As shown in figure 5.1, after analysis of the problem and a review of the literature, the next step is the development of the mobile phone application.

6.8 Mobile application design principles

Mobile phone application development is a new, constantly changing and evolving field, with researchers finding it problematic to document and review these improvements. There is limited documentation on analysis, development and support for application developers and a continual need for development tools and techniques to assist developers (Joorabchi, Mesbah, & Kruchten, 2013). Mobile apps can extract information from online resources and download the information into the application for use, so users can access information even without an internet connection. When designing mobile phone applications, it is important to consider user enjoyment and satisfaction, and other key factors that include functionality, usability and aesthetics (Mennecke & Strade, 2003). When designing a mobile application, it is important to plan a navigation scheme that assists the user in easily accomplishing his or her tasks. Users may become frustrated with a navigation scheme that is not consistent or predictable and this may result in an application becoming unusable (Android Developers, 2014). A good design enables users to navigate quickly, in a lateral direction, to the next screen, instead of being forced to hierarchically navigate through the pages of the phone (Griffiths, 2015). Common navigation includes using tabs, springboard, gallery and swipe. Some of the most fundamental issues to consider when designing mobile phone applications will be discussed in the following subsections.

6.8.1 User-centred design

UCD describes the design processes that focus on user goals and motivations, ultimately influencing the approach to the design. UCD demands that designers create system interfaces to fit the goals, tasks and needs of the user, resulting in an increase in user satisfaction and acceptance (Endsley, 2016). In UCD, the system users are at the centre of the design process and are involved throughout the analysis, design and use of a system. Adopting this approach for the design of the mobile phone application means that the inhabitants of Bulilima district were involved in the prototype's design and development. During this iterative design process, twenty community members participated in the development of the mobile phone app. This assists in the creation of applications that satisfy the needs of their intended users. In order to gain greater understanding of user and tasks requirements, the user becomes actively engaged during the iterative design cycles and evaluation of the system (Vredenburg, Mao, Smith, & Carey, 2002). UCD does not only focus on understanding the users of an app, but includes their views and involvement in the testing and evaluation of the system (Stone, Jarrett, Woodroffe, & Minocha, 2005). UCD is iterative and the prototype undergoes a redesign process through consultation with users. This sequence is repeated until agreement is reached between the developers and users of the system.

The International Standardisation Organisation (ISO) developed a framework (1998, 2010) for UCD, as stated below:

i. Design is focused on an understanding of the various groupings of users, the tasks they perform and their different operating environments.
ii. Users are involved throughout the entire development process.
iii. During the design, users are consulted in order that they drive the design process through a refinement of their needs.
iv. The design process is iterative.
v. The design must cater for the whole user experience.
vi. The design team must be composed of a multidisciplinary skills base.

When designing information systems such as mobile phone applications, it is important to consider key design elements. These are listed below.

6.8.2 Navigation

Designing a good navigation system is a high priority in application design and this can be used to rate the overall design of the application. Mobile phone application users expect a smooth navigation system that helps them locate the desired information, therefore, a navigation system must be simple and intuitive (Reza, 2005). Users expect a clear and concise navigation system, and will not want to search for navigation controls, meaning that navigation must be simple, logical and consistent (Griffiths, 2015). It must also be coherent and use icons or other signifiers that are clear enough for the user to locate content with multiple pages simply. A poor navigation system will result in an application that is difficult to use and that therefore may not achieve its intended goals. Good navigation follows a conventional system that many users are already familiar with, while creating a completely new system may prevent users from accessing content. The navigation system designed for the rural people of Bulilima, was simple to use, since some of them had limited experience with mobile apps and low digital skills, and included icons to improve the visibility of menus.

6.8.3 User experience

Hassenzahl (2008) defined user experience as that momentary feeling that is either negative or positive when a user interacts with a product. ISO also defines user experience as “a person’s perceptions and responses that result from the use and/or anticipated use of a product, system or service” (ISO, 2010). What makes users continue using a mobile phone application may be determined by user experience and whether it meets the minimum requirements for searching

(Law, Roto, Hassenzahl, Vermeeren, & Kort, 2011). The design of the proposed application kept simplicity in mind, in order that the user perceived it as easy and pleasurable to navigate, assured the information was organised in a hierarchical manner.

6.8.4 Consistency

Mobile phone applications designed through a continual striving for consistency will give the users more room to appreciate the intended design experience. Consistency ensures that a design is better and easier to distinguish. Consistency helps the designer to tie elements into a single design or unifying elements across a brand, resulting in a unique and usable product (Cousins, 2016). In this mobile phone application design, the font face, colour, buttons and background remain consistent throughout all of the pages. This is harmonious and users do not become confused or surprised by drastic changes in colour schemes or font faces. An example is shown in figure 6.3, where Google portrays high level of consistency across its product ranges.

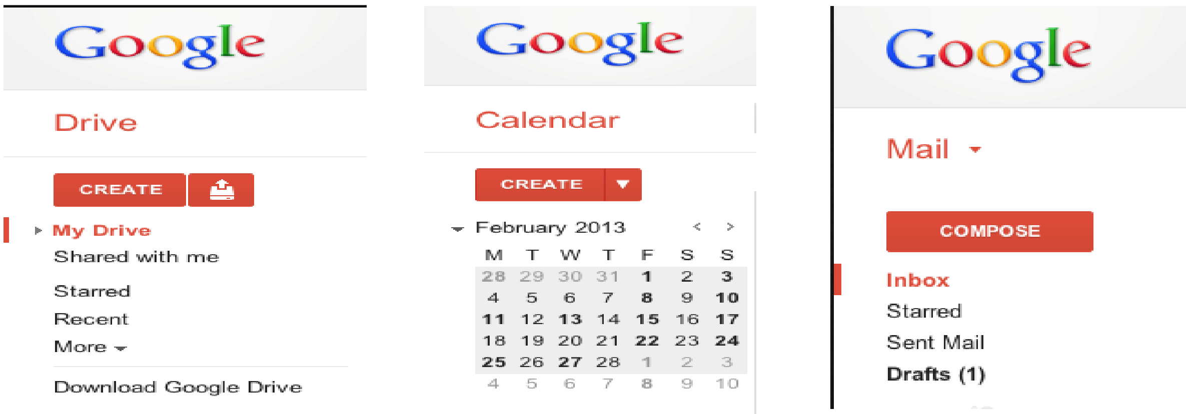

Figure 6.3: Consistency, courtesy of Google

6.8.5 Usability

According to ISO 9241:11, usability is defined as “the extent to which a product can be used by particular users to achieve specified goals” (Stone, Jarrett, Woodroffe, & Minocha, 2005). Mobile phone developers and users have agreed that usability is a central component in terms of measuring the quality of an application (Jokela, Iivari, Matero, & Karukka, 2003). Usability also involves answering questions such as: will the prototype provide the necessary and suitable functionality to enable the user community to perform their tasks in a manner they desire? Usability testing is a metric for evaluating how well users can use a particular system. When design is anchored around usability, some of the main aims are to ensure that the system is useful, effective, easy to learn and users like it. After a review of usability literature, one study (Harrison, Flood, & Duce, 2013) concluded that the major attributes used to measure usability were effectiveness, efficiency and satisfaction. Their conclusions were based on a performance metric defined by the ISO, which measures effectiveness (error rates), efficiency (complete times) and satisfaction (ISO, 1998).

Another standard, ISO/IEC 9126-1, defines software quality as a composition of five different attributes, namely: understandability, learnability, operability, attractiveness and usability compliance. Usability is judged according to the app's colours, to ensure a good contrast exists between the text and background. In this application, light brown was chosen as the primary colour of the icons and logos, while the background was white and the colour of the font black. For the communities of Bulilima, the perceived usability of the app was tested in the field, through the installation of the mobile phone application on their mobile phones and allowing users to test if the application was useful. The usability tests involved 13 users, in line with recommendations made by other scholars (Kaikkonen, Kallio, Kekäläinen, Kankainen, & Cankar, 2005). Based on ISO 1998, the mobile phone application was tested to determine the following:

i. effectiveness
ii. utility
iii. satisfaction

6.8.6 Typography

Typography involves a firm understanding of the use of letters and the application of these principles when designing applications for devices with small screen sizes. Designing for small-sized screens requires the use of fonts that are reasonably large enough to enable easy reading and the use of appropriate colours that blend in with the overall background and the colour scheme of the app (Cuello & Vittone, 2013). There must a good contrast between the font face and the background, as the mobile phone could be used outdoors, such as in fields, on the way to fetch water and even herding cattle, in situations of direct sunlight. When designing for mobile phone applications, it is critical to be consistent in terms of font type and colours, as users can become distracted from their tasks, while becoming distracted by these differences (Hoekman, 2011). The leading, between the lines and text, is important, as this allows the text to be read easily, without it being cramped and thus annoying the reader. In this design, the main font family utilised was the serif family, which is clear and enhances readability on small-screen devices. The choice of overall typography was guided by the rural communities of the Bulilima district, as they preferred simple, legible fonts, as highlighted during the iterative design process.

6.8.7 Home screen

The mobile phone application's home screen must provide an overview of the application, show users the journey they have to take and provide functionality that meets users' expectations (Griffiths, 2015). It also uses icons to provide simple visual cues for the user to identify links to information that they may want to access. The main screen must be uncluttered, without too much text and information. Most of the secondary content will be revealed when a user selects a menu or link of their choice. The screen has a combination of brown, orange and white colours. Brown was chosen to represent the soils in Bulilima district and the logo was crafted from a common idiom used in these communities, meaning "together as a community we can achieve so much", when translated into English. In the local language, it is "*Tjinyunyi babili komba woga tjowuluka*". The layout of the home screen is shown in figure 6.4.

Figure 6.4: Main screen for the application

6.9 Overview of the system

Figure 5.4 demonstrates how rural communities will interact with the app and the flow of data from the sources. The app will allow community members to create content and gather local news, which gets edited before it is published by a moderator. A moderator is an individual who is an expert at moderating content that goes into an application. He or she can be a retired health worker, who is able to provide health education on basic health related topics such as the management of chronic diseases, nutrition and disease control, and provide general health tips. The health moderator may help to recommend other external sources that contain appropriate health information. A retired Agritex officer could also be a moderator who provides information related to agricultural topics, such as animals, crops, better farming methods, farm management and post-harvesting procedures, among others. This expert could also recommend other external sources of information, such as online resources, accessed through hyperlinks.

The mobile phone application will enable rural communities in the Bulilima district to access accurate and current information that impacts on daily life. It will further allow communities to access local and national news and provide market information on commodity prices, cattle sales, weather information and community-based activities, such as community meetings. Information could also include topics relating to education, health and agriculture – and focus on specific subjects such as disease outbreaks with guidelines for communities on how to prevent its spread. Education-based information could concern, for instance, the grade seven results. Any successful development of a system that users will accept and use will depend upon superior system requirements, as presented in section 6.10.

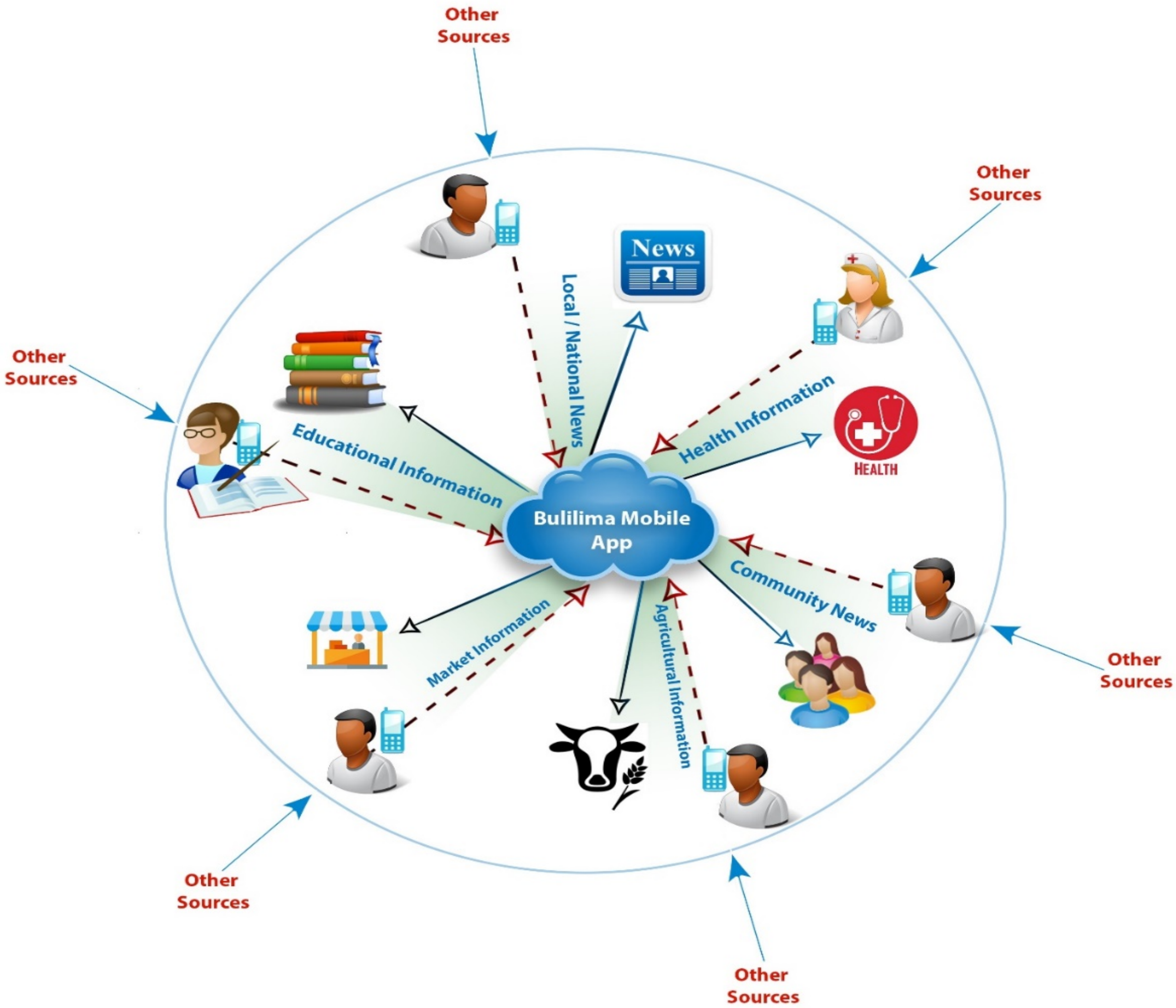

Figure 6.5: schematic presentation of how the community will interact with the mobile application

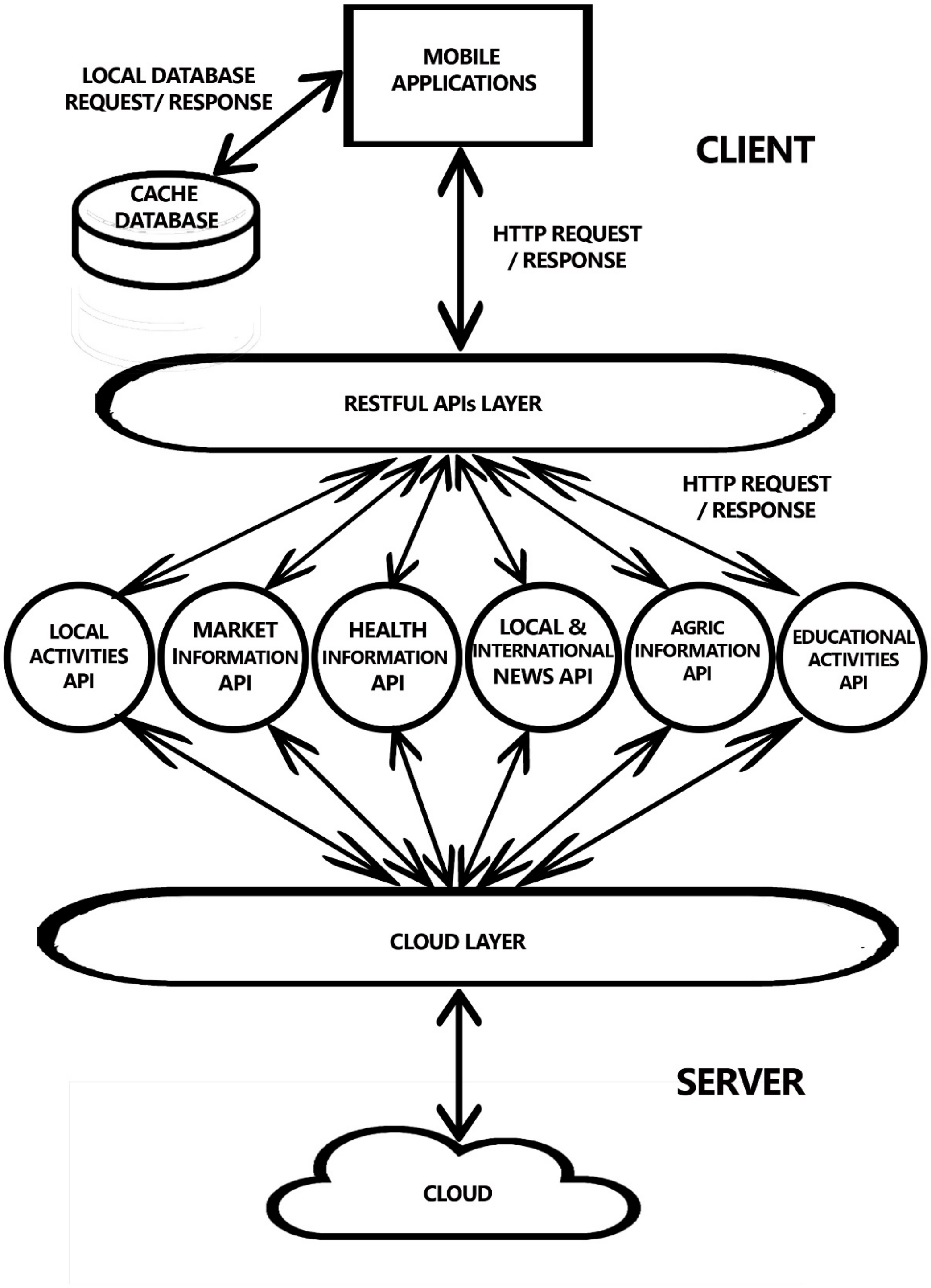

Figure 6.6: Mobile application framework

6.10 Gathering requirements

The gathering of requirements is the process of formulating software needs for the system, based on users' needs and input (Sommerville, 2009). The development of a mobile phone application begins when user requirements are specified, clearly and without ambiguity. Failing to formulate these requirements leads to a poor-quality system that may fail to address the needs of the user. A user requirement document specifies which mobile phone application will suffice for rural communities in Bulilima and provides an outline of what the developer will do. To create this document, there is the need to revisit the research problem, as outlined in chapter one – using mobile phone applications to enhance access to socioeconomic development information in the rural districts of Matabeleland South province in Zimbabwe.

