MOBILE CROWDSOURCING IN CROP PRODUCTION FOR FARMERS IN RURAL AREAS OF THE SOUTH KIVU (DRC)

By

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AUTHOR'S DECLARATION FOR SUBMISSION OF A DISSERTATION

I, Kahasha Iranga Emmanuella, student number: 209044837 hereby declare that this dissertation title: "MOBILE CROWDSOURCING IN CROP PRODUCTION FOR FARMERS IN RURAL AREAS OF THE SOUTH KIVU" was written as a part of Magister Technologiae (MTech) in Information and Communications Technology at Vaal University of Technology.

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DEDICATION

To my late mother, for your unwavering commitment, your sacrifices for me through all your years of existence.

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ABSTRACT

In most African countries, agriculture remains a key factor in economic development with over half the population living in rural areas and directly or indirectly deriving their livelihoods from agriculture. Agriculture still faces several challenges that prevent it from being able to make its maximum contribution to economic expansion, despite it being the backbone for economic growth. As a major cause for change in all spheres of human lives, information and communications technology (ICT) has played a positive role in different segments of society, such as agriculture, education and community development. However, it could play a greater role in agriculture by assisting farmers who face challenges on a daily basis. Farmers may lack an operative way to gather farm produce data, to obtain information from other interested parties (e.g. agriculture advisers) and to record farm input expenses and expenditure on farm chemicals. These and other challenges experienced by farmers may be solved by gaining ICT access through using available technologies. Farmers need to benefit from earlier unexploited opportunities regarding the provision of cost-effective communication and learn about advanced practices previously unknown to them. In this research study, the researcher studied factors that influence farmers in the adoption of a mobile crowdsourcing portal for agriculture purposes. A model was used to measure the perception of farmers about the technology after having used it for a season. The model consisted of the following variables: quality factors; perceived ease of use; experience; perceived usefulness; attitude toward using; and behavioural intention to use. A test for reliability and validity proved that the model was acceptable. The results of the data analysis indicated that there was a strong relationship between the multiple independent factors and the dependent variable in the model. The researcher concluded that mobile crowdsourcing applications are perceived as enhancing agricultural development in remote areas with regard to data accessibility, the development of crop production, support in the decision-making process and their importance in sustaining agricultural activities.

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LIST OF ABBREVIATIONS

AFQ	Agricultural information frequency questionnaire
CCK	Communications Commission of Kenya
DOI	Diffusion of innovations
DRC	Democratic Republic of the Congo
FAO	Food and Agriculture Organization
ICT	Information communications and technology
IICD	International Institute of Communication and Development
IITA	International Institute of Tropical Agriculture
M&E	Monitoring and Evaluation
MOARD	Ministry of Agriculture and Rural Development
MTech	Magister Technologiae
PEOU	Perceived ease of use
PU	Perceived usefulness
QF	Quality factors
SMS	Short message service
SQ	Survey questionnaire
TAM	Technology acceptance model
TAMQs	Technology acceptance model questionaire
TOE	Technology-organisation-environment
TRA	Theory of reasoned action
UEA	Université Evangélique en Afrique
UTAUT	Unified theory of acceptance and use of technology.

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CHAPTER 1

THE PROBLEM AND ITS SETTING

1.1 INTRODUCTION

Information, communication and technology have always mattered in agriculture. Growing crops, raising livestock, and catching fish have brought farmers to seek information from one another. Questions arising from their need for information are typically as follows: What is the most current planting strategy on steep slopes? Where should one go to obtain improved seed and feed this year? What are the highest prices in the market? It is difficult to obtain answers to such questions, even if similar questions arise season after season. For centuries, farmers in rural communities may have planted the “same” crop. However, weather patterns, conditions in the soil, pest epidemics and diseases come and go over time. Because of the highly localised nature of agriculture, it can be difficult to provide such information; moreover, the information must be custom-made exclusively for distinct conditions.

The increasing need for farmers to be trained on how to pick an acceptable range of agricultural inputs, pesticides, seed variety, and fertilizers has also increased the value of constantly updating farmers' awareness and information on land planning, crop mixing, water control, irrigation and many other practices related to agriculture. Via electronic communication technologies, such as mobile phones, radio and television, this knowledge could be passed on to farmers (Zakar and Zakar 2009).