Many strategies are capable of soliciting these requirements – including interviews, questionnaires and prototypes, among others. Two main categories of software requirements are functional and non-functional. The baseline survey that was conducted with results presented in the previous chapter provided insight into the information that must be provided by the application. The app must provide access to socioeconomic development information, such as that related to agriculture, health, markets, news and local and educational information, which is currently not easily accessible. To develop an application that satisfies the needs of the potential users, it is essential to specify what the application will do to fulfil the needs of the user and the constraints on its development. These requirements are broken down into functional and non-functional requirements.

6.10.1 Non-Functional Requirements

Non-functional requirements describe of the characteristics that a system should have; they do not describe what a system will do but are rather a measure of how it will enable its functioning (Sommerville, 2009; Wiegers, 2003). Non-functional requirements include quality attribute goals and performance objectives that guide the design process, including usability, reliability and maintainability, which control the specification and implementation of functional requirements (Benslimane, Cysneiros, & Bahli, 2007; Sommerville, 2009). A system that does not fulfil any of these requirements may have failed to meet organisational and user requirements. To guide the design process, the acronym "Furps" has been coined, which embraces the main, non-functional requirements of functionality, usability, reliability, performance and supportability (Leffingwell & Don, 2003).

Some of the major non-functional requirements are listed below:

i. **Scalability:** The mobile application is designed to adapt to new requirements and a changing environment, including any easy addition of further functionality and other operations.

ii. **Usability:** The mobile application is designed to ensure that the people of the Bulilima district find it usable, with little or no assistance required. The intention has been to reduce the time it takes for individuals to familiarise themselves with the application without assistance.

iii. **Reliability:** The app has been designed to ensure that it works correctly under the stated conditions and produce the desired output, despite changing environmental characteristics such as low bandwidth or intermittent connectivity.

iv. **Maintainability:** The application has been developed through the use of a three-tier approach, where data is stored in data storage tier, separated from business logic which manipulates data, while the user view presents the information to the user. Users will be required to download and upgrade their application when a new version is released.

The non-functional requirements developed for the app are shown in table 6.1.

Table 6.1: Non-functional requirements

ID	Description	Function
NFR1	The screen must be dynamic and display on all devices	The menus, buttons and layouts should be consistent across all screens
NFR2	Mobile application should present the user with clear notification messages	Pop-up windows with clear notification must be presented to the user, e.g. if some action is required from the user or if the app is busy
NFR3	Mobile application must be able to run directly on all Android devices	Mobile application developed to run on all Android devices, such as mobile phones, tablets and other devices consistently, as images and logos have been preloaded for different devices
NFR4	The mobile application will have a fast response time	The mobile application must provide fast execution of its operations and if there are delays, the user must be informed
NFR5	The mobile application must have a fast processing time	The mobile application must provide fast execution and processing during operation

NFR6	The mobile application must be designed for extensibility	The design of the mobile application must allow additional features and operations to be added easily through the source code.
NFR7	The mobile application must provide security	The mobile application must use a secure method for authentication through the use of tokens and connections should be encrypted to prevent unauthorised accessing of any communication

6.10.2 Use Cases

Use cases describe a sequence of events that takes place as different actors interact with a mobile application, as shown in figure 6.7. The main actors in the mobile phone application system are the user, representing community members, the domain expert or moderator and external sources of information, such as websites and external experts. Every article has a unique ID number, title and date on which it was published.

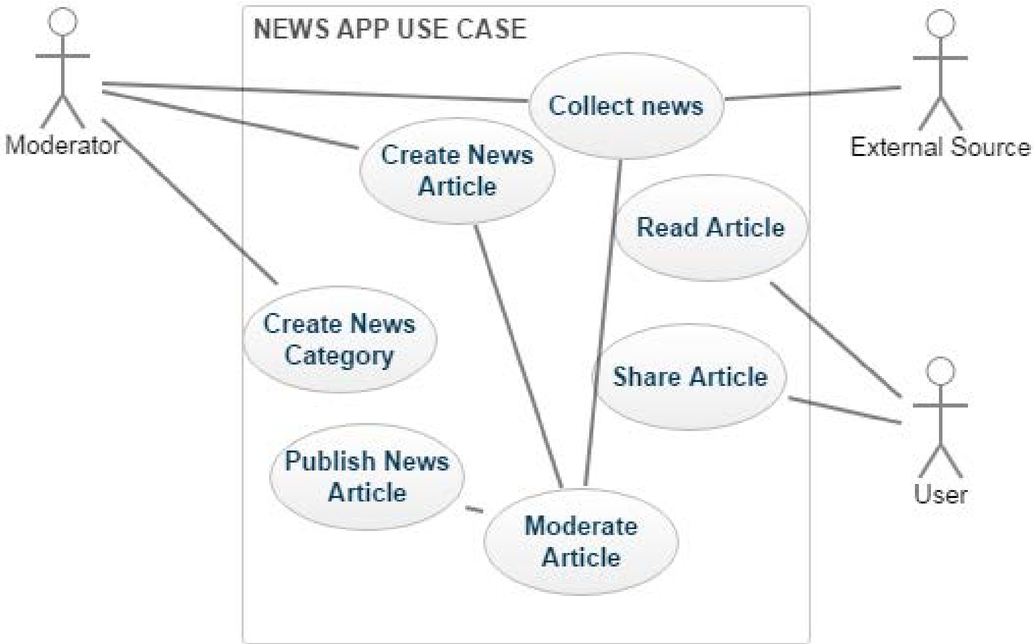

Figure 6.7: Mobile application Use cases

6.10.3 Class diagrams

In this mobile phone application, the main class diagrams are the Person, User, Moderator, Category and Article. Figure 6.8 shows the main classes, their attributes, operations and relationships between the classes. The Person class is a super class and the User and Moderator classes are sub-classes that inherit the properties of the Person class. To manage the information stored on the mobile application easily, every article belongs to one category of information.

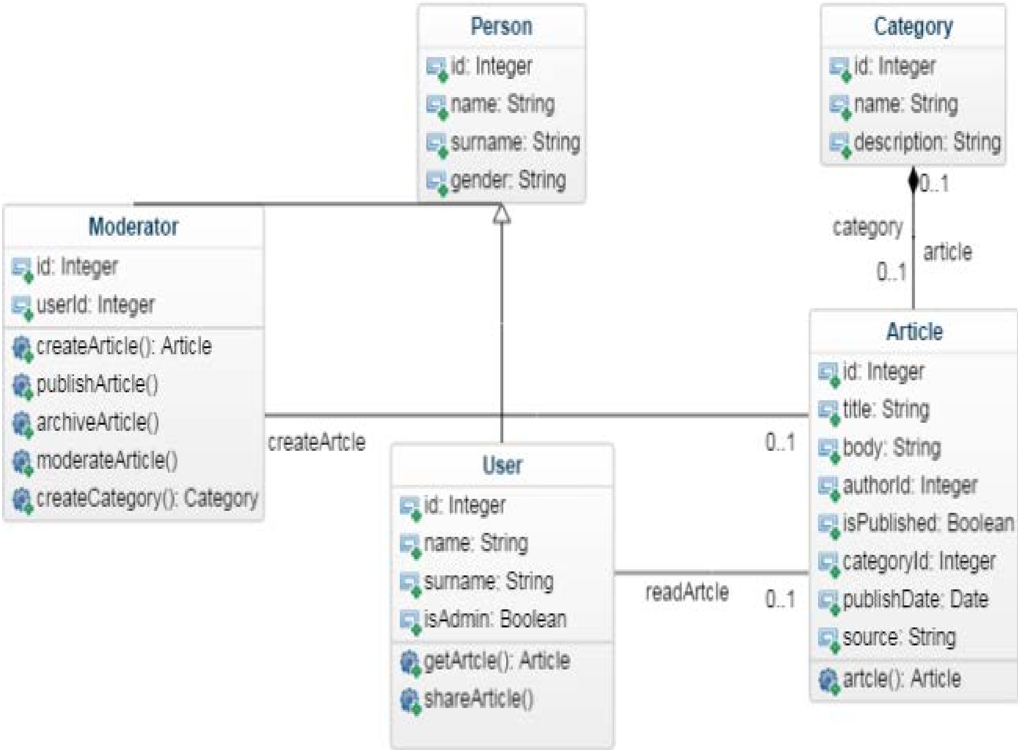

Figure 6.8: Mobile application Class Diagrams

6.11 Choosing the platform to use

Mobile phone applications can be developed using native, web and hybrid approaches, each having its own challenges and advantages. The hybrid approach is a compromise between the native and web approach. It is a quicker, cheaper way to develop applications for deployment on a native and a web environment (Appel, 2014). The native approach is best suited for top-performing applications with a higher development budget. The web approach is the cheapest and worst in terms of user experience and engagement.

6.11.1 Native

A native application is a smartphone app designed and coded for a particular device and written in a language compatible for a particular platform, such as Objective-C for Apple and Java for Android devices (IBM, 2012). The application is downloaded from an app store and the executable binary files are installed and stored in the device. The drawback of native applications is that the developer must have deep knowledge of the target OS and there are costs associated with frequently updating the application (Appel, 2014). Native applications are fast, reliable and more responsive, and can access the rest of the hardware without an intermediary.

6.11.2 Hybrid

The advantage of using the hybrid application development tool is that apps are developed more quickly across multiple platforms, with less maintenance time. The disadvantage of hybrid applications is that they do not have full access to all of the device's hardware features without a native container (Appel, 2014). Hybrid applications cannot develop top applications that demand full functionality and exceptional user experience.

In developing countries with limited access to development frameworks and a lower skills base, a hybrid approach is the best to follow and, therefore, its development framework will be utilised to develop the mobile app.

6.12 Mobile phone operating system market share

The overall usage of mobile phone applications is growing tremendously, as individuals demand to stay connected and access essential information, with 52% of their time spent on music, health and fitness, social networking, entertainment, sports and news (Entrepreneur, 2014). A survey conducted by Pew Research revealed that information applications were the most popular, providing regular updates on news, weather, markets and those that enable people to communicate (Brenner, 2014). Google Play Store has more than 2.8 million applications, while the Apple Store has over 2.2 million applications (Statista, 2017). Research predicts that mobile phone downloads will exceed more than 268 billion, generating an income of $77 billion by end of 2017 (Business 2 Community, 2017). The battle to control the mobile OS market has mirrored the Apple versus PC battle, as the Android OS global market share rose to 86.2%, followed by Apple's iOS with 12.9%, with Windows at 0.6% (Gartner, 2016; Quartz, 2017). The iOS is licenced and distributed by Apple, while the Android source code is released by Google under an Apache licence as open source, allowing free modifications by manufacturers and developers (Apache, 2017).

The Android is a complete open and free platform that includes an operating system based on a Linux kernel with sufficient libraries (Android Developers, 2014). The Android phone is very popular in developing countries, as it can run on very cheap devices that are developed to target low-income earners. The Android application can run on diverse third-party devices that can have different versions of the Android API and this may create functionality challenges depending on the device and Android version (Android Developers, 2017). The Android platform is open for any developer to build and run applications on any handset. smartphone (Aol, 2014). Low-cost smartphones have been developed by Chinese manufacturers and are being sold for less than $100, making them affordable even in the developing world (GSMA, 2017). In Zimbabwe, the mobile phone operating system market share is dominated by Android, with a 76.17% share, while Apple's IOS came fourth, with 3.04% of market share, behind Windows and others (StatCounter, 2017). Guided by this statistic in Zimbabwe, the app will be developed for the Android market.

6.13 Android architecture

Android is a comprehensive open-source, Linux-based platform, an operating system and middleware developed for creating applications to run on mobile devices (Sunguk, 2012). Android mobile phone application development is based and managed by Java language codes and the controlling device is provided by Google-developed Java libraries (Holla & katti, 2012). Mobile applications are built through Google's Android SDK stack of software. The various software components are arranged as a stack, as shown in figure 6.9, where the applications and widgets are at the top, while the Linux Kernel is the bottom layer. The layers in the stack overlap to the nearest layers.

Figure 6.9: Android architecture, (Hoog, 2011)

6.13.1 Android applications

The application and widgets layer consists of core applications that include email, maps, SMS, calendar, contacts, browser and others (Sunguk, 2012).

6.13.2 Libraries

The native libraries (e.g. libc, libm) are written in C/C++ which are called through a Java interface (Muir, 2015). Common libraries include those for graphics and multimedia that support media files and the SQLite database.

6.13.3 Linux Kernel

This is the lowest layer in the stack, which runs Linux version 2.6 for core systems and provides several device drivers for the hardware, such as cameras, network, memory and power management. The abstraction between the software and hardware stacks is provided by the kernel.

6.13.4 Android programming framework

This is a free and open, source-rich environment with many libraries that can equip the developer with the creative tools to produce market-driven applications (Gargenta & Nakamura, 2014). This environment is composed of the SDK, the Eclipse and the JDK, all of which are pre-installed. Some of the libraries contained in the SDK include sample projects, the handset emulator, sample codes and tools such as the Dalvik Cross-Assembler, which are required to build apps (Sunguk, 2012). Dalvik allows several devices to run multiple virtual machines and executes the files in the (.dex) format.

6.13.5 Implementation framework

A Slim framework was used in the implementation of this project. Slim is a dynamic micro PHP framework that helps to build web and mobile content, with the aid of Model View Controller (MVC) architecture that is lightweight and demands limited resources from the server (Agriya, 2016). The MVC design standard allows the developer to separate an application into three components – the model, view and component – and this enables applications to be extensible and very scalable. The model component is the engine, where all the application logic occurs, including retrieving articles from a database. The view component is created for the user interface, which may be composed of text boxes, menus and links, etc.

In between the model and the view components lies the controller, which manipulates data using the model and forwards the results to the view for output.

Slim allows developers to create APIs in a simpler way, through a URL route that supports encryption, flash images and middleware (Tamada, 2014). Some of the major attributes of this framework for developers include its lightweight structure, highly flexibility and easy tools for debugging, thus reducing development time (Agriya, 2016). Some of the advantages of using Slim, as noted by Agriya, (2016), include:

- Deployment of solid routing features (GET, POST, DELETE, and UPDATE);
- Effective usage of template rendering systems;
- Use by API of protected keys;
- Proper initialisation of database and security against SQL injections;
- Lightweight framework;
- The inclusion of Route Middleware validations; and
- Backed by a varied response formats.

6.13.6 API routes

The Slim framework maps resources' URLs to specific HTTP callback functions using GET, POST, PUT and DELETE, through invoking the first route that matches the HTTP request's URL (Tamada, 2014). If the Slim application does not find routes with URLs that match the URL and method when executing the HTTP request, error 404 will be returned (Vaswani, 2012).

6.13.6.1 Handling GET requests

Slim works by defining route callbacks for HTTP methods and a REST method (GET/articles) request will list all the articles that have been created in the "bulilima/user" resources.

6.13.6.2 Handling POST requests

A (POST/articles) request will create a new resource, which is an article that contains other fields defined in the database, such as title, date and author. The HTTP callback will decode the request body, save it to the database and return a JSON representation of the resource (Vaswani, 2012).

6.13.6.3 POSTMAN

Postman will be used to test routes and is a Google Chrome feature that provides an environment for interacting with HTTP APIs (envyandroid, 2014). Using Postman simplifies the development and testing of APIs, and helps in automating the process of requesting and testing API responses (Wagner, 2014).

6.14 Accessing the database

Articles in the mobile application will be stored in a database, as shown in figure 6.10, representing the database schema with its main tables of: category, article, user and comment. All articles published on the app will be stored in this database. From the database schema, “comments” is a view created in the database for viewing articles that have been created.

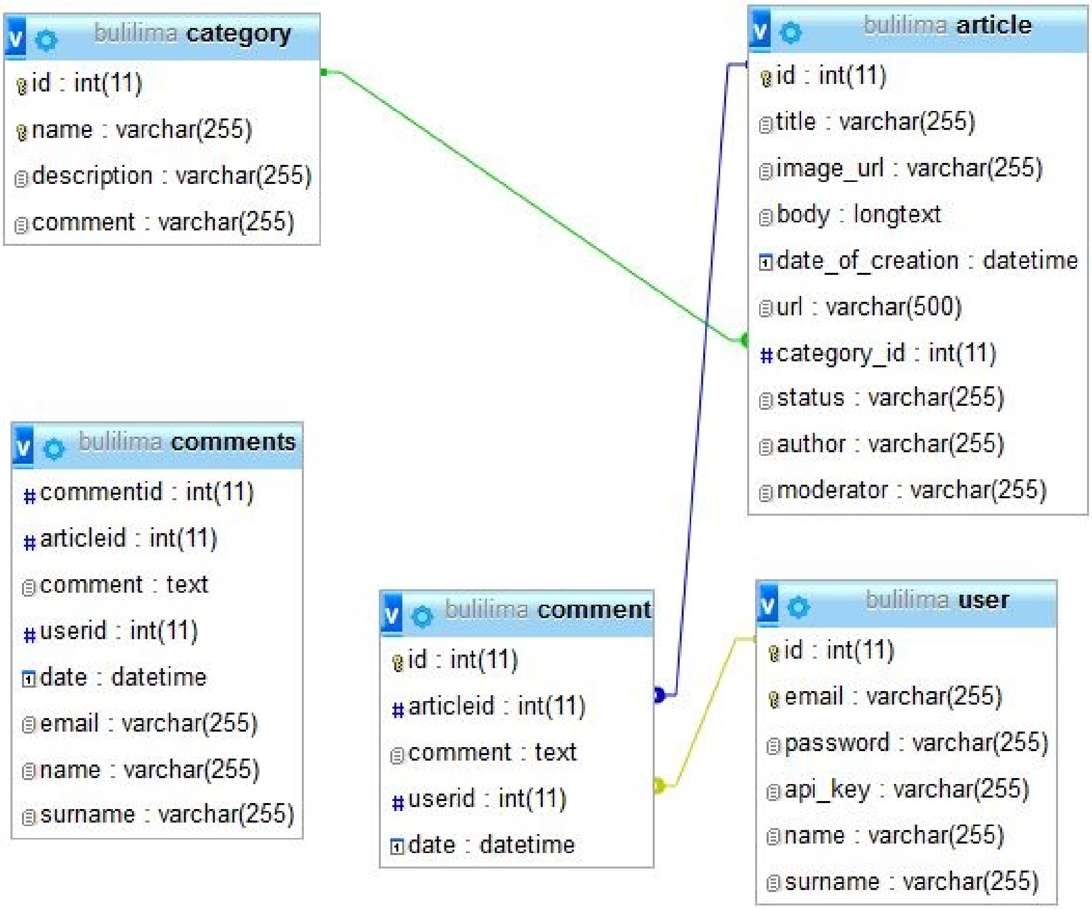

Figure 6.10: Database Schema

6.14.1 RESTful

The mobile application uses a RESTful endpoint for database access. This is a design pattern allowing users to access structured information through unique URLs (Tamada, 2014). HTTP requests are sent to the unique URLs and these comprise instructions on what must happen to the data, while responses have status codes that signify what has occurred to it. Table 6.3 shows the URL, method and a description of the API function.