The model proposed in the study aims to provide accurate and affordable data that involves the use of a mobile crowdsourcing portal to farmers in the rural area within a specific period, allowing quick and useful decisions as well as providing information in advance by suggesting alternative solutions. The proposed model will make use of application tools (open-source software that allows affordable and easy circulation of information between farmers) and information communication and technology (ICT) tools (a mobile phone as a platform for exchanging information through short message service (SMS) text messaging) to identify problems based on collected historical data and real-time data. The data gathered in the study was used to develop the proposed model.

The use of mobile crowdsourcing seems advantageous to agriculture development in general and might lead to a large number of farmers in the remote areas adopting this solution.

0However, the question remains whether the use of mobile crowdsourcing supported by a crowdsourcing platform will be able to enhance agriculture development in a remote area of the South Kivu with regard to data accessibility, agriculture development, the decision making process in crop production and the farmers' perception of the importance of ICT in sustaining their activities.

1.2 BACKGROUND TO THE PROBLEM

Droughts, floods, swarms of insects and poor farming techniques have plagued agricultural communities for centuries. Improvement has been made to ensure the safety and improvement of crops worldwide. Yet, the above-mentioned challenges and many more continue to make or break individuals and communities affected by them.

Geographic information system (GIS) applications are able to assist farmers by mapping and projecting current and future fluctuations in temperature and crop output. Thus, scientists and farmers work together to create farming techniques that are more efficient and could increase crop production.

The introduction of a collaborative approach is possibly another solution to the challenges experienced by farmers, whereby farmers are grouped based on their geographical location. A mobile crowdsourcing portal would then allow farmers to access one another for information as well as contacting agricultural agencies, government agencies and other stakeholders. This would allow the inter-exchange of information in the search for solutions and knowledge about efficient farming techniques that would improve crop production and help in the fight against pests.

More than 60 percent of the sub-Saharan African, Asian and Latin American populations were expected to have access to mobile telephone coverage in 2009. Cell phones have been increasingly adopted by rural and urban populations in developing countries that have benefitted from the latest weather, business and related information (Aker and Summer (2010).

Cell phones have been supplied to remote farmers, which has reduced the costs of contact and greatly educated rural people. This technology has provided them with new opportunities to gain knowledge and information on agricultural issues and contributed to agricultural expansion.

Mobile phones have provided farmers with a new approach to making informed decisions that is more easily done than before. The use of mobile phones has led to greater social unity and strengthened the interconnections between farmers and industry. Moreover, SMS text messaging, mobile social networking and voice archives of short messages have improved social relations in developing countries. In addition, mobile phones are perceived as important for agricultural growth (Bagtasa, Tongson et al. 2015).

The research described in this report aimed to improve access to information through the design of a crowdsourcing agricultural portal to be used to improve the information access rate of the agrarian community. A mobile application was used to measure the effectiveness of the crowdsourcing framework for effective information sharing among farmers. Moreover, the study involved people with expertise who were recognised in the agriculture environment and who could contribute towards the improvement in agriculture in the South Kivu region.

1.3 KEY ISSUES IN THE STUDY

The study aimed to assess the use of mobile crowdsourcing in remote areas to determine how likely it is to enhance the production of crops and develop agricultural patterns for rural farmers in rural areas. In addition, the study aimed to develop understanding of the meaning of terms used, such as crowdsourcing and crop production.

1.4 THE IMPORTANCE OF THE STUDY

The use of mobile crowdsourcing supported by a crowdsourcing platform was able to enhance agriculture development in a remote area of the South Kivu with regard to data accessibility, agriculture development of crop production, support in the decision-making process and the farmers' perception of the importance of ICT in sustaining their activities.

The introduction of a collaborative approach was a solution to the challenges experienced by farmers, whereby farmers were grouped based on their geographical location. A mobile crowdsourcing portal then allowed farmers to access one another for information as well as contacting agricultural agencies, government agencies and other stakeholders. This allowed the inter-exchange of information in the search for solutions and knowledge about efficient farming techniques that would improve crop production and help in the fight against pests.