Table 6.2: Mobile application API Routes

URL	Method	Description
/api/bulilima/article	POST	Sends data to a specific URI and expects the resource at that URI to handle the request.
/api/bulilima/article	GET	Retrieves data from a specific URI and expects the resource at that URI to handle the request.
/api/bulilima/article	PUT	Puts an article on the specified URI and if article already exists it will be replaced.
/api/bulilima/article	DELETE	Deletes an article on the specified URI

The following code extract shows how the POST request is implemented.

```
$response = array();
$title= $app->request->post('title');
$image_url = $app->request->post('image_url');
$body = $app->request->post('body');
$date_of_creation= $app->request->post('date_of_creation');
$url = $app->request->post('url');
$category_name = $app->request->post('category_name');
$status = $app->request->post('status');
$author = $app->request->post('author');
$moderator = $app->request->post('moderator');
global $user_id;
$db = new DbHandler();
```

6.15 Gradle build

Gradle is an open-source project licensed under Apache, which offers an advanced automated, general-purpose-build toolkit for the developer to create a management system based on pre-defined configuration files. Through Gradle, each project is defined, together with its dependencies and resources, facilitating reuse of existing systems (Android Studio, n.d.). Gradle provides the developer with a self-contained environment and provides inter-operability through its command line (techotopia, 2016). The code below shows how Gradle was implemented.

```
apply plugin: 'com.android.application'

android {
compileSdkVersion 25
buildToolsVersion "25.0.0"
defaultConfig {
applicationId "org.bulilimainfocentre.bulilima"
minSdkVersion 15
targetSdkVersion 25
versionCode 2
versionName "Design Phase"
testInstrumentationRunner "android.support.test.runner.AndroidJUnitRunner"
}
buildTypes {
release {
minifyEnabled false
proguardFiles getDefaultProguardFile('proguard-android.txt'), 'proguard-rules.pro'
}
}
}
dependencies {
compile fileTree(dir: 'libs', include: ['*.jar'])
androidTestCompile('com.android.support.test.espresso:espresso-core:2.2.2', {
exclude group: 'com.android.support', module: 'support-annotations'
}
compile 'com.android.support:appcompat-v7:25.2.0'
compile 'com.android.support:design:25.2.0'
compile 'com.android.support.constraint:constraint-layout:1.0.2'
compile 'com.mcxiaoke.volley:library:1.0.17'
compile 'com.android.support:support-v4:25.2.0'
compile 'com.amulyakhare:com.amulyakhare.textdrawable:1.0.1'
```

```
testCompile 'junit:junit:4.12'
}
```

6.16 Client Side

The clients will be run on the Android Mobile Operating System and will interact with the backend using RESTful web services/API. The RESTful web services will receive HTTP requests and respond using HTTP responses by returning JSON (JavaScript Object Notation) data, which is a lightweight data-interchange format algorithm for interfacing with the backend (Tamada, 2014). RESTful web services are lightweight and can run on multiple clients and require minimal tools to develop. The API accesses data from the database and sends the response in JSON format. The advantage of using RESTful web services is that developers can build multiple clients on the same backend, such as iOS, Symbian and Windows.

6.17 Server

Custom web services powered by the Apache, this is an open-source web server used for the creation, deployment and management of software. Apache is a web server that is used to create and deploy efficient and extensible HTTP services (Apache, 2017). Apache can operate and support a multi-programming platform, as well as perform other functions, such as database authentication. This server can provide a safe and secure environment through the provision of scalable and robust services that support HTTP requests (Apache, 2017). The sever will provide a platform to post and retrieve articles from the database. Each category of information is managed by a domain expert, who moderates any entry and verifies information that comes from external sources. Articles are stored in a MySQL database and can be downloaded into the mobile phone for offline access.

6.18 Tools to be used

To implement the mobile phone application, whose architecture is revealed in figure 5.9, a number of programming packages were used – such as Java, Javascript, PHP and MySQL – to constitute the development environment. Java is one of the common languages for building Android applications and this will be utilised, as other languages such as Objective-C have a steeper learning curve (Android Studio, n.d.). The Android studio will be employed, as it has emerged as being a great tool to deliver Android apps that can be favourably compared to Apple apps. Once development was completed, the project was distributed as Java Archive (JAR) files and users could download these from the website for installation on their mobile phones

(Android Studio, n.d.). The system employs Volley as its core development library and other tools that include Slim and Android Studio.

6.18.1 Programming environments

- Java – this is an object-oriented programming language licenced under Sun Microsystems, which has many powerful libraries that help developers produce superior applications (Muir, 2015).
- PHP – this is an open-source, general purpose scripting language whose code is executed in the server. PHP is a powerful tool and its code is embedded in HTML and is used for developing powerful and interactive applications.
- JavaScript – this is an open-source, interpreted dynamic language used for creating dynamic applications (Muir, 2015).

6.18.2 Database

MySQL – this is a freely available open-source RDBMS that can store data, which can be easily retrieved through queries by means of the SQL.

6.18.3 Development libraries

- Volley – this is an HTTP library that makes networking for Android applications easier and, most importantly, faster (envyandroid, 2014).
- Slim – this is a PHP micro framework that helps developers to quickly write simple, yet powerful web applications and APIs. At its core, Slim is a dispatcher that receives HTTP request, invokes an appropriate call-back routine and returns an HTTP response (Tamada, 2014).

6.18.4 Mobile application platform

- Android – this a powerful application framework that allows developers to produce applications that can be utilised on devices powered by Google's Android platform.
- Android SDK – this is a software development toolkit that contains sample projects, source code, an emulator and other tools that support the developer in building applications (Android, 2016).

6.18.5 Integrated development environments

- Android Studio – this is a framework for developing the Android Application.
- PHP Storm – this is an integrated environment for developing the RESTful web services in PHP and consuming existing ones.

6.19 Development iterations

It is important to understand a problem from a user's point of view so that the proposed design and the expectations of intended users correspond. After gathering and refining the collective input from the users through a questionnaire survey, consensus was reached on the general layout of the user interfaces and the content to be provided by the application. Each iteration begins with the users and the researcher agreeing on the problem and applying the knowledge gained from user feedback to construct the artefact which has to address the stated problem. A better understanding of the problem is achieved after every iteration and helps in building the artefact. Three iterations guided the development of the mobile phone application, with each phase resulting in the improving the artefact's capacity to address information access challenges. The iterations also helped in refining the system design as well as consolidating the research output. Through traversing through the feedback loops, the design is refined by discovering new ideas and problems raised by potential users to ensure that the application meet their needs (Schimidt-Rauch & Schwabe, 2011). Further knowledge about the problem is build up as the team engages each other through suggestions, designs and evaluations.

Failure of systems has been attributed to lack of expected features in a system, difficult to use and failing to provide the expected functionality (Ode, 2010). Conceptualisation of the mobile phone application began with paper sketches based on the results of a baseline survey which was conducted in line with the ISDM. The baseline survey results provided empirical evidence on some of the information access challenges faced by the rural communities as highlighted in section 5.6.1 to 5.6.7. In Bulilima district, where there are no appropriate devices or computer laboratories with special equipment and software for prototyping, paper- and-pen based sketches were the only available tools for deriving simple but effective prototypes, as posited by Sommerville, (2006). These development iterations were incremental, with each iteration resulting in additional functionality incorporated based on user feedback.

The fidelity of the prototype is the degree to which the prototype resembles the final product in terms of functionality, look and feel (Nielsen Norman Group, 2016). A low-fidelity prototype is created to test and seek clarity on broad concepts and is therefore simple, sketchy and incomplete, and does not fully resemble the final product. Low-fidelity prototypes can include paper-based sketches, mock-ups and story-boards (Stone et al., 2005). High-fidelity prototypes provide a functional version of the system that may include user interfaces and navigation links (Stone et al., 2005). The development of high-fidelity prototypes has its own challenges. More resources must be given to the development of the prototype and, because users may think this is the final product, it may be discouraging to the developer to have to overhaul the prototype once users make recommendations (Rogers, Yvonne, Helen, & S, 2011).

The first prototype was utilised as a springboard to engage users, since they were not experts in terms of mobile application development. The prototype kept being refined to incorporate feedback gathered during interviews and meetings with users. The other iterations tested the prototypes and incorporated user feedback to refine the concepts and rectify user inputs. According to Hevner (2004), before the final artefact is produced, several iterations are to be performed in DSRM. The prototype was evaluated to discover usability problems and ensure it could be used without ambiguity. The following section outlines the iterative design processes in building the mobile phone application, as guided by the DSR methodology.

6.19.1 Demographics of the participants who took part in the first consultative meeting

During the mobile application design consultative meeting, 10 participants were drawn from the local community and the rural district council. Their ages ranged between 19 years and 55 years. All the participants understood the aim of the study as well as consenting to participate in the study. All the participants had attained secondary level education, with two rural district employees who had attained degrees. The two employees from the district were community development experts. From the community, participants included community knowledge workers, an agricultural expert and a community leader. These participants were recruited through the questionnaire survey and were deemed to be extensive users of mobile phone applications within the community.

6.19.2 Bulilima mobile application design iteration 1

The session took place in April 2017 with the intensive users of mobile phone applications identified in the initial questionnaire survey. The researcher paid for the transport costs of the participants. The group was introduced to the theme of the meeting, and the different ways of extending information to the communities were presented. The group was asked to list information access challenges currently being experienced by the community and consider how a mobile phone application could be used to address some of them. The group discussed how television and radio, newspapers, pamphlets, and mobile phones could be used to improve access to information. The group observed the availability and increased use of mobile phones as a more feasible and economic way of improving access to information. Participants were asked to list the main categories of information they wanted to be included in the mobile application as well as explaining why this information was important to the community. These broad categories would form the main screen menus for the application. The categories of information that were suggested were then discussed and synthesised to provide the general functionality of the application into paper-based prototypes. Collective input was written on a flip-board and then refined. The questions and responses are summarised in appendix 6.

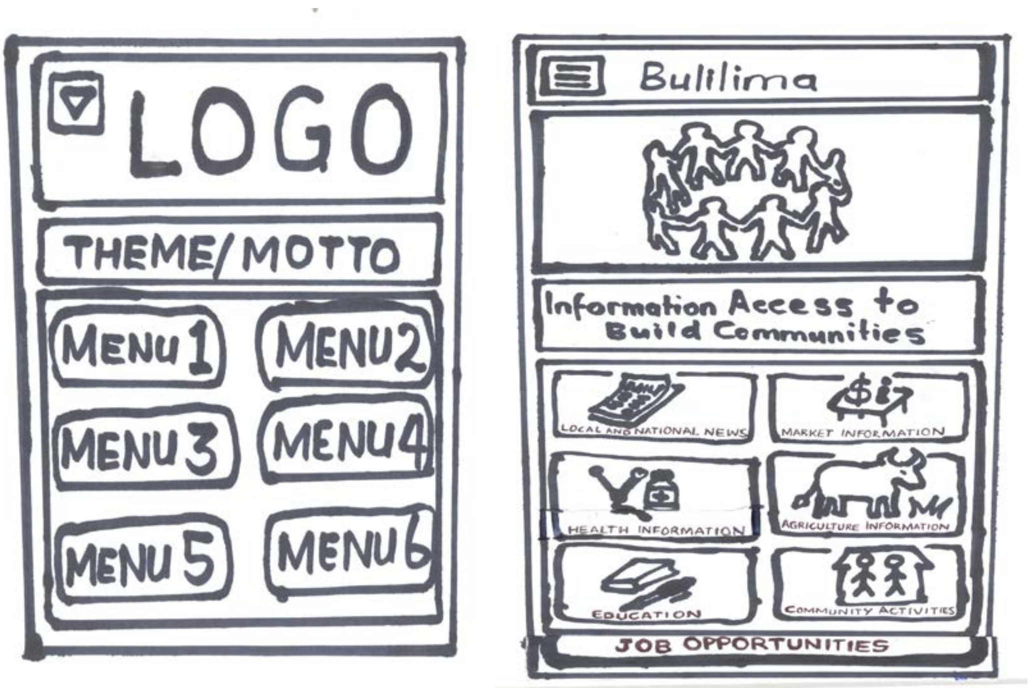

Figure 6.11: Low-fidelity, paper-based prototypes: Mobile Application version 1

During the session participants were also asked to sketch the main screen of the proposed mobile phone application. During the production of these prototypes, it became clear that the participants understood the initial problem that was being addressed and the role of the proposed app in addressing it. It was crucial that participants were part of the design team evaluating the sketched designs. The potential users thus had a clear idea, at an early stage, of the utility to be provided by the mobile phone application. The sketch shown in figure 6.11 represents the final paper-based version of the mobile phone application design, with the second image the final refined, low-fidelity prototype. This is complementary to the first and second activity of the DSRM, as presented by Hevner, March and Park (2004). During the first iteration, participants suggested that the information presentation was supposed to be simple and easy to follow since most community members have limited digital skills. Participants also suggested that the design of the prototype was positive as they found the icons, layout and colour themes good and relevant. Participants discussed the general content to be displayed on the application as shown in table 6.4.

Table 6.3: General topics and sub categories raised by participants

Topic	Sub-categories
Community activities	General meetings, Community gatherings, Notices, Transport services, Local government
Market information	Market prices, link to several markets
Agriculture information	Weather forecast, topics on crop and animal, disease outbreaks alerts,
Health information	General tips on hygiene, information on common diseases, immunization information, disease outbreaks,
Education	General topics in education, link to free educational resources
Local and national news	Local news, national news summaries with links to online newspapers.

6.19.2.1 Transforming the paper based prototype

After gathering the initial requirements in terms of the broad categories of information, the first stage was to decide on the layout of the user interface for the mobile phone application. A layout simply defines the construction of the user interface and several layouts have been developed. The most common include:

1. ListView

In this view, objects on a screen are displayed as a scrollable list by extracting content that has to be displayed on a screen and formatting it into a list.

ii. GridView

The objects are displayed as a vertical or horizontal scrollable grid, with items dynamically inserted on the user interface in a grid format. In this view, the grid contains images or icons with minimal descriptive text. During the design, the researcher created icons that were easily recognisable.

iii. RecycleView

In this view, the items are displayed in reverse chronological order, so that older items are at the bottom of the list and the latest items at the top.

iv. LinearView

This is the main layout, where all elements are aligned vertically or horizontally, as indicated in the source code below. Most of the layouts have been incorporated into the application design for managing different elements within the system. For example, the RecycleView has been utilised to manage the articles, ensuring that the latest one is always displayed at the top and the older ones pushed to the bottom. For rural communities, a home screen layout with icons, instead of text, will be more usable and clearer. A snippet of the code used for the layout is shown below.

```
<LinearLayout
  android:layout_width="match_parent"
  android:layout_height="match_parent"
  android:orientation="vertical">

  <LinearLayout
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    android:background="@color/colorPrimary"
    android:orientation="horizontal">

    <TextView
      android:id="@+id/textView4"
      android:layout_width="wrap_content"
      android:layout_height="wrap_content"
      android:layout_weight="1"
      android:text="Information Access to Build Communities"
      android:textAlignment="center"
      android:textColor="@color/colorText" />
  </LinearLayout>
```

6.19.3 Bulilima mobile application design iteration 2

Low-fidelity prototypes that were consolidated during the first consultative meeting, together with feedback from the initial sketches, assisted in the development of the second prototype, with the transformation of the paper-based prototype into a high-fidelity one. The researcher incorporated the views of the community, represented by the ten selected members. After the screen layout was chosen for the application, the design of the other related functions and behaviours began.

During the second meeting, held on the 15th of May, 2017, nine members of the same group gathered for the second meeting, the domain expert was not available. The group was introduced to version two of the mobile phone application prototype, which was downloaded onto a laptop and sent, via Bluetooth or copied through a USB cable, to their phones for installation. The researcher also had a dongle containing data and he set up a wi-fi access point. Some members were asked to connect to the internet via the wi-fi hotspot, download the application into their phones and test whether it was indeed useful and if earlier input had been incorporated.

Figure 6.12: Mobile Application prototype version 2 – Home screen

Participants were satisfied with the menus and the categories of information that was displayed as shown in figure 6.12. Participants also highlighted that they preferred simple interfaces with very few icons as this minimises errors and a steeper learning curve. These recommendations were used to improve the design. During the semi structured interviews, participants drilled down on the actual content that was supposed to be displayed on the application as well as the major sources of the information as shown in section 6.19.3.1 and appendix 6.

6.19.4 Functional requirements

During the design iterations, the input and feedback from potential users was translated into functional requirements, which spelt out what the completed artefact should do. These are explicit statements that spell out the services that must be provided by a system, including its behaviour under certain conditions or operations, as shown in table 6.4. These comprise the system's operational constraints, detailing the functions and services that the system is expected to deliver and form the basis of the contract between the system owner and the developer (Sommerville, 2009). All of the possible steps and actions that the user takes to access information on mobile application were evaluated and translated into functions and features that must be provided by the application prototype.

Table 6.4: Functional requirements

ID	Description	Function
FR1	System administrator and domain experts must be able to log in	The system must authenticate logins from the system administrator and domain experts through their user names and passwords
FR2	The system administrator must be able to create categories of information	The backend must allow the system administrator to create categories to which articles must belong
FR3	The system administrator must be able to edit categories	The system administrator must be able to edit, add and delete categories
FR4	The system administrator must be able to add an announcement	The mobile application must allow the administrator to add an announcement, such as a cattle sale or a wedding date.
FR5	The system administrator must be able to edit or delete an announcement	The mobile application must allow the administrator to edit or delete an announcement
FR6	Users must be able to create an article	The mobile application must allow users to create an article that must belong to a certain category
FR7	Users must be able to edit an article	The mobile application must allow users to edit an article that they wrote
FR8	Users must be able to comment on an article	The mobile application must allow users to write a comment on a particular post.
FR9	Domain expert or moderators must be able to review articles	The mobile application must allow the domain expert to review an article created by community members or an external source.
FR10	Domain expert or moderator can publish or un-publish an article	Mobile application must allow a domain expert to publish an article after reviewing it or un-publishing the article
FR11	Domain expert or moderator can edit or delete an article	The mobile application must allow the domain expert to edit or delete an article

FR12	Application downloads content automatically into local storage	The mobile application downloads content automatically into the user's mobile phone local storage for offline use

6.19.4.1 Categories of information to be displayed

i. Local and national news

Rural communities in the Bulilima district still lack access to national news, due to the unavailability of radio and television signals in the district, 37 years after Zimbabwe's post-colonial independence. The mobile application should provide access to national news through the provision of news, development information and breaking news. This will be facilitated by means of links to online national newspapers and, in the future, it will be worth considering subscribing to national newspapers through RSS feeds. Authorities in the community, such as ward secretaries, will be able to compile the important news about the community and load the articles into the app. The aim is to provide news and information that is acceptable and keeps readers engaged in issues that affect their communities.

ii. Market information

The application will allow communities to access information related to markets, for example, to obtain updated prices for local commodities, such as the price of crops, inputs and vegetables, poultry products and animals from the local markets. Economic news will also be conveyed through the mobile application. By providing the correct prices timeously, middlemen will be bypassed and this may perhaps result in improved profitability. A link to other markets such as Plumtree town or Bulawayo should be provided.

iii. Health information

Access to health care services is limited and many people are dying from preventable diseases due to lack of information and access to medication. It is important for communities in Bulilima to access health information, tips on how to prevent disease outbreaks, awareness of available healthcare delivery and associated costs. The application will provide basic health information on common diseases and conditions, such as diarrhea, HIV/ AIDs, pregnancy tips, post-natal care, TB and malaria, etc.

iv. Agricultural information

Channels to disseminate agricultural information in Bulilima are limited, resulting in communities using unsustainable farming methods, thereby limiting their agricultural productivity. There is the need to provide rural communities with prompt, up-to-date and reliable information regarding input information, better methods of cultivation and fertilizer application, planting season dates, rainfall prediction, pest and weed control/eradication, plant and animal diseases, and conservation techniques. Additional information, such as dipping and vaccination schedules, will also be provided by the app.

v. **Community related activities**

The application will provide information on community activities, such as meetings, weddings, parties, sports galas and funeral notices. Community members will convey this information through their normal communication channels through Community Knowledge Workers and Ward secretaries for loading into the application. A schedule of available transportation, such as bus and taxi timetables and reports on the condition of roads and bridges will be provided.

vi. **Educational activities**

To promote lifelong learning in the community, there is need to provide links to relevant and quality educational content that must be reviewed before publication. Harnessing the power of mobile phone applications promotes lifelong learning and offers learning opportunities for rural communities. An amount of content will be locally generated, once experts in the field have been identified.

Participants began to evaluate the second version of the prototype by pointing out design flaws and bugs, and this feedback assisted in refining the next version of the prototype, in line with DSRM. Participants were asked to brain storm on the main sub categories under each general category or topic. Participants also agreed on the general features of the application. The content will be summarised and divided into single pages, to reduce the amount of scrolling down of pages.

Tests were performed to investigate if the second version of the prototype wholly addressed the problems that had been raised by users during the first design consultative meeting. However, no major changes were proposed to either the user interface or the administrator's access forms. Participants, though, made the following suggestions on improving the prototype:

i. There was a suggestion that a menu item on job opportunities be included, so that those who wanted general labouring work could advertise on the application.

ii. Participants also suggested that the application could have a static session on important dates, including those for immunisation and ward meetings.
iii. Another suggestion was made that the application also contain a real-time chatting system.

6.19.4.2 Testing

In order to ensure that errors are limited during integration, each module of the application underwent testing during the development phase. Feedback from the users provided valuable feedback. Testing proves that a particular program does what it is intended to do, so that any glitches and bugs can be found and corrected before deployment (Sommerville, 2009). Some tests on the mobile phone application are carried out during coding, using Postman, a Google Chrome application for interacting with HTTP APIs through constructing requests and reading responses (Wagner, 2014). Valuable opinion was obtained throughout these processes and it helped to improve the application design, especially its colour scheme.

6.19.4.3 Securing users

To enhance the security of the application, each user has a unique API key and no user passwords are stored in the Android application. It also interacts with the database through a secure API and user passwords are stored as encrypted text in the database. A user registers his or her email address and password, then a hash function is performed on the password and is bound to the API key. This facility is for users who want to post comments on the articles. The app must use a secure method for authentication, by means of tokens and connections that are encrypted to prevent unauthorised access on the communication channel.

```
public function makeUser($email,$password) {
    require_once 'PassHash.php';
    $response = array();
   if (!$this->isUserExists($email)) {
      $password_hash = PassHash::hash($password);
      $api_key = $this->generateApiKey();
      $stmt = $this->conn->prepare("INSERT INTO user(email, password, api_key)
values(?,?,?)");
     $stmt->bind_param("sss", $email, $password_hash, $api_key);
          echo "password = ".$password. '-';
          echo "email = ".$email. ";
```

```
$result = $stmt->execute();
$stmt->close();
```

6.19.5 Bulilima mobile application design iteration 3

During the final design iteration, six participants that were part of the first consultative meeting were presented with the designed screens showing the sub categories of the main topics as per suggestions in the second meeting as shown in figure 6.13. The meeting sought to establish the features which the users wanted versus what was technically feasible. Participants were satisfied with screens and the relevance of the content in enhancing access to information.

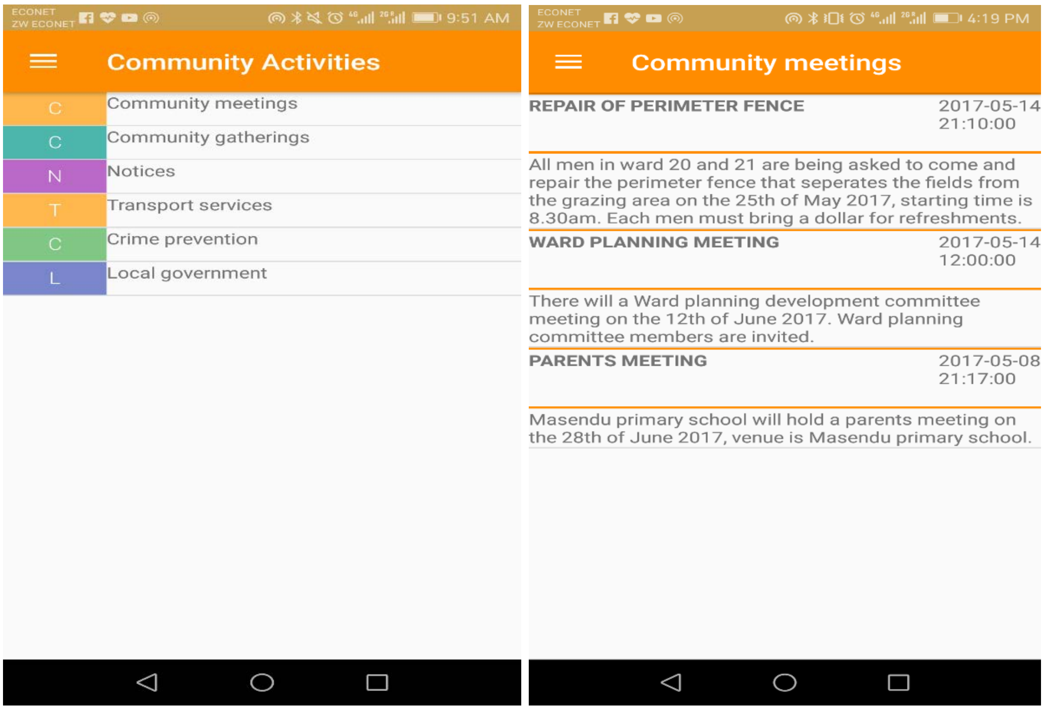

Figure 6.13: Mobile Application prototype version 2, community activities sub menus

Following the iterative nature of DSRM, a third version of the mobile application was developed to incorporate user feedback from stakeholders. Some recommendations were feasible in the short term and others in the long term, or could be applied in the future. After reflecting on feedback, the following recommendations were implemented into version three:

i. additional functionality to allow readers to leave comments on articles, so that the app provides some interactivity; and
ii. a change in the design, placing static sessions for activities such as immunisation dates or ward meetings.

iii. Allowing the application to download content into the mobile phone’s internal storage once a connection has been established to reduce costs by supporting offline access.

It was impossible to implement all of the suggestions made at user feedback sessions, due to technological limitations and time constraints. Some that could not be implemented in the short term included the development of an interface to link the community with local government, the provision of a link for the diaspora community to make contributions and an online chatting platform. One feature for future incorporation was RSS feeds to provide notifications on new information and news. Other functions, however, were implemented, including one that allowed users to add comments on an article (as shown in figure 6.14 and 6.15) and a link for job opportunities, as shown in figure 6.16. As air time credit was a significant expense to this community, coupled with erratic mobile connections, it was felt that this was an important feature of the application. Users said it was vital that the app allow community members to place adverts for casual work, including those that concerned tilling the land and fetching firewood.

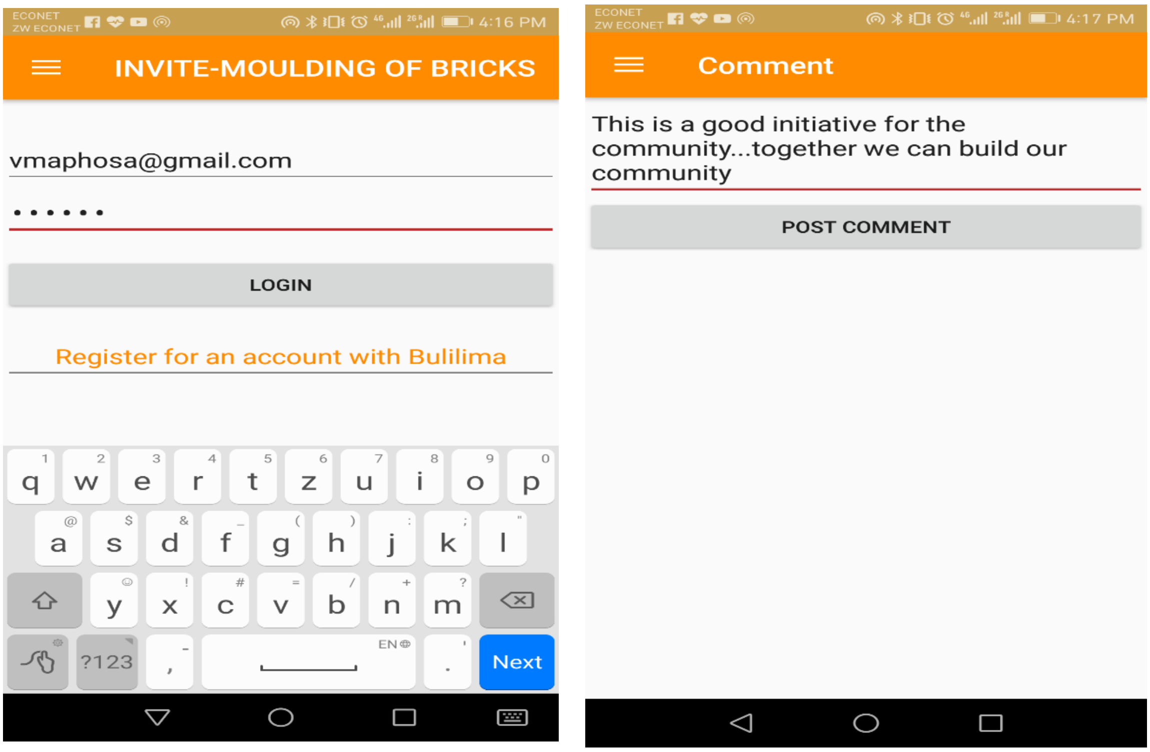

Figure 6.14: Registering to post comments and typing the comment

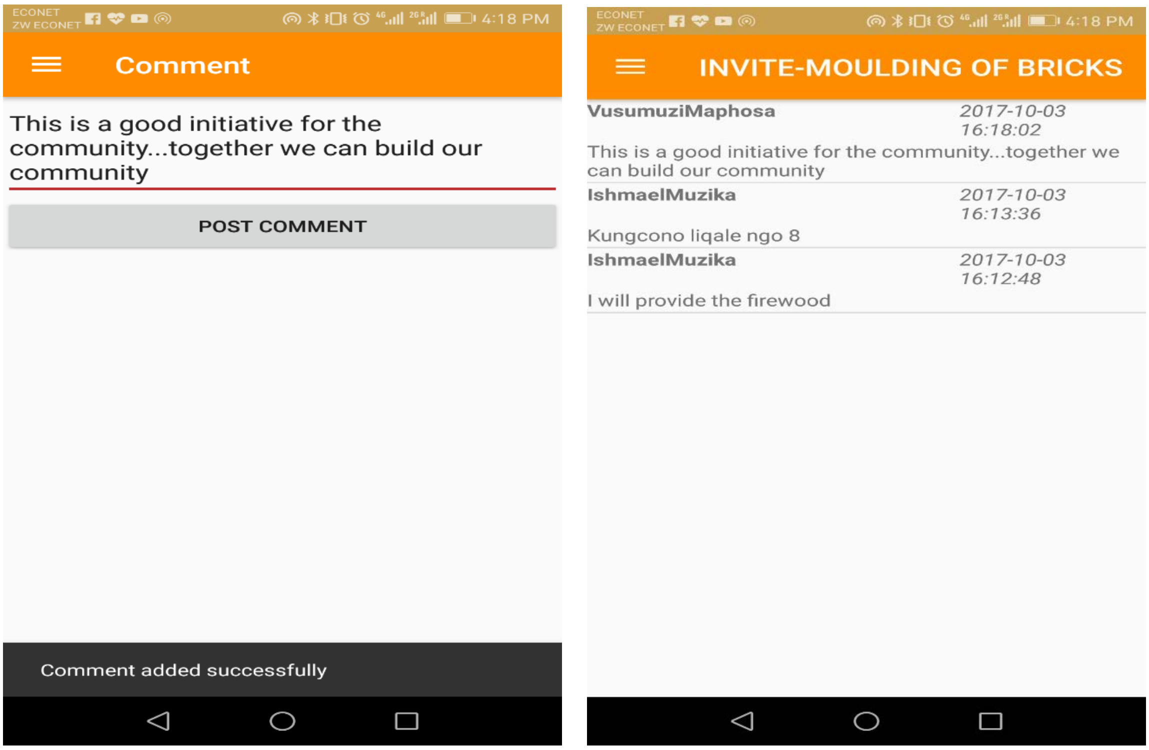

Figure 6.15: Successful posting and displaying comments

Figure 6.16: Mobile Application prototype version 3

Figure 6.14 shows a screen-shot of comments posted on the mobile phone application. The code extract below reveals how the backend executes the function for users to add comments on an article. This feature provides the application with some form of interactivity.

```
$app->post('/comment', 'authenticate', function() use ($app) {
  verifyRequiredParams(array('articleid' ,'comment' ,'userid'));
  $response = array();
  $articleid= $app->request->post('articleid');
  $comment= $app->request->post('comment');
  $userid= $app->request->post('userid');
  global $user_id;
  $db = new DbHandler();
   $comment = $db->add_comment($articleid ,$comment ,$userid);
  if ($comment != NULL) {
    $response["error"] = false;
    $response["id"] = $comment;
    $response["message"] = "Comment added successfully";
    echoRespnse(201, $response);
  }
  else {
    $response["error"] = true;
    $response["id"] = 0;
    $response["message"] = "Something went wrong ,please try again";
    echoRespnse(201, $response);
  }
```

6.20 Implementing offline access

One important consideration for a DSRM is the novelty of the artefact. In this study, the novelty of the application is shown through its ability to support low bandwidth and unavailability of credit on the user’s phone.