1.5 THE RESEARCH AIM AND OBJECTIVES

The research study aimed to propose a model for the adoption of mobile crowdsourcing to be used as a tool to improve access to information in rural agrarian communities.

The objectives of the study formulated to fulfil the research aim were as follows:

- To study the topic of mobile crowdsourcing in agriculture as it appears in the literature and investigate what has been done to improve information sharing systems for agrarian communities.
- To determine the factors that influence the adoption of a mobile crowdsourcing framework in crop production for farmers in rural areas.
- To propose a mobile crowdsourcing framework for the adoption of an information-sharing system
- To measure the effectiveness of the framework for the adoption of mobile crowdsourcing in crop production
- To recommend a model for the adoption of the mobile crowdsourcing framework

1.5.1 The research question and sub-questions

The primary research question of this study was as follows: How is a mobile crowdsourcing application perceived in enhancing the agricultural development in remote areas with regard to data accessibility; agriculture development in crop production; support for the decision-making process; and its importance in sustaining these activities?

Secondary research questions were based on the primary research question as follows:

- What does the literature reveal about the use of mobile crowdsourcing in agriculture?
- How can a mobile crowdsourcing model be designed for effective decision-making processes in farming communities regarding crop production?
- How can the effectiveness of the proposed mobile crowdsourcing model be measured?
- What recommendations can be made for future research?

1.6 THE HYPOTHESIS

Based on the findings of previous studies concerning the dissemination of information to the agrarian community in rural areas in developing countries, the assumption was that crop production in the rural area of the South Kivu suffered. This was due to insufficient information being made available to farmers in due time or when needed, resulting in poor farming techniques, low crop quality and a poor harvest for that planting season.

1.7 THE DELIMITATIONS

1.7.1 Scope of the study

This study was based in three villages: Walungu, Kabare and Kalehe. These villages form part of the South Kivu Province and are based in a rural area at a strategic location. The results of the study are likely to be generalised to similar provinces within the DRC.

1.7.2 Inclusion criteria

The study only included rural farmers: women and men aged between 20 and 81 years. Participants had to be farmers from households in Kabare, Walungu, and Kalehe in South Kivu Province.

The study focused specifically on the three areas mentioned above, as the researcher was deeply concerned about the information-accessing platform available to the farmers in locations known to be isolated. Thus, a suitable platform is likely to influence their decision-making positively with regard to choosing an appropriate range of agricultural inputs, pesticides, seeds and fertilizers.

In addition, the Ministry of Agriculture and Rural Development (MOARD) has determined that 80% percent of the farmers in the rural areas of South Kivu Province are severely affected by limited access to information.

1.7.3 Exclusion criteria

The study excluded farmers with smartphones; farmers with no phone, those who did not subscribe to be part of the survey; and farmers residing outside of the three selected areas.

1.8 DEFINITIONS OF TERMS

The terms listed below are commonly used in this report about the study of the use of mobile crowdsourcing in crop production for farmers in rural areas. In the context of the report, the in-depth definitions of the terms that follow are provided for clarification.

1. **Crowdsourcing** is defined as the subcontracting of traditionally simple and small tasks, by means of an open or targeted collaborative call. Crowdsourcing is carried out by individuals or organisations to an unknown broad group of people or a (crowded) population. Crowdsourcing methods are used to operate continuously on mobile devices, finding new ways to solve complex problems. It is not a modern paradigm because it has several historical precursors. The current use of enhanced portable devices makes it possible for users not to be limited to stationary use.

2. **Mobile crowdsourcing** is a term that describes crowdsourcing activities that are processed on smartphones or other mobile devices. Thanks to the improved, technological smartphone features, including reliable GPS, very good cameras, and continuously new apps, mobile phone users can work on crowdsourcing tasks without any further difficulties. Nowadays, these tasks involve more than simple site descriptions.

3. **Crop production** is a branch of agriculture that deals with growing crops for use as food and fiber.

4. **A farmer** is a person who operates a farm or cultivates land.

5. **Agricultural inputs** are defined as products permitted for use in organic farming. These include feedstuffs, fertilizers and permitted plant protection products as well as cleaning agents and additives used in food production.

6. **Agrarian community** (agrarian society or agricultural society) is any community whose economy is based on producing/maintaining crops and farmland. In an agrarian society, cultivating the land is the primary source of wealth.