Developing countries which are still establishing their mobile network infrastructure are characterised by limited and variable bandwidth which is an obstacle for deploying data hungry applications. This challenge is worse in rural communities, where constant connectivity cannot be guaranteed due to poor network infrastructure and lack of airtime. As per baseline survey results, the mobile network in Bulilima support low bandwidth and is sometimes slow and unreliable. When designing mobile apps for rural communities it is critical to ensure that the app supports low bandwidth and intermittent connections as well as situations where users may often run out of air time credit. The Adobe AIR NetworkInterface API is used to check if the user has mobile internet. If the API detects that the user has lost the internet connection, it activates offline access. During the offline access mode, the core functions of the app are made available to the users, such as access to content as well as interacting with the app and inputting data. The app utilises device storage and cloud storage services to synchronise between the server and local storage once connectivity has been established. Any changes that are made to the local database are synchronised with the server once a connection has been established. This concept is similar to caching of web content by a web browser for offline use, the app's data is made available in offline mode (Nguyen, et al., 2015). The synchronisation services run in the background by picking the latest data for synchronisation. The users can make comments on the articles or any user-initiated content changes in the offline mode and this content will be synchronised with the server when connectivity has been established. Some source code snippets are shown below.

```
package org.bulilima.offline;
import android.content.ContentValues;
import android.content.Context;
import android.database.Cursor;
import android.database.sqlite.SQLiteDatabase;
import android.database.sqlite.SQLiteOpenHelper;
import android.util.Log;
import android.widget.Toast;

import java.util.ArrayList;
import java.util.List;

import models.Article;
import models.Comments;

/**
 * This class defines all methods that retrieve data from the
offline sqlite database to the use interface
 */
public class DatabaseAccess {
    private SQLiteOpenHelper openHelper;
    private SQLiteDatabase database;
```

```
    private static DatabaseAccess instance;
    public static Context mContext;

    private DatabaseAccess(Context context){
        this.openHelper = new ExternalSQLDatabase(context);
    }

    public static DatabaseAccess getInstance(Context context){
        if (instance == null){
            instance = new DatabaseAccess(context);

        }
        return instance;
    }
    public void open(){
        this.database = openHelper.getWritableDatabase();
    }

    public void close(){
        if (database!= null){
            this.database.close();
        }
    }


    private void saveArticleOffline (Article a){
        ContentValues values = new ContentValues();
        values.put("id" ,a.getId());
        values.put("title" ,a.getTitle());
        values.put("body" ,a.getBody());
        values.put("url" ,a.getUrl());
        values.put("imageUrl" ,a.getImageUrl());
        values.put("date_of_creation" ,a.getPresidentialcast());
        values.put("category_id" ,a.getConstituencycast());
        values.put("author" ,a.getWardcast());
        values.put("moderator" ,a.getUserid());
        values.put("created_at" ,a.getCreated_at());
        values.put("updated_at" ,a.getUpdated_at());


        database.insert("article","",values);
    }

public List<Article> getArticles(){

        List<Article> list = new ArrayList<Article>();
    this.database = openHelper.getReadableDatabase();
        Cursor cursor = database.rawQuery("SELECT * FROM
articles",null);
        cursor.moveToFirst();
        while(!cursor.isAfterLast()){
            Article Article = new Article();
            Article.setId(cursor.getString(0));
            Article.setTitle(cursor.getString(1));
            Article.setBody(cursor.getString(2));
            Article.setUrl(cursor.getString(3));
```

```
            Article.setImageUrl(cursor.getString(4));
            Article.setDateofCreation(cursor.getString(5));
            Article.setCategory_id(cursor.getString(6));
            Article.setAuthor(cursor.getString(7));
            Article.setModerators(cursor.getString(8));
            Article.setCreated_at(cursor.getString(10));
            Article.setUpdated_at(cursor.getString(11));

            list.add(Article);
            cursor.moveToNext();
        }
cursor.close();
        return list;
}
}
package com.sqlite.bulilima;

/**
 * This class initilises the connection to the internanl sqlite
database for offline storage
 */

import android.content.Context;

import com.readystatesoftware.sqliteasset.SQLiteAssetHelper;

public class ExternalSQLDatabase extends SQLiteAssetHelper {

    private static final String DATABASE_NAME = "bulilima.sqlite";
    private static final int DATABASE_VERSION = 1;


    public ExternalSQLDatabase(Context context) {

        super(context, DATABASE_NAME, null, DATABASE_VERSION);

    }

}
```

6.21 Conclusion

The mobile phone is a powerful force for change, whose intrinsic availability should be harnessed to solve problems affecting developing countries, where other technologies have made little impact. The DSRM guided the design of the artefact, whose role was to solve real-world problems affecting rural communities in Zimbabwe. Through multiple iterations involving the design, build and evaluate cycles the artefact was refined until it was sufficiently usable and could meet the needs of the community. One aspect of the application which set it apart from others is its ability to offer content during offline mode by downloading content into the user's phone when the network is poor or when the user has run out of air time credit. Module testing was performed to ensure that there are very few integration errors.

The mobile phone application was designed for such communities through an iterative process centred on user involvement. The development process included the derivation of both the functional and non-functional specifications of the application – including the coding, evaluation of prototypes and incorporation of user feedback – and, finally, the deployment of the app onto a website in order to allow users to download it. The app provides information on market developments, local and international news, community activities, agriculture, education and health. Each category has a domain expert, who acts as an editor to regulate the information added to the application. The app also provides some form of interactivity and feedback, allowing users to post comments on articles that they have read. This engagement facilitates an easy exchange of information and provides users with clarity on issues raised and may even allow them to determine the type of information to be added to the app.

In the future, more advanced features added to the application could provide further functionality, including direct links to local government offices – for example, the district administrator. Users also suggested incorporating a chat platform, where community members could engage in discussion on topics or issues that affected them. Another function that must be implemented in the future allows domain experts to subscribe to RSS feeds, supplying notifications about fresh information and news posted on the application. Suggestions were given that a platform be provided for the diaspora community, residing mainly in South Africa, Botswana and other countries, to actively participate and contribute to the development of rural communities. There will be a requirement for continual improvement of the application's functionality and content. The incorporation of a language translation function, as a way of encouraging the use of local languages and preserving indigenous knowledge systems, could be considered in the future.

Chapter 7: Demonstration and evaluation

7.1 Introduction

Demonstrating and evaluating the utility of an artefact is one of the important phases of a DSRM based study. The demonstration and evaluation phases were conducted in the user's natural environment in this study. Demonstrating the utility of the artefact provides a proof-of-concept. Generally the demonstration and evaluation must show how the artefact was deemed to be working and meeting the expectations of the potential users.

A pilot demonstration was conducted with five potential users, with the aim of testing the usability of the application. These users were composed of a domain expert and three community knowledge workers. All of the participants resided in the selected wards from the district. The application was uploaded onto a website – http://www.bulilima.org/bulilima.apk – and the participants were shown how to download and install it on their mobile phones, and also how to use it. There was the need to demonstrate how the domain experts or moderators would log into the website and create articles, since most of the information had been entered directly into the database by the researcher. The task of logging and creating articles was not problematic, although it will be necessary to train future domain experts. Figure 7.1 provides a screen-shot for the domain expert screen, where the expert creates and publishes articles.

Developing the mobile phone application followed the DSRM, which is iterative, involving the user community from the initial stages of development until the deployment of the application. During these tests and demonstrations, user experience, usability and functionality are checked. The success of the app is evaluated based on certain factors that include usability, responsiveness and whether the app delivers on its expected functionality. All the participants found the application to be functioning properly, according to their expectations. The researcher covered the transport costs for the participants, who had come from the wards to attend the feedback meeting.

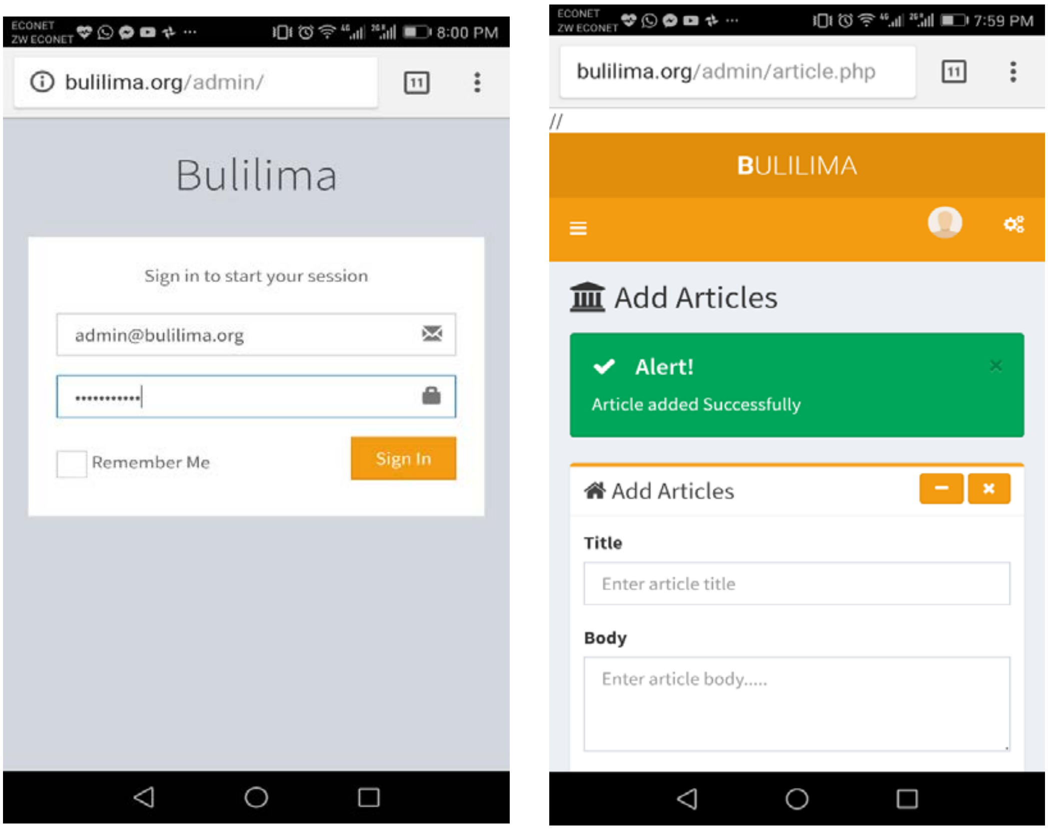

Figure 7.1: Domain expert administrator screen and posting an article

7.2 Pilot deployment

After the development of the application was completed, it was uploaded onto a website and team members, including research assistants, were contacted to download it so that they could undertake a final testing of the app. In some cases, they were supplied with data bundles to accomplish this, since most of them were unemployed and were unable to purchase data for this purpose. Participants were encouraged to familiarise themselves with the use of the application and most participants were eager to use it. At this stage, users were asked to test and ensure that the application was responsive and that it provided the required functionality without freezing or crashing. Users were asked to test if they could navigate through the different pages, access information and make comments on some of the articles. Users were also asked to check if they were able to access content when the network was erratic or when their phone had run out of credit.

7.3 Demographics of the participants evaluating the application

Five participants from the community and rural district council were recruited for the evaluation of the mobile phone application, who did not participate in the design iterations. They used the application for a week before evaluating the app using a questionnaire. The purpose of the evaluation was to collect empirical data from a segment of the target population regarding the usability of the application. Community members were composed of community knowledge workers and a domain expert. A retired agricultural extension officer served as the domain expert. All the participants had reached Secondary level education level, and were considered to be intensive users of mobile phone applications. One development worker from the rural district council participated, was very experienced in using mobile phone applications and understood broad concepts related to socioeconomic development. All the participants owned an Android smartphone and were provided with some airtime by the researcher. Users were asked to perform simple tasks which included going through all the categories of information, searching for information, reading the information posted as well as placing comments after reading an article. Participants were asked to move between these tasks randomly and thereafter completing a 14-item questionnaire shown in table 7.2. The questions that were asked were based on TAM2 and are shown in table 7.1. Participants were informed that the evaluation was voluntary.

Table 7.1: Demographics of the participants who evaluated the mobile phone application

Category	Participants	Avg Age	Avg Education level	Sex (M)	Sex (F)
Knowledge workers	3	23.5	Secondary level	1	2
Domain expert	1	66	College diploma	1	0
Social Development workers	1	28	Degree	0	1

7.4 Mobile application evaluation

Mobile application evaluation is still in its nascent stages, with very limited guidelines provided by the Nielsen Norman Group, (2016), HCI, ISO 9241-11 measuring usefulness, effectiveness, efficiency, learnability (Hussain & Mkpojiogu, 2015). To verify the contributions of the artefact in solving the stated problem, there is need to evaluate its utility (Hevner, March, Park, & Ram, 2004). Artefact evaluation can be naturalistic or artificial. Naturalistic investigates the utility of the artifact within a real environment under contextual factors, in this case in the rural community whereas artificial is centred on theory building (Sun & Kantor, 2006). Other scholars have noted that DSRM is outcome-based, proving the intended utility across contexts (Peffers, Tuunanen, & Niehaves, 2018). Through this naturalistic evaluation, knowledge about the artefact and the design processes is produced. The artefact was evaluated by subjecting it to experimentation in the field with real users and real data, as guided by the DSRM. Gregor and Hevner (2013) outlined an evaluation criteria which includes validity, utility, quality and efficacy. In this study, the evaluation was based on validity and utility. The main aim was to determine how the proposed solution could address the problem at hand and its limitations. Evaluation of the app can be absolute, that is whether the app achieves its set goals or can be relative that is, in the absence of similar artefacts (Prat, Comyn-Wattiau, & Akoka, 2014). The evaluation of this app was both absolute and relative. This evaluation was Ex post, as it evaluates an instantiated artefact, with Ex ante evaluation focusing on an un-instantiated artefact, which is in the form of a model or a design (Venable, Pries-Heje, & Baskerville, 2012). The instrument for evaluating the app was based on the adapted TAM2. Most apps that have been developed cover a specific subject area, but in the case of Bulilima, communities have limited and in some cases no access to traditional sources of information, therefore the app acts as an information access gateway. The usability of the artefact was measured through factors identified by the scholars Preece, Rogers and Sharp (2002), addressing the app's usability, utility, learnability and design. The advantage of using potential or target users is that it provides empirical real usage data, which in many cases is impossible for the developers of the system to perceive. The results of the evaluation phase allowed the researcher to decide about whether to go back to the previous activities to try to improve the effectiveness and utility of the artefact or recommend improvements for future work. The evaluations were done to assess the utility of the application, verify if its content was useful and also the general design and layout of the application.

The app was evaluated through asking questions related to ease of use and usefulness was provided, in line with TAM2. Some of the elements tested were adapted from a model developed by Harrison, Flood, and Duce (2013), measuring attributes such as functionality, simplicity, usability and design. A five-point Likert scale questionnaire, using levels of agreement ("strongly agree" to "strongly disagree") was employed to gather information from the group as a way of evaluating the mobile phone application. All of the questions are listed in table 7.2. The users were satisfied with the utility of the information provided by the app and were keen to continue to use it.

Table 7.2: Questionnaire questions for application evaluation

Number	Statement
1	If I have access to the mobile application, I intend to use it frequently.
2	During usage, the app did not crash or freeze
3	During my use of the mobile application, I found it easy to use and easy to remember.
4	The design of the graphics and menus is satisfactory
5	The app uses clear and simple navigation
6	I can use the mobile application without anyone's assistance.
7	I found the mobile application to be a useful tool in the community.
8	I intend to use the mobile application to access agricultural information.
9	I intend to use the mobile application for educational or learning purposes
10	I intend to use the mobile application for community mobilisation.
11	I intend to use the mobile application to access health information
12	I intend to use the mobile application for accessing news
13	How often would you want to use the mobile phone application?
14	I could access content even when the network was poor or when I did not have credit in my phone

7.5 Results

Potential users were asked to go through all the menus of the mobile phone application to try and access information and evaluate if this information was useful in fulfilling their day to day duties. The evaluation also sought to establish if users found it easy and simple to access information from the app. The overall result of the mobile phone application evaluation is shown in table 7.3. The average score was calculated for every question that was asked, as presented in table 7.2. To conclude, when communities can access socioeconomic development information, they can make informed decisions on issues that affect their day to day living. The objectives of the solution were achieved as the participants rated the application as useful, easy to learn, memorable and would encourage other members to use the application. This resonates with the work of Gregor and Hevner (2013) who pointed out that the results must be compared with the objectives. It is important to involve potential users in understanding their needs as this helps in developing applications which are very usable to them. From the baseline survey, it was clear that participants were willing to pay for airtime to access information that impacts their day to day life and this has a direct impact on adopting the mobile app. Following the

ISDM framework, UCD and DSR supports the involvement of the user in the design process, content creation and testing the application. The evaluation scores provide some indication on how the users perceive the system as usable and lower scores may require redesigning.

Table 7.3: Mobile Application evaluation scores

Number	Average score (out of 5)	Standard deviation
1	4.5385	0.66023
2	4.7084	0.47309
3	4.4615	0.51887
4	4.3486	0.65044
5	4.1078	0.83608
6	4.3077	0.48038
7	4.6154	0.50637
8	4.0769	0.75955
9	4.6154	0.50637
10	4.2308	0.82305
11	4.0769	0.86232
12	4.3077	0.75107
13	4.6923	0.48038
14	4.7084	0.47309

7.5.1 Functionality

A questionnaire was used to investigate the quality of the app on serving its purpose, through this statement and question: “During use the app did not freeze or crash”, a mean score was 4.7084 out of five. Other questions that measured functionality, “If I had access to the mobile application, I intend to use it” and “How often would you want to use the mobile phone application? The average score was 4.5385 out of five. The majority of the participants agreed that the application satisfied their information access needs. As shown in table 7.5 the scores for using the application for accessing community information, learning, mobilization, health information, news had a high mean score of 4.2615. This means that the participants viewed the app as very useful and functional. When participants were asked to evaluate the application’s ability to offer offline access or its usefulness when the user had run out of airtime or credit, a mean score of 4.7084 was recorded. Participants regarded this functionality a major utility factor.

7.5.2 Learnability

Through the questionnaire, the learnability of the application was investigated through this statement: "I can use the mobile application without anyone's assistance." From the responses, with an average score of 4.4615 out of five, it was evident that the app was very simple to use and easy to learn. It is important to develop applications which are very easy to learn for rural communities as the difficulty experienced in using a system maybe a barrier to its usefulness. The use of simple menus, consistent navigation, categorizing of information as well as use of descriptive icons aided learnability.

7.5.3 Usability

The next evaluation focused on the usefulness and utility of the mobile application, through a series of questions that focused on each category of information that it provided. With an average score of 4.3205 out of five, it became evident that the participants found it useful in providing access to socioeconomic development information relating to the community. An average score of 4.7084 out of five, was recorded when participants were asked to rate the application in allowing them to access content when their phones had run out of credit or when the network was erratic. This in an important function for communities with low bandwidth as well as low economic activities.

7.5.4 Design elements

Developing applications for rural areas require design of simple, yet intuitive menus and icons. These applications must have a short learning curve. Participants assessed the mobile phone application, by evaluating the placing of elements, organisation and flow of information, visual appeal of the icons used, and navigation options. Participants highlighted that the application was easy to navigate, and information was categorised to facilitate easy and faster location of relevant content. A mean score of 4.3486 was recorded for the clarity of the graphics and simplicity of the menus. Navigation is an important element of good design and a mean score of 4.1078 was recorded, meaning users could easily find their way around the app. These results indicate that the application was usable.

7.6 Communicating the artefact

The researcher attended two international conferences in Kenya and France, as highlighted in section 4.4.7. There he made presentations that highlighted the current problem faced by rural communities in Zimbabwe and Africa at large. The presentation explained how the artefact could enhance access to socioeconomic information in rural Zimbabwe and narrow the digital divide. Positive audience feedback occurred, suggesting that the app be commercialised, and a discussion was held on how to ensure that the application was sustainable.

7.7 Limitations

It was difficult to establish a larger sample size from the community, for integration into the development team. The participants who were recruited to evaluate the mobile app were unemployed and the researcher had to pay for the transport costs. In some cases, he had to provide airtime to allow them to download the application into their phone for testing and evaluation purposes. Only post-evaluation was conducted and more comprehensive results could have been attained if pre-evaluation had been performed.

7.8 Lessons learned from developing applications for rural communities

Rural communities have unique characteristics, such as limited power to charge their phones, lower digital literacy levels and limited income to purchase data. Integration of the ISDM, DSR and TAM in developing this mobile application was intriguing. Providing local and relevant content for rural communities is an important element in the development of mobile applications and this is achieved through the involvement of communities in terms of provision of content for the app. For this application, a local expert was chosen to act as a moderator/domain expert and gatekeeper for each category of information. The expert determines the content for the application. Through user feedback, the mobile application was designed in such a way that once an article is opened, it is downloaded into the phone for offline use. Usability of rural information systems can be increased through involving users in the entire development process and offering interactivity where readers can leave comments after reading an article. The interfaces are also driven by information accessibility and simplicity, and the app utilises low-resolution graphics, to ensure that it does not use a great deal of data. Its graphics were designed for extensibility and adaptability, depending on the resolution of the target phone. The English descriptions used on the app are, in general, simple and easy to comprehend and are based on the results of the survey that revealed that all participants had attended school and could read and write. In the future, the app will have a feature to translate English into the local language.

7.9 Contributions to Design Science Research theory

This research produced a socio-technical artefact to solve community problems and its presentation is different from computer science or engineering artefacts which are driven by theory and models (Niederman and March 2012). Scholars have come with two divergent views, with some asserting that DSR is theory driven (Gregor and Hevnor 2013) while others view it as pragmatic (March and Smith 1995; Gerfalk, 2010). Pragmatist regard the utility of the artefact in a particular context while the theorists pay attention to abstractions and theories that are developed to solve related problems in a particular domain. The study is more pragmatic. The pragamatist contend that the instatiation of the artefact is the major contribution to knowledge through its incremental iterative development process which incorporate user feedback to improve functionality and must be evaluated (Weber, 2012). In this study the focus was instatiating an artefact and therefore there was less theory compared to studies that focus on building abstract theories for building future artefacts. The knowledge contributions for this research falls in the exaptation quadrant of a "high maturity of solution but low maturity of application" as posited by Gregor and Hevnor (2013), and supported by some other scholars Venable, Pries-Heje, & Baskerville, (2012) and Woo, Saghafi, & Rosales, (2014). In their analyis Gregor and Hevnor (2013) highlighted that the knowledge contributions of a DSR project has different levels, from developing an artefact to solve an existing problem to specifying abstract theories which can be applied to develop generic artefacts. The design iterations that were followed in this study provide empirical knoweldge on developing applications for rural areas and can be used to guide similar studies.

In reviewing some DSRM literature, Peffers, Tuunanen, & Niehaves, (2018) noted a number of articles which were weak on theory generation but very solid on the technical bases for designing and developing the artefact. Other scholars have concluded that contributions to the knowledge base are provided through the utility and the effectiveness of the artefact in solving specific user problems, its ease of use and simplicity (Hevner, March, Park, & Ram, 2004; March & Smith, 1995). Evaluation results have proved the utility, simplicity and ease of use of this application. Other scholars have noted that the evaluation results add new knowledge as they can inform the development of similar artefacts (Baskerville, 2008). Through prototype evaluation, new knowledge on the identified problem is generated by incorporating user feedback which improves the design of the artefact (Hevner, March, Park, & Ram, 2004).

The study followed the ISDM guidelines to develop a mobile phone application based on the sociotechnical attributes of the community. The ISDM framework was developed based on many theories related to development of information systems for rural communities. In my research, the ISDM was adapted to fit into the socio-technical environment in Bulilima. The design guidelines followed here can be used for developing community-based applications for enhancing information access. The artefact was also created by combining principles of user centred design and usability principles in a rural context. Through artefact evaluation and feedback information can be used to further improve the functionality of the artefact and enhance its utility in rural communities. Niederman and March (2012) concurred that the building of the artefact as well its evaluation for utility are contributions to design science research theory in Information Systems. This approach can be used to guide the implementation of similar interventions where mobile phone applications are designed to enhance access to information.

The novelty of the artefact lies not in the processes that construct it, but rather in its creative design and unique ability to solve the challenge of information access in rural communities. The ability of the application to download information into the phone's local storage for offline use is one adaptation for an application developed for low bandwidth environments. This is a general design theory which may be applied in developing systems for rural communities (Schimidt-Rauch & Schwabe, 2011). Another contribution made by this research is the evaluation results which future researchers can use to improve similar artefacts. The results revealed that users found the app easy to learn, as they did not require any significant assistance during evaluation tests and the app performed as per the expectations of the user. The mobile app can be deployed within any rural community with the same socioeconomic and information access challenges.

7.9.1 Conclusion

This section shows how the utility of the app was demonstrated and evaluated by the potential users. Four members were recruited to evaluate the utility of the artefact by installing it on their Android phones. The researcher solicited information for evaluating the functionality of the prototype against the set objectives. Participants were asked to test and evaluate its usability and usefulness using a questionnaire. Participants revealed that the application offered more realistic and economic means of accessing information such as market prices, national news and health information among others. The usability of the app was also demonstrated by having domain experts creating articles for posting on the app via the website. The feedback from users was positive, with all the participants expressing satisfaction regarding the utility of the mobile phone application. Community members revealed that the app would be a superior tool for communication and access to information if it was deployed in rural areas. The results of the evaluation reveal great potential for the adoption of this application to provide information access to the rural communities of Zimbabwe and beyond.

Chapter 8: Conclusion

8.1 Introduction

The impact of mobile phones on humanity has surpassed that of any other prior communication technologies, including the television, fixed landline phone and the computer. By 2015, the number of unique mobile phone subscriptions grew to over 5.7 billion, while the number of active sim cards surpassed eight billion (GSMA, 2016). This growth will continue steadily. The advent of the internet has ushered in new possibilities on how communities can access and share information, as well as made an impact on economic activities. In the global south, mobile phones have emerged as a panacea for overcoming communication and information access challenges in rural communities (who are mostly marginalised and living in remote areas), thereby enhancing socioeconomic development. Access to information has to be backed by provision of other basic services to truly transform the lives of local communities.

As highlighted in chapter one, internet access, in general, will not spur socioeconomic development in the global south unless content is localised and, in some cases, made available in local languages. Mobile phone applications provide tremendous financial opportunities for developing countries, as witnessed by the more than 140 billion application downloads that have generated over $77 billion globally, and it is predicted that payments made through mobile phone apps will surpass $721 billion globally by end of 2017 (Business 2 Community, 2017). Developing countries have a small share of global app revenue at present, but the development of this app will help to inculcate a culture of mobile phone app use, thus helping to grow market share.

The United Nations has declared access to online content without restriction and the availability of supporting infrastructure for internet access as a basic human right (UN, 2011). The mobile phone has enormous impact on the SDGs that address infrastructure expansion, financial inclusion, gender equality and access to information related to health and agriculture (GSMA, 2017). The influence of the mobile phone on humanity has been exceptional, therefore, it is important to develop applications that can provide rural communities with opportunities to improve their standards of living and reduce poverty. Research has also revealed a need to develop services and products to extend the socioeconomic impact of the mobile phone to consumers in developing countries (GSMA, 2017). These factors motivated the researcher to engage in this study, which culminated in the design a mobile phone application to enhance access to socioeconomic information in the rural districts of Zimbabwe.

Scholars have contended that in some developing countries, it would be better to repurpose technologies, rather than hope that they could create new technological innovations (Ray & Kuriyan, 2011). The thrust of this research is in extending the use of mobile phone applications to cover information access gaps in rural communities. The study also sought to establish factors that inhibited adoption and use of ICTs in rural areas. Over the years, it has become clear that governments alone cannot fulfil the needs of their populace and, therefore, the private sector, development agencies and scholars must intervene to offer solutions. This chapter provides: concluding remarks on the work undertaken for this study and a section on its limitations; contributions to the body of knowledge; answers to research questions based on data collected; and recommendations and directions for future work.

8.2 Purpose of the Study

Rural communities in developing countries are faced with many challenges, among them lack of access to socioeconomic information, which prevents them making informed decisions that impact upon their economic and social well-being**.** One objective of the study was to develop a mobile phone application to enhance access to socioeconomic information in rural communities of Zimbabwe. This study provided an innovative way of enhancing access to information in rural communities and during the study, no other researcher had conducted any related work in Zimbabwe. The research was motivated by the scholars Burrell and Matovu (2008), who argued that there was a need to provide rural communities with information, so that its members could access and act upon messages, and therefore make informed decisions. The study sought to investigate factors that affect ICT adoption in rural areas, and determine if rural communities were aware of opportunities that mobile phones could provide in enhancing access to socioeconomic information. The researcher presented the results of the data analysis through tables and figures, with the results revealing that the mobile phone is now a more important device than those used for accessing traditional media, such as radio and television. Factors including cost and language are no longer considered important determinants of ICT adoption in rural areas, as previously reported in other studies. The results also reveal that the community is not fully aware of some of the benefits and services of mobile phone apps, as revealed by usage trends.

8.3 Revisiting the study

The research shows how DSR, ISDM and UCD can be used to guide the development of an artefact that addresses information access in rural communities. At the core of the DSRM and ISDM is the iterative development of an artefact and this was accomplished through the design of a mobile phone application to enhance access to socioeconomic information in the rural communities of Zimbabwe. To achieve the purpose of the study, quantitative data was analysed from 150 questionnaires sent to schools, clinics, government departments, religious organisations and local villages in the Bulilima district. It assisted in formulating the requirements for the system. A sample of participants from the community was selected for designing and evaluating the mobile phone application prototype. TAM2 was adapted for this study to include variables important to determining technology adoption in rural areas, such as simplicity, cost and effectiveness. Rural communities will use the mobile phone applications if they believe their attributes are simple, effective and inexpensive.

Research was conducted in two phases. The first involved the solicitation of information, through the administration and analysis of a questionnaire, to determine usage trends, factors that inhibited or promoted the use of ICTs and usage trajectories. The second part concerned the development of a mobile phone application and, through the process, also established issues critical to the building of mobile phone applications for rural communities. The study sought to establish issues that affected the adoption and use of mobile phones and other ICTs in the rural communities of Zimbabwe. It further established whether rural communities were aware of the opportunities that these phones and their applications could afford to socioeconomic information and development.

Chapter five provided insight into the sample, the data gathering process and how the analysis was undertaken. From the findings, it is important for the government and other developmental agencies to consider the information needs of rural communities and package it, so that rural communities will find it useful in meeting their day-to-day needs. The results of that chapter helped in formulating the requirements for the artefact.

Chapter six of this study presented the work undertaken to develop the mobile phone, the methodology used and the evaluation of the final prototype. Due to experience gained by the researcher, it was considered critical to assess rural information gaps and needs before any solution was proposed. The design of the mobile phone application – guided by DSRM, developed by Peffers, Tuunanen, Rothenberger and Chatterje (2008) – allowed users to test the prototype at every stage of its development, as well as propose new functionalities and information to be added on the prototype. Following the DSRM also ensured easy acceptance of the proposed solution and that it met the needs of the target community. An advantage of involving potential users at every stage of the development was that it improved upon user acceptance of the system.

The development of the mobile phone application followed the DSRM methodology. Key features included:

i. Taking an initial step to identify the problem and situate it within its environment. This was done through the baseline survey and was further confirmed by participants during the design iterations. The main problem was limited access to socioeconomic information, due to lack of access to radio and television signals in most rural communities of Zimbabwe. In addition, criteria used in the evaluation of the prototype were presented.

ii. Through examining the feasibility of the proposed solution, the objectives of the solution were crafted, highlighting how the proposed solution would address the main problem.

iii. The development of the artefact to solve the stated problem was undertaken at this stage. This involved designing the backend, frontend and user interfaces, through an iterative process relying on user involvement. Using an iterative design process enabled the researcher to acquire rich user feedback and this helped to refine user requirements.

iv. The utility of the app was tested when it was installed on a few of the selected community members' mobile phones. The idea was to allow members to operate the application in a natural environment, so that the researcher could demonstrate how the artefact was able to solve the stated problem.

v. Through a field study, the prototype's utility was evaluated against set objectives, to determine what contributions the artefact would bring to the problem domain and technological solutions brought to society or organisations. Some evaluation metrics proposed by Hevner and Chattejee (2010) include functionality, completeness, accuracy, usability and reliability.

vi. The researcher presented two conference papers communicating the magnitude of the problem, as well as presenting a proposed solution. The first conference was the

Africa Internet Summit held in Nairobi, Kenya, and the second was the second Artem conference on creativity, innovation and sustainability, held in Nancy, France. Results will also be made available to the local community, development agencies and local government, as well as through a publication.

The DSRM allows the researcher to address a problem, beginning with any activity. If a problem is well documented, he or she can begin with the design of a solution, which is the third activity, or the researcher may prove that an existing solution could be adapted to solve another problem (Peffers et al., 2006).

8.4 Fulfilment of Research Objectives

The mobile phone has been integrated into our daily lives, influencing every sphere, and this potential must be harnessed to solve challenges that rural communities face through innovative and creative ways of reconfiguring technology to meet their needs. The main objective of the study was to develop a mobile phone application to enhance access to socioeconomic information in the rural districts of Zimbabwe. This research objective, concerning the process of developing the app, was achieved and this was explained in chapter six. The other research objectives, relating to the use of mobile phones in rural areas, hindrances to adoption and use of ICTs, were fulfilled through the results of data analysis in chapter four. The study was motivated by the assertion by CNN (2011) that the mobile phone was a powerful weapon for fighting global poverty and that it was the most disruptive and transformative technology for development in Africa.

8.5 Responding to the Research Questions

Four research questions, crafted in chapter one, were used to guide the study and in this section, an overview of how the researcher answered each research question using the results of the data analysis is presented. The success of this study was also demonstrated through an evaluation of the extent to which the artefact addressed the stated problem.

8.5.1 Research question one

What are the development processes and methodologies considered when developing mobile applications for rural communities?

ISDM was used to guide the design process, ensuring that the needs of the users are properly met and users are satisfied, by considering the socio-technical environment of the community. A user-centred approach was followed in the design of the mobile application, whereby users were consulted throughout the development process and feedback was employed to refine the requirements. These two fitted well with the chosen methodology, the DSRM, where design iterations were held with the potential users. The feedback from these iterations were used to refine the requirements and the design. The advantage of following these approaches was that they helped to integrate the needs of the user and their experience in the development of the proposed solution. The design and development of the mobile phone application followed the DSRM, from the identification of the problem, its situation within its environment and the communication of the artefact to the community and other professional bodies. Three design iterations were conducted, after each instantiation of the prototype, the design, content and functionality were refined.

A Slim framework was used in the implementation of this project through the Model View Controller (MVC) architecture. MVC allows the developer to develop extensible projects through splitting it into three components – the model, view and component. Designing mobile apps for a target population which has less experience in digital technology requires simple menus which ensure usability and a simplified layout used to facilitate easy of accessing content. Common, consistent, easy and basic navigation was used to allow the community to easily navigate through the application. Providing high contrast between the foreground and background is important to ensure that the text is readable, in this design a plain background was used. During the design iterations, potential users highlighted that there was need to limit the use of text and as well as small font sizes. The application must not demand a lot of cognitive effort in learning how to use it, as this may negatively impact usability.

8.5.2 Research question two

How are communities utilising improved mobile phone coverage to access socioeconomic development information in rural communities??

Mobile phone ownership has remarkably increased in the rural communities, as the study revealed that 95% of respondents owned a mobile phone, while zero percent owned a fixed telephone landline. Before the advent of mobile signals in the ward, communication was difficult, as participants had to travel to convey messages. In this regard, 82.2% of participants agreed that the mobile phone had lowered communication costs. From the results, 78.2% of the recipients strongly agreed that they felt secure because of the presence of a mobile phone signal in the ward. A Pearson correlation of 0.83 was observed between mobile phone ownership and participants feeling safer, signifying a strong relationship. Baboo, Pandian, Prasad and Rao (2013) concluded that individuals would want to communicate and be in touch with their families. With regard to accessing agricultural information, 58% strongly agreed that the mobile phone had improved access, while another 62.4% strongly agreed that they could now access educational material. The findings augment the work achieved by Kim, et al. (2011), who posited that the mobile phone could offer rural communities more utility in supporting socioeconomic development.

8.5.3 Research question three

What are the main issues that communities face in the uptake and use of ICTs in the rural communities of Zimbabwe?

From the analysis, participants did not agree that the use of English language on the mobile phone applications was a hindrance to ICT uptake and this was supported by 71.3% of the sample. A Spearman correlation, performed to establish the relationship between English language and ICT uptake, recorded a strong relationship with a positive value of 0.801. This was contrary to studies by Jiyane and Mostert (2010), and Islam and Gronlund (2010), who concluded that the use of the English language was a deterrent to mobile phone usage. With regard to costs, 76.2% of the population disagreed that the cost of communication was a deterrent towards usage of ICTs. This was in line with a 2012 World Bank report indicating that farmers were willing to pay to access the information they needed, and survey findings by Baro and Endouware (2013), which revealed that 93.4% of the population did not consider the costs of mobile phone as a hindrance to usage. About 45.4% of participants agreed that cultural issues could be a hindrance to ICT usage, while 54.2% disagreed. Lack of electricity supply is no longer a major issue, as 76.2% of the participants disagreed, while 23.8% highlighted that lack of electrical power supply affected adoption. The main issue negatively affecting mobile phone usage in rural areas is a weak signal, as indicated by 63.3% of participants, who indicated that the infrastructure was inadequate.

8.5.4 Research question four

What is the impact of the instantiated artefact??

The mobile phone application was evaluated to measure the impact and obtain empirical knowledge on how representatives of the target population perceived its utility. Five potential users were recruited for this exercise who included three community knowledge workers, domain expert and rural development officer. The mobile application was evaluated based on the TAM2 model which was adapted for a rural community. A questionnaire with 14 questions that measured the utility of the application through a Likert scale was developed and administered.