7. **A decision support system** is an information system that either helps to identify decision making opportunities or provides information to help make a decision (Bentley and Whitten 2007).

8. **A short message service (SMS)** is a text messaging service component of most telephone, internet, and mobile-device systems. It uses standardised communication protocols to enable mobile devices to exchange short text messages.

9. **A mobile application** is a software program that is designed to run on specific hardware, namely mobile handhelds computing devices such as tablets and smartphones. They are the programs that execute when you press an icon on your mobile devices, such as an iPad or android phone.

10. **Crop modelling**: is the use of equations or sets of equations to represent the behavior of a system. In effect, crop models are computer programs that mimic the growth and development of crops. The model simulates or imitates the behavior of a real crop by predicting the growth of its components, such as leaves roots, stems, and grains. Thus, the crop growth simulation model not only predicts the final state of crop production or harvestable yield but also contains quantitative information about major processes involved in the growth and development of the crop. Reactions and interactions at the level of tissues and organs are combined to form a picture of the crop's growth processes.

11. **Drought** is a period of unusually dry weather that persists long enough to cause problems such as crop damage and water supply shortages. However, because dry conditions develop for different reasons, they account for the water needs of crops during different growing stages. For instance, not enough moisture at planting time may hinder germination, leading to low plant populations and a reduction in yield.

12. **Food security** is a measure of the availability of food to individuals who access it, where accessibility includes affordability.

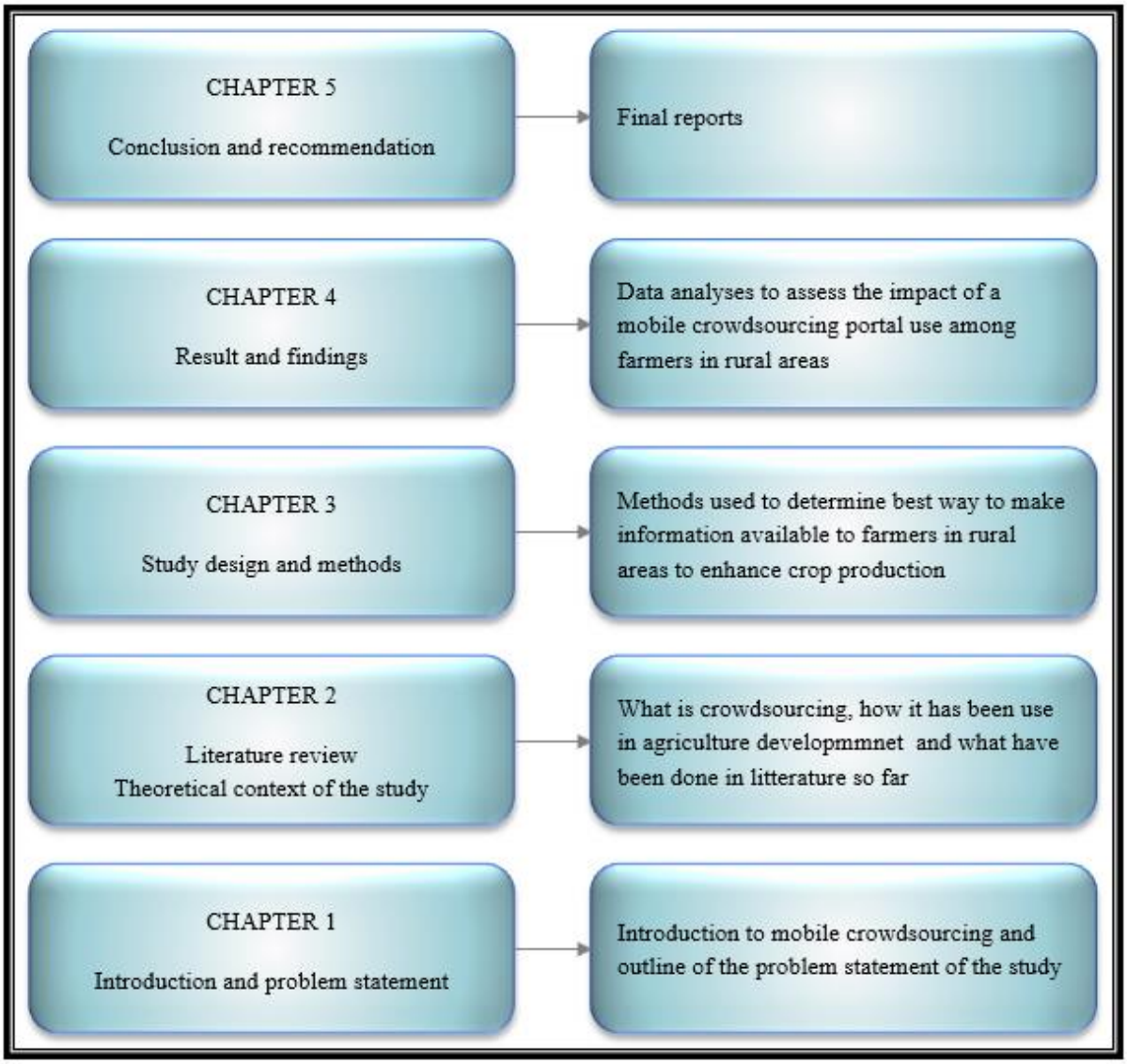
13. **Forecasting** is a planning tool that helps management in its attempts to cope with the uncertainty of the future, relying mainly on data from the past/present and analysis of trends. Forecasting starts with certain assumptions based on management experience, knowledge, and judgment.