The application was evaluated for user satisfaction, learnability, usability and design. The majority of the participants agreed that the app provided the required utility and was easy to use as per the mean and standard deviation scores in table 7.5. Better results regarding the impact of the application could have been obtained if a pre-evaluation of the community information needs was done and compared to the post-evaluation when information had been provided through the application.

8.6 Process Development

The development of the mobile phone application began with an analysis of the development processes for Android-based applications and design principles such as usability, aesthetics and functionality. ISDM and UCD, were used to guide the design process, ensuring that the needs of the user are properly met and users are satisfied, with regard to their focus on goals and motivation during the design process. DSRM allows the researcher to convert ideas into real prototypes, which are refined through iterative steps that involve user feedback. During the design of the app, participation was critical as it allowed the involvement of community members in the process, from the initial paper sketch prototypes to the development of the final prototype through iterations. Three main iterations were involved, from the initial paper-based prototype to the final version. It was important to involve the user in the early stages of the development, as this helped to align the researcher's views to the user requirements. It also helped while conducting early usability tests. Each stage of the iterative process involved obtaining feedback from the user, which was then used to improve and refine the prototype. The final iteration resulted in an improved version of the application, which was presented to the users, and their evaluation feedback allowed the researcher to implement key functionalities. The advantage of participatory design is that it reduces development time, increases acceptance and users feel a sense of ownership over the artefact. After releasing the final prototype, the selected users were asked to evaluate the mobile phone through a Likert-scale questionnaire.

Mobile phone application design considers navigation an important design element, which can affect its utilisation. Therefore, a very simple and intuitive navigation system was employed in the app development, to help users locate information quickly (Reza, 2005). This was consistent with work done by Griffiths (2015), who concluded that navigation systems for applications deployed in rural communities should be simple, visible, logical and consistent. The app was further designed to foster a good user experience by providing a look and feel that built positive initial perceptions. Consistency was also considered, in order to ensure the harmony of design elements. During the study, some of the standards developed by ISO/IEC 9126-1 were applied to the app, where five different attributes – understandability, learnability, operability, attractiveness and usability – were incorporated into the design. The mobile phone application's home screen acts as the index page, which must provide visual cues to the main functions of the application and, from this screen, all of the other major pages can be accessed (Griffiths, 2015).

After consideration of all the design attributes, the researcher started compiling functional and non-functional requirements for the app. Non-functional requirements describe certain characteristics to be demonstrated by the system, such as scalability, usability, maintainability and reliability (Sommerville, 2009; Wiegers, 2003). Functional requirements are explicit statements about services that should be provided by a system and were refined and concluded during design iterations. To demonstrate how the different elements in the system would interact, the researcher used use cases. The mobile phone application was developed using the Android system, while a web-based interface was built using PHP. The purpose of having a web interface is to allow domain experts to manage the creation and publication of articles. The system administrator can also create categories for articles, add a new category and perform general maintenance. The mobile application was written with JAVA, through the Android's software Development Kit for the Dalvik Executable (.dex) format, which is optimised for minimal memory and battery usage (Muir, 2015). Other programming tools utilised were Javascript, with Slim and Volley for the core libraries. The database was designed using MySQL, where articles were stored, accessed and retrieved using RESTful web services, using unique URIs (Tamada, 2014). After testing the final mobile phone application prototype, the researcher deployed it onto the website http://www.bulilima.org to allow community members download and install on their mobile phones.

Quantitative data was then employed to evaluate the prototype for its usefulness, satisfaction, design and learnability. The study followed recommendations by Preece, Rogers and Sharp (2002) that a mobile application should be evaluated for its effectiveness, utility, learnability and memorability. The results were highly positive, with 91% of participants satisfied with the utility of the mobile phone, while 89% indicated that it was easy to learn and 86.4% regarded the app as useful. Overally, the participants found the application useful for enhancing access to socioeconomic information in the rural communities of Zimbabwe. Through their observations, they found the application simple to use, highly useful and would use it if it were deployed in their community.

8.7 Research contribution

The major output of this research was the development of a mobile phone application for use in rural communities with limited access to socioeconomic information, due to the unavailability of traditional information dissemination media. This research adopted a naturalistic view of the DSRM where an artefact is developed, instantiated and evaluated within a natural environment. Peffers et al., (2008) highlighted that the research contribution of a DSRM study is embedded in the design and development of the artefact. The knowledge contributions for this research falls in the high maturity of solution but low maturity of application domain. An iterative design process was used to refine the prototype, at each iteration, new knowledge relating to improving the functionality was obtained through user feedback. This knowledge gained can be applied in designing similar applications for use in rural areas. The evaluation results provide empirical evidence on the potential impact of the app once deployed, with users revealing that the system was easy to learn, usable and its aesthetics were pleasing to potential users. One unique feature which sets the app apart from others is its ability to automatically download content into the mobile phone's internal storage so that users can still access content when offline. Once a connection has been established or the user has credited their phone with airtime the app allows content to be synchronised. The app also allows the community to actively participate in the generation of content that goes into the app. Readers are allowed to comment on an article they would have read, this provides bidirectional flow of information and this can improve the app and determine future topics. Communities can also market their products on the app and this improves sustainability.

This research adds more empirical evidence to the growth and use of the DSRM in developing countries. An adapted TAM2 was used to guide the data collection process, this model could be further subjected to statistical rigour for its validation. Empirical data revealed that rural communities preferred mobile phones over the more traditional forms of information dissemination, such as radio and television. Rural ownership of ICTs has revealed glaring differences between radio and mobile phones, with 95% of the population owning a mobile phone, compared to 17% who possessed a radio and 0% who had a fixed telephone landline. Unlike many communities in Africa where the use of English language was a hindrance, in this study, 65% of the participants were comfortable with the use of English language on the app.

Mobile phones are becoming highly popular in rural areas and, as such, MNO must invest in these areas, in order to help improve their infrastructure. These findings help to provide evidence on the state of affairs in the rural communities of Bulilima, as far as mobile phone use and adoption is concerned. At this point, the researcher has not found any research that relates to the use of mobile phone apps for enhancing access to socioeconomic information in Zimbabwe and this study will therefore add knowledge to this domain.

8.8 Infrastructure consideration

From the results of the survey, it is evident that rural areas lag behind in terms of infrastructure to support their socioeconomic development initiatives. From the results of the survey, 63.6% of the respondents indicated that the infrastructure was inadequate and thereby fueling digital exclusion. The network infrastructure is characterised by limited and variable bandwidth which is an obstacle for deploying applications. The results also buttress the notion that government alone cannot institute meaningful development and there is need for private players to invest in network infrastructure to extend coverage even to the most remote areas. The establishment of the USF has not transformed the fortunes of rural communities, mainly due to the abuse of funds. This confirms research revealing that these funds in Zimbabwe were not being allocated appropriately, but were being used to fund drug procurement and shore up the other financial obligations of the state (GSMA, 2014; POTRAZ, 2015). There is the need to ensure that the USF is used to deploy and strengthen ICT infrastructure in rural areas, to serve these populations. The government must incorporate rural ICT infrastructure development in its core plans, so that these communities are freed from isolation and marginalisation. The Zimbabwean national ICT policy also recognises the lack of high-speed broadband coverage in rural areas, due to the non-transparent utilisation of the USF (TechZim, 2015). Improving connectivity in rural areas has the potential to spur socioeconomic development, as highlighted in chapter one. The government could provide subsidise or reduce taxation for companies that directly target the marginalised in infrastructure roll-out and expansion. The telecommunications sector is highly taxed and over-protected and, as reported in chapter one, this has stunted its growth in Zimbabwe. These concerns were noted by Dancombe (2014), who highlighted that taxation regimes in many developing countries had a negative and regressive effect on the growth of the sector – unless these monies were reinvested in projects to improve the industry. There is therefore the need to craft policies to improve the regulation of this sector, encourage the entry of new players and offer competitive prices.

The following issues were noted:

i. There must be strong links between rural communities, mobile network operators, farmer organisations, development agencies and local government to ensure adoption and use of ICTs.
ii. Establish policies to address infrastructure inadequacy in rural areas, with incentives offered to organisations that deploy infrastructure in rural areas, through strategies such as Public-Private Partnerships.
iii. Development organisations, government and rural communities must be encouraged to spearhead ICT adoption.
iv. Transparency must be ensured concerning the distribution and use of funds raised through the USF.

Once the infrastructure is in place, there is the need to establish innovation hubs and allocate funds for local start-ups to develop applications to foster rural development. Rural communities must also be made aware of the opportunities provided by apps so that they can utilise these and thereby narrow the digital divide.

Data costs remain prohibitive in the developing world, as studies reveal that the average cost of 1GB is 35 times more expensive than it is, for instance, in North America (Alliance for affordable internet, 2017). These costs could be prohibitive in rural areas. There is the need to engage in strategies that can result in a reduction of the cost of data in Africa, such as negotiating with mobile network operators for special rates for vulnerable populations and partnerships with developmental agencies to subsidise data costs in rural areas. One major design consideration for this application was to ensure that content is automatically downloaded into the mobile application when a connection is established. During offline mode, due to erratic connections or when the user has no credit, community members can still access content and this can help save them air time.

From a study carried out by the World Bank (2012), covering more than 90 mobile phone applications, only 15% could generate revenue to sustain themselves, with 85% surviving on government and donor organisation subsidies. To ensure the sustainability of this application, there is the need to partner with other organisations and government. Once users start to benefit from the use of the application, income could be derived through advertising. There was considerable debate over sustainability of the app, once further improvements were made, users would have to pay to access some of the utilities. This would ensure the sustainability of the application. Organisations involved in community work could be asked to pay for advertisements placed on the app. This money could be used to pay content creators as a way of motivating them.

8.9 Limitation of the study

The mobile phone application prototype was designed to enhance access to socioeconomic information in rural areas. The findings reveal that the involvement of the community members in generation of content increase the usage and acceptance of the mobile application. To deploy the application for commercial purposes in the community, there will be need to set up local level structures for content development as well as subjecting the application to more rigorous evaluation through experts, but its potential has been demonstrated through evaluations in the previous chapter. The use of the DSRM meant that more time was devoted to the development of the mobile phone prototype and less on the evaluation of the mobile phone application. The selected wards in Bulilima district are 178km away from Bulawayo, with an approximate 79-kilometre stretch of road that was inaccessible and difficult to drive with a vehicle unsuited to all terrains. This limited the number of iterations in this study to three. Ideally, five iterations would have been adequate. There is a need to conduct pre- deployment survey and perform a longitudinal study after deployment that test the utility of the app over a longer period of time to have a clear picture on the utilisation of the app. Mobile phone operating system market share statistics favour Android for the Zimbabwean market, but the researcher experienced challenges attempting to get people who lived outside the country to test the application, as they used iOS. Currently, it is impossible to place the application in an app store and google store, as Zimbabweans will not be able to afford it or, if they were able to, download it, due to a ban on all external payments by the Reserve Bank of Zimbabwe.

The main spoken language in Bulilima district is Kalanga and there is the need to translate the questionnaire into this language. The researcher experienced challenges, with some of the technical words relating to ICTs not being available in the local language. Only a handful of respondents preferred a Kalanga questionnaire, as the language was more difficult to read than to speak. Some questionnaires contained a few unanswered questions and only two of the forms could not be used for the study. Certain statistical evaluations were limited by the design of the questionnaire. For example, it was not easy to test the adapted TAM2 model, as it was impossible to solicit for information on the actual usage of the system from the original sample of 101 participants.

In adapting the TAM2, there is no guarantee that all of the possible factors relating to ICT adoption in rural areas have been exhausted and comprehensively covered, therefore, appropriate tests may be implemented to validate each construct. TAM has been used to measure technology acceptance, mainly in formal organisations, and has limited application in a communal setup such as Bulilima. The second questionnaire, to solicit information on the actual usage of the mobile application, had five participants and this made it difficult to perform significant statistical evaluations with a high degree of generalisability. In the future, there will be the need to engage a larger sample, so that the results can be more applicable and further statistical tests could be applied. Due to financial constraints and time limitations, the study used questionnaires as the sole data gathering tool, however, future studies could use in-depth interviews and observations. The current economic meltdown made it difficult to organise a stakeholders' meeting to present the prototype to the local community, local government and developing partners. This was unfortunate, as it would have provided the researcher with a chance to evaluate the application through a broader audience. The mobile phone application was designed to take up a small amount of space, as mobiles have limited internal storage capacity, small screen sizes and their batteries require constant recharging.

Interventions such as this app will not single-handedly solve problems faced by rural communities, therefore, government and other development partners should provide other basic services to help improve living standards in rural communities in a sustainable manner.

8.10 Reflection

The literature review chapter was critical in guiding the research through choosing the methodology, data elicitation methods and analysis strategies. At the core of designing mobile phone applications for rural communities is the addressing of information gaps relating to their socioeconomic activities. The purpose of the application is to provide access for rural dwellers to community activities, local and national news, health, education and economic information. The engagement with the potential users was intense, from refining the perceived problem, developing the mobile phone application and finally evaluating the artefact. Using low-fidelity prototypes made it easy to refine the initial ideas, through integration with the input from the communities, and this precipitated into the actual development of the mobile phone application. The process of working with the DSRM was intriguing and translating ideas into low-level prototypes, developing the application through user feedback and finally testing the final prototype was a great experience. One observation made by the researcher was that the provision of access to information without the existence of other essential services might not be enough to change the living standards of rural communities in a significant way, so there is the need for government and development agencies to bring services to the people.

8.11 Future work

This application can be deployed in any rural community experiencing the same socioeconomic constraints as those of Bulilima, although there is room to improve the design, functionality and usability of the prototype so that it can meet the testing rigour that other commercial applications undergo that have been deployed in rural communities. This application has the potential to narrow the digital divide by providing rural communities with a platform to enhance access to socioeconomic information affecting their day-to-day lives. The mobile phone application could be improved through further consultation, to obtain more input from a variety of potential users, as this will enhance the system's functionality and usability. The application could also be integrated with other government systems, such as the Central Registry, so that rural communities could access and apply for important documents through their mobile phones, without having to travel hundreds of kilometres. In the future, there will be the need to redesign the application so that it is platform independent, to accommodate as many possible users. There is also the need to consider integrating the mobile application with other features, such as interactive voice response (IVR) systems. When the data signal is erratic, rural communities can benefit from IVR, accessing health, educational, agricultural and other information when they dial a number and press a particular key – for example, pressing one and listening to a message on the weather forecast. The mobile phone application could be integrated with an-SMS based system so that when a data signal is weak or unavailable, rural communities could still access some information via SMS messaging.

While the research team was distributing questionnaires, it was noted that clinics were using paper forms to admit patients. This, however, makes it difficult to monitor patients' previous treatment history. It would therefore be advantageous to integrate an individual's medical records and store them on the patient's phone, through means of the app. Voter registration and census-taking are labour-intensive as data-gathering activities require enumarators to access every household. However, through mobile phones, this information can be easily provided to central government without huge human resources costs. This functionality could be integrated into the application.

8.12 Conclusion

Advances in mobile phone design have allowed these devices, once merely used for communication, to be multi-purpose with the capability to solve some of humanity's many problems. Rural communities remain marginalised in terms of communication and information access, due to lack of infrastructure, and there is the need to be innovative and utilise emerging technologies to improve their livelihoods. Rural communities in developing countries face many challenges, such as lack of access to electrical power and poor roads, and this research established that fixed landline telephone penetration in Bulilima was 0%, while that of the computer or laptop was nine percent. However, mobile phone ownership in rural areas has increased to over 95%, thereby providing new opportunities for information access and communication in the rural districts of Zimbabwe. While the government has begun to introduce some of its services online, many rural communities still lack digital skills. Therefore, the development of this mobile application attempts to increase the digital footprint of these isolated communities.

DSRM was used to guide the development of the mobile application through a user-centred approach, where feedback from users helped to refine the application, so that the final prototype could be employed to address information access challenges in the Bulilima district. Mobile phone applications provide a creative and innovative way of packaging information for rural communities, which helps to narrow the digital divide and enhance access to information, resulting in socioeconomic development. The successful development of the mobile phone prototype allowed the researcher to present a paper at the Africa Internet Summit held in Nairobi, Kenya, in May 2017, and at the second Artem conference in Nancy, France, in September 2017. The researcher presented an innovative and creative mobile phone application that provides localised information to rural communities, thus impacting upon their day-to-day living. The research results will also be communicated to the local community, development agencies and local government, as well as through a publication.

One distinct advantage of this app is that it allows communities to actively participate in the creation of content. Communities can also market their products on the app and this improves sustainability. Rural communities suffer financial losses through lack of access to market information, as well as exploitation by middlemen, who thrive on profiteering. Mobile phone applications could therefore be used to provide instant access to market information. The poor doctor-to-patient ratio in Zimbabwe has resulted in people dying and suffering from preventable diseases, due to lack of access to vital information and, therefore, the Bulilima mobile phone application could be used to provide information to reduce the outbreak of disease in rural areas by managing it and, further, improve patients’ adherence to medication.

The app prototype will require improvements, in order that it be adapted to other communities with similar socioeconomic environments in Zimbabwe and other developing countries. Information sharing in rural areas is usually through folklore and oral traditions and this limits access to a particular location yet the mobile app could allow information access beyond geographic boundaries.

The study has demonstrated the implementation and evaluation of the mobile phone application, which could have a transformational effect on communities. The research also provided empirical evidence on the mobile phone usage trajectory in rural areas, analysed factors that affected adoption as well as highlighted issues concerning awareness of the potential of these devices. The scalability of the proposed solution must be considered, in order to provide rural communities with the opportunity to access real information that will affect their livelihoods, resulting in improved standards of life.