14. **Food and Agriculture Organisation:** is a specialized agency of the United Nations that leads international efforts to defeat hunger. His primary goal is to achieve food security for all and make sure that people have regular access to enough high-quality food**.**

15. **M-Agriculture** refers to the delivery of farm and information services by means of electronic devices such as mobile phones, personal digital assistants (PDAs), laptops, and other portable communications or computers. The mobile apps are used for remote weather surveillance (Gichamba and Lukandu 2012).

1.9 THE CONCEPTUAL FRAMEWORK OF THE RESEARCH REPORT

The study described in this research report was motivated by the need to provide reliable, cost-effective and easy access to information through the design of a crowdsourcing agricultural portal to improve the information access rate of the agrarian community in rural areas of the South Kivu Province. The lack of effective communication channels was seen as crucial, as it endangered the crop production of many farmers in the South Kivu Province in the Democratic Republic of the Congo (DRC). It was likely to cause the farmers to waste valuable time asking one another about the most recent planting strategy for steep slopes; the right place to obtain the best seed/feed this year; and the highest prices in the market. Because of poor communication facilities, the farmers would have found it difficult to obtain answers to their questions. For example, they would not have been able to provide information about market prices, since they would have had to go to the market physically to find out about them. Figure 1.1 below illustrates the framework of this study.



Source: established by own study

Figure 1.1: Conceptual framework of the research report

The following section explains the framework of the research report depicted in Figure 1.1.

Chapter 1: Introduction, problem statement, and objectives of the study

This chapter provided a brief introduction to mobile crowdsourcing portals as a topic. The chapter included a brief investigation into how this technology has been used in remote and rural areas.

Chapter 2: Literature study

This chapter will take a detailed look at the existing literature on the use of the mobile crowdsourcing portal as an ICT tool in crop production and agricultural development. This review will also describe the results that have been achieved in other studies. The historical background and the development of the topic of the study will be investigated and discussed in detail. A thorough literature review will provide the necessary background knowledge for the reader to understand the study.

Chapter 3: Research methodology

This chapter will explain the research methods chosen for the study that followed the positivist paradigm. A detailed description of the data collection and analysis methods will be presented, discussed and justified in terms of obtaining complete, relevant and meaningful information.

Chapter 4: Data analysis and findings

This chapter will explain the analysis of the data gathered in the experimental process and survey. The chapter will explain how the data was organised and how common factors were identified and grouped together to obtain the results required to fulfill the research objectives of the study.

Chapter 5: Conclusions and recommendations

In this chapter, the researcher will conclude the research report and discuss the findings. The chapter will present a discussion on the feasibility of using the mobile crowdsourcing framework, which was explained in the previous chapter, in crop production. Moreover, the chapter will discuss the outcome of the process of using the mobile agricultural portal compared to the usual sharing information approach used by farmers. A conclusion will be drawn on whether the use of a mobile crowdsourcing portal has a positive impact on agriculture performance regarding crop production, postharvest demands, access to agricultural information and the decision-making process.