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APPENDIX 1: Questionnaire

1. DEMOGRAPHIC DATA

1.1 Village Name ____

1.2 Gender _______________

1.3 Ward ____

1.4 Age

Under 14	☐
15 – 18	☐
19 – 25	☐
26 – 49	☐
Over 50	☐

1.5 Education Level

Primary	☐
Secondary	☐
College/University	☐

1.6 Which device do you own or have daily access to?

Mobile phone	☐
Computer/laptop	☐
Fax/landline	☐
Radio	☐
Television	☐

2.0 Mobile phone efficacy and usage

2.1 I have found it easy to use my mobile phone?

Yes	☐
No	☐

2.2 How do you recharge your mobile device?

Institution has electricity	☐
I have solar power	☐
I use car battery	☐
I recharge from others	☐

2.3 Where do you buy your airtime?

From grocery shop	
Air time vendor	
Through mobile money service	
Sent by my child/relative	
Other (Specify)________________	

2.4 Rate how you have used your mobile phone functions to access information.

Using a scale of 1 to 5, with 5 being "Always" and 1 being "Never". Please how you will rate the following statements:

	1 (Never)	2 (Rarely)	3 (Occasionally)	4 (Frequently)	5 (Always)
I have used the alarm, clock, Notebook and calendar on my mobile phone					
I have used the mobile phone for mobile banking					
I have used the mobile phone to access medical health information					
I have used the mobile phone for community mobilization or community related activities					
I have you used the mobile phone for educational purposes and learning					
I have used the mobile phone to be in touch with my friends and relatives					
I have used the mobile phone to access news					

I have used the mobile phone to access agricultural information					

2.5 Before there was mobile phone reception in your ward what challenges did you face? *Using a scale of 1 to 5, with 5 being "strongly agree" and 1 being "strongly disagree". Please indicate the extent to which you agree or disagree with the following statements:*

	1 *(Strongly disagree)*	2	3	4	5 *(Strongly Agree)*
Could not keep my money secure					
Had difficulty in contacting friends and relatives					
High transport cost as I had to travel to pass a message to friends and relatives					
Could not access current affairs and news					
Could not access educational information.					
Could not access Agricultural information such as weather, disease outbreak and market prices					
Other (Explain)					

2.6 What challenges did mobile phone address? *Using a scale of 1 to 5, with 5 being "strongly agree" and 1 being "strongly disagree". Please indicate the extent to which you agree or disagree with the following statements:*

	1*(Strongly disagree)*	2	3	4	5*(Strongly Agree)*

The mobile phone gives me a sense of safety since I can call friends when I am in trouble					
Reduced transport costs and time since I can make a call or send an SMS to pass a message					
Easy to access agricultural, economic, social information through internet and mobile applications					
I can perform and access banking services and purchase airtime					
Through the mobile phone I can access social media, facebook, twitter, blogs, MySpace, Flicker etc.					
I have used the mobile phone to be in touch with my friends and relatives					
I use my mobile phone to access educational information or conduct research on the internet or use mobile applications					
The mobile phone has made us join the global village					
Other (Explain)					

3 Using the mobile phone and your work

3.1 Does using your mobile phone improve your day to day work/activity?

Yes ☐

No ☐

3.2 If your answer is Yes, in what ways does the mobile phone improve your work or daily activities?

____
____
____
____

3.3 Select your 5 favourite mobile phone applications or features which you frequently use

Making and receiving calls	
Sending and receiving SMS	
Chatting (Whatsapp/gtalk/skype)	
Making and receiving phone calls	
Accessing the internet	
Email	
Playing games	
Using camera/watch/calendar	
Using or downloading mobile applications	
Listen or download music or video	
Facebook	
Blogs/twitter	
Other (Specify)___________________	

3.4 Rate the usefulness of the mobile phone
Using a scale of 1 to 5, with 5 being "strongly agree" and 1 being "strongly disagree". Please indicate the extent to which you agree or disagree with the following statements:

	1*(Strongly disagree)*	2	3	4	5*(Strongly Agree)*
Using a mobile phone allows me to do more work					
Using a mobile phone improves my output					
I find using the mobile phone easy					

4.0 **Societal influence**

4.1 Rate societal influence to owning or using a mobile phone?
Using a scale of 1 to 5, with 5 being "strongly agree" and 1 being "strongly disagree". Please indicate the extent to which you agree or disagree with the following statements:

	1 *(Strongly disagree)*	2	3	4	5 *(Strongly Agree)*
The mobile phone is viewed as a symbol of status in the community?					

I use the mobile phone because everyone uses it in my village/school/work					
Using my mobile phone keeps me in touch with friends and relatives					
Using my mobile phone makes me feel safe since I can contact family when I need help					

4.3 What are the issues that hinder the uptake and use of ICTs in general such as mobile phones and the internet?

Cultural degradation/ Children and pornography	
Literacy barriers since content is in English	
Lack of privacy	
Expensive to use	
No electricity to power devices	
No relevant content	
Other (Specify)________________________	

5. Mobile Phones and financial Inclusion

5.1 Have you used a mobile phone for mobile money transfer?

Yes	
No	

5.2 If answer is No, why haven't you used it?

Don't know about it	
Expensive	
Poor signal reception	
Other (Specify________________	

5.3 If the answer is Yes, in what ways has it improved your conducting of financial transactions?

____

____

____
____

5.4 What type of mobile money transactions do you mainly do?

Sending and receiving money	
Paying bills	
Purchasing goods and services	
Bus fare when travelling	
Paying school fees	
Other (Specify________________	

6 **<u>Mobile phone internet</u>**

6.1 How often do you use mobile internet?

Always	
Regularly	
Periodically	
Not at all	

6.2 If you chose Not at all, what is the reason?

Don't know about it	
Expensive	
Poor signal reception	
Other (Specify________________	

6.3 If you use mobile internet, select your main uses

Chatting	
Join online communities	
Send emails	
Search for information	
Educational purposes	
Other (Specify________________	

7.0 Mobile phone applications for agricultural information

7.1 Have you used a mobile phone for sending and receiving agricultural information?

Yes	
No	

7.2 Which type of Agricultural information have you received or sent using mobile phone?

- Cattle sales ☐
- Animal disease outbreak ☐
- Market price/product information ☐
- Weather forecast information ☐
- Other (Specify)_________________________ ☐

8.0 Mobile phone application for educational purposes

8.1 Have you used a mobile phone for educational purposes?

- Yes ☐
- No ☐

8.2 In what ways have you used mobile internet for educational purposes?

- Searching for information ☐
- Collaborating with other students ☐
- Communicating with my teacher ☐
- Receiving assignments/notices ☐
- Using the calculator/calendar/watch ☐
- Other (Specify)________________________ ☐

9.0 Mobile phone application for community related activities

9.1 Have you used a mobile phone application for community related activities?

- Yes ☐
- No ☐

9.2 In what ways have you used the mobile phone applications?

- Sickness/Death/Funeral notice ☐
- Community mobilization ☐
- District/Ward/village level announcements ☐
- Other (Specify)________________________ ☐

10.0 Mobile phone applications and health access

9.1 Have you used a mobile phone for accessing health information?

Yes	
No	

9.2 In what ways have you used your mobile phone to access health information?

Receiving SMS from health care practitioners	
Using alarms for medication compliance	
Accessing medical websites	
Using whatsapp to receive medical information	
Receiving audio/video messages on health issues	
Other (Specify)______________________________	

11.0 Mobile phone applications

11.1 Do you intensively download and use mobile phone applications?

Yes	
No	

11.2 If you answer is Yes, list up to 5 mobile applications that you have downloaded into your mobile phone.

Email	
Whatsapp	
Youtube	
Facebook	
Blogs/twitter	
Email	
Flicker	
Games	
Skype	
Google earth	
Dropbox	
Other (Specify)___________________	

11.3 What other applications or functionality will you want to be provided on the mobile phone?

____
____
____
____
____

12 Mobile phone infrastructure

12.1 What are your major uses of the mobile phone network infrastructure?

Voice	
SMS	
Mobile money	
Data – Internet	
Other (Specify________________	

12.2 Do you think the current infrastructure is adequate?

____
____
____
____

12.3 Which type of mobile phone data signal are you accessing?

Edge	
3G	
4G	
Other (Specify________________	

12.4 Which network are you subscribed to?

Econet Zimbabwe	
Netone Zimbabwe	
Telecel Zimbabwe	
Mascom Botswana	
Other (Specify________________	

12.5 What influenced you to subscribe to this network?

Signal strength and availability	
Lower tariffs	
Air time accessibility	
Other (Specify________________	

13.0 Mobile phone and news

13.1 How do you view access to the following?

Using a scale of 1 to 3, with 3 being "Very important" and 1 being "Not Important".

Please indicate the extent to which you rate the importance of the following:

	Not important(1)	Quite important	Very important(3)
Newspaper			
Radio			
Television			
Mobile phone			
Internet			

13.2 Can you rate accessibility and availability of the following?

Using a scale of 1 to 3, with 3 being "Very important" and 1 being "Not Important".

Please indicate the extent to which you rate the importance of the following:

	Not accessible and available(1)	Sometimes accessible and available(2)	Very accessible and available(3)
Newspaper			
Radio			
Television			
Mobile phone			
Internet			

13.3 Are you currently accessing national news and current affairs on your mobile phone?

Yes ☐

No ☐

13.4 If answer is No, what are the reasons?

____

____

____
____

13.5 If your answer is Yes, how are you accessing the news?

Through SMS news alerts	
Visiting news websites	
Podcasts (Online audio)	
Online news (video)	
Other (Specify)__________________	

13.6 Which news items are you currently accessing on your mobile device?

Sports	
Current Affairs	
Entertainment	
Politics	
Developmental news	

Thank you for taking your time and filling in this questionnaire.

APPENDIX 2: Mobile App Usage questionnaire

Gender

Male	☐
Female	☐

Age

Under 18	☐
19 – 25	☐
26 – 49	☐
Over 50	☐

	1 (Strongly Disagree)	2 (Disagree)	3 (Neutral)	4 (Agree)	5 (Strongly Agree)
1.3 If I had access to the mobile application, I intend to use it.					
1.4 During my use of the mobile application, I found it easy to use and easy to remember.					
1.5 Using mobile application increases my productivity.					
1.6 I can use the mobile application without anyone's assistance.					
1.7 I intend to use the mobile application to access agricultural information.					
1.8 I intend to use the mobile application to					

access health information.					
1.9 I intend to use the mobile application for educational or learning purposes					
1.10 I intend to use the mobile application for community mobilisation.					
1.11 I intend to use the mobile application for accessing market information					
1.12 I intend to use the mobile application for accessing news					
1.13 The feature that allowed me to use the mobile application when I did not have a signal or had run out of content was very useful					

1.14 How often would you want to use the mobile phone application?

1(Never)	2(Once a month)	3(Once a week)	4(More than once a week)	5(Daily)

APPENDIX 3: Code snippets

Adding an article

```
public class Article {
    private String id;
    private String title;
    private String image_url;
    private String body;
    private String date_of_creation;
    private String url;
    private String category_id;
    private String status;
    private String author;
    private String moderator;

    public String getId() {
        return id;
    }    public void setId(String id) {
        this.id = id;
    }    public String getTitle() {
        return title;
    }    public void setTitle(String title) {
        this.title = title;
    }    public String getImage_url() {
        return image_url;
    }    public void setImage_url(String image_url) {
        this.image_url = image_url;
    }   public String getBody() {
        return body;
```

```
    }    public void setBody(String body) {
        this.body = body;
    }    public String getDate_of_creation() {
        return date_of_creation;
    }    public void setDate_of_creation(String date_of_creation) {
        this.date_of_creation = date_of_creation;
    }    public String getUrl() {
        return url;
    }    public void setUrl(String url) {
        this.url = url;
    }    public String getCategory_id() {
        return category_id;
    }    public void setCategory_id(String category_id) {
        this.category_id = category_id;
    }    public String getStatus() {
        return status;
    }    public void setStatus(String status) {
        this.status = status;
    }    public String getAuthor() {
        return author;
    }    public void setAuthor(String author) {
        this.author = author;
    }    public String getModerator() {
        return moderator;
    }    public void setModerator(String moderator) {
        this.moderator = moderator;
    }
}
```

```
public class CommentsAdapter extends
RecyclerView.Adapter<CommentsAdapter.DatabaseViewHolder> {

    public ArrayList<Comment> commentArrayList;

    private Context mContext;

    public CommentsAdapter(Context context, ArrayList<Comment>
myArticleList) {

        commentArrayList = myArticleList ;

        mContext = context;

    }

    public void clear(){

        commentArrayList.clear();

        notifyDataSetChanged();

    }

    public void addAll(ArrayList<Comment> myList){

        this.commentArrayList = myList;

       notifyDataSetChanged();    }

    @Override

    public CommentsAdapter.DatabaseViewHolder
onCreateViewHolder(ViewGroup parent, int viewType) {

        View view =
LayoutInflater.from(parent.getContext()).inflate(R.layout.comment_ro
w, parent, false);

        CommentsAdapter.DatabaseViewHolder viewHolder = new
CommentsAdapter.DatabaseViewHolder(view);

        return viewHolder;

    }

    @Override

    public void onBindViewHolder(CommentsAdapter.DatabaseViewHolder
holder, int position) {

        holder.bindDatabase(commentArrayList.get(position));   }

    @Override
```

```
    public int getItemCount() {

        return commentArrayList == null ? 0 :
commentArrayList.size();

    }

    public class DatabaseViewHolder extends RecyclerView.ViewHolder
implements View.OnClickListener{

                public TextView cdate ,cname ,comment;

        public DatabaseViewHolder(View itemView) {

            super(itemView);

            cdate = (TextView) itemView.findViewById(R.id.cdate);

            cname = (TextView) itemView.findViewById(R.id.cname);

            comment = (TextView)
itemView.findViewById(R.id.usercomment);

            itemView.setOnClickListener(this);

        }

        public void bindDatabase(Comment comments) {

            cdate.setText(comments.getDate());
cname.setText(comments.getName()+""+comments.getSurname());

            comment.setText(comments.getComment());

       }

       @Override

        public void onClick(View v) {


        }

    }

}
```

APPENDIX 4: Consent letter

I ____________________________ a student at Madlambuzi Secondary school have been informed about the study entitled enhancing access to Socioeconomic Development information using Mobile Phone Applications in rural Zimbabwe: The case of Matabeleland South Province, by Vusumuzi Maphosa.

I understand the purpose and procedures of the study. I have been given an opportunity to ask questions about the study and have had answers to my satisfaction.

I declare that my participation in this study is entirely voluntary and that I may withdraw at any time without affecting any of the benefits that I usually am entitled to.

I have been informed about any available compensation or medical treatment if injury occurs to me as a result of study-related procedures. If I have any further questions/concerns or queries related to the study I understand that I may contact the researcher at (provide details) vmaphosa@gmail.com and +263772 365755.

If I have any questions or concerns about my rights as a study participant, or if I am concerned about an aspect of the study or the researchers then I may contact:

HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION

Research Office, Westville Campus
Govan Mbeki Building
Private Bag X 54001
Durban
4000
KwaZulu-Natal, SOUTH AFRICA
Tel: 27 31 2604557 - Fax: 27 31 2604609
Email: HSSREC@ukzn.ac.za

Additional consent, where applicable

I hereby provide consent to:

Audio-record my interview / focus group discussion	YES
Video-record my interview / focus group discussion	NO
Use of my photographs for research purposes	NO

______________________ ______________________

Signature of Participant **Date**

______________________ ______________________

Signature of Witness **Date**

APPENDIX 5: Questions and responses that guided participants during the mobile application design consultative meeting 1 held on the 15th of May 2017

Questions that guided participants during the development of the mobile phone application and summarised responses

1. How is information access a challenge in this community?
    a) Unavailability of general information dissemination media such as radio, television and newspapers
    b) Poor road network and unreliable transport makes it difficult for newspapers to reach the community
    c) Communities cannot make instant decisions due to lack of information
    d) Difficult to track price variations of commodities and middle men exploit the community
    e) Communities feel they don't belong to this country as they have better access to radio and television from Botswana and South Africa BUT cannot access the Zimbabwean one.
2. Describe the information you would want to access as a community
    a) We want to access news, so that we know what is happening in our country
    b) As clinics are very few, we want to be able to access general health information
    c) We also want to share information amongst ourselves
    d) As a community we practice subsistence farming and we want more access to agricultural information
    e) We want to access market information and know how to sell our produce at competitive prices
    f) A platform that we can share information on community activities
3. How can this information be made available?
    a) Lobby government to install television and radio transmitters
    b) Rehabilitate and construct new roads
    c) Set up telecentres and libraries
    d) Use mobile phone technology such as SMS, Whatsapp or mobile applications
4. Which ICTs are you currently using
    a) Mobile phones

APPENDIX 6: Questions and responses that guided participants during the mobile application design consultative meeting 2 held on the 23rd of June 2017

1) Summarised contributions on the General topics and sub categories raised by participants
   a) Community development initiatives, meetings and social events schedules. Some events that require mobilisation of people are poorly attended. Community members may advertise for manual jobs such as tilling the land, fetching firewood or water.
   b) Community members want information on market prices, rural communities often have no information on price fluctuations and availability of commodities.
   c) The community relies on subsistence farming as the main economic activity and community members felt that it was important to avail
   d) Health related information such as immunisation dates, outbreak of diseases and basic health education is important for the rural communities.
   e) Respondents felt that it was important to provide information related to sporting activities and other recreational activities.
   f) Participants felt that the application must allow them to access receive local government information.
   g) Community members felt that they were not treated fairly by the government as they were not receiving any national news as they have no access to radio and television signals.
2. Which design issues must be considered for this mobile phone application?
   a) Designing simple app for low digital skills audience
   b) Use of simple graphics and menus
   c) Clear and consistent navigation
   d) Application to support offline access, to reduce costs on data
3. General design of icons and colours
   a) Usage of icons that depict community participation, focusing on our theme
   b) Use simple icons and font which is visible
   c) Very easy to use
   d) Very memorable and easy to learn

APPENDIX 7: Ethical Clearance letter

UNIVERSITY OF KWAZULU-NATAL

INYUVESI YAKWAZULU-NATALI

29 May 2017

Mr Vusumuzi Maphosa (215080927)
School of Management, IT & Governance
Westville Campus

Dear Mr Maphosa,

Protocol reference number: HSS/0350/017D
Project title: Enhancing access to Socio-economic Development Information using Mobile Phone Applications in rural Zimbabwe: The case of Matabeleland South Province

Approval Notification – Expedited Application

In response to your application received on 18 April 2017, the Humanities & Social Sciences Research Ethics Committee has considered the abovementioned application and the protocol has been granted **FULL APPROVAL.**

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number.

PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

The ethical clearance certificate is only valid for a period of 3 years from the date of issue. Thereafter Recertification must be applied for on an annual basis.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

....

Dr Shenuka Singh (Chair)

/ms

Cc Supervisor: Professor Manoj Maharaj
Cc Academic Leader Research: Professor Brian McArthur
Cc School Administrator: Ms Angela Pearce

Humanities & Social Sciences Research Ethics Committee
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