1.10 CONCLUSION

This chapter has stated the problem concerning providing better, cost-effective and easy access to information, with a specific focus on farmers in rural areas of the South Kivu Province, whose crop production is threatened by droughts, floods, swarms of insects and poor farming techniques.

The next chapter reviews the literature relating to the key issues of the study as examined by international and national sources and researchers.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This literature review mostly focuses on the success of different types of mobile crowdsourcing portals and open-source software in accessing accurate information within a required, specific and short time, as well as improving the livelihoods of poor smallholders in rural areas.

2.2 RELATED RESEARCH

According to Odhiambo (2014), smallholders need access to effective information technology to improve their agricultural production: "Small producers remain at the mercy of global market forces and without the knowledge and without the communication capabilities required to access, analyze and share the information required to create knowledge" (Odhiambo 2014).

Hellin confirms that ICT enhances agricultural and rural development: "Small producers with knowledge can have a competitive advantage over larger farm operations and corporate agriculture. They often have the suppleness to quickly change crop choices, develop products for small niche markets and even market directly to the consumer or commodity broker in distant countries" (Hellin Jon 2002).

According to Odhiambo (2014), for smallholders, gaining access to information and markets is a continual problem that precludes them from successful commercialisation. However, through the introduction of ICT, efforts are being made to tackle these problems. Odhiambo (2014) wrote an article entitled *Market in their Palms* describing a study that explored mobile phone application usage in Kenya in 2013. His study allowed smallholder farmers to access information about the market. Finding out whether the apps improved the smallholders' marketing capability and businesses was the aim of his research. While interviewing these smallholder farmers, he explored four key areas: the influence of mobile applications on the smallholder farmers' access to information; the types of mobile phone applications used; the cost of using those mobile phone applications; and their impact on smallholders' production. A platform for accessing inputs and market information through their mobile phones was introduced to farmers. It integrated mobile applications and Internet service, providing wider access to crucial agricultural information to the farmers, to which they gained access by sending

out a text message or by calling. They agreed unanimously that the applications made information accessibility cheaper, faster and easier. The information was reliable, the communication with consumers was faster and the services were affordable as well as being particularly useful. which empowered them to make quick marketing decisions, generating higher returns (Odhiambo 2014).

In Senegal, Benin, Zambia, Bolivia, Uganda, Tanzania and Ghana, set up/delivery prices and market/trading information have been conveyed to farmers by short message and text services via mobile phone piloted by International Institute of Communication and Development (IICD). Partner organisations are supported by implementing ICT in core processes. By linking rural soybean producers to mills through the use of satellite, databases and mobile phones, the Social Enterprise Foundation of West Africa (SEND), was supported by IICD, thereby ensuring a fair income for producers and a steady supply of raw materials for the mills (Stienen Jac 2007).

Cropster software was proposed as an initiative that seeks to support sustainable agriculture by empowering farmers with access to key information and ensuring data transparency (Lisa 2014). It supports people and communities at all levels of the supply chain and enables them to make informed decisions. This app offers a Monitoring and Evaluation (M&E) tool that facilitates data collection as well as the exchange of information within producer groups, NGOs and commercial partners in Latin America. This tool offers allows users to customise data and verify input. Moreover, it provides decentralised monitoring and real-time information.

The award-winning mobile app EpiSurveyor lets users create an account, design forms, download them to their mobile phones, collect data and send them to a server. In 2010, the World Bank stated that this application was used by nine data collectors to interview beneficiaries in 25 municipalities. In a second survey (the first one was conducted in 2009 using paper and pen), which was the World Bank Conditional Cash Transfer Project, digitisation cut the cost of an interview by 71%, increased the sample size from 200 to 700 beneficiaries, and reduced the individual interview time by 3.6% in Guatemala.

The ITC e-Choupal initiative, which was started by ITC-IBD in 2000, is one of the earliest and the most successful private sector ICT enabled initiatives. It was started initially in the state of Madhya Pradesh to overcome soybean supply-chain inefficiencies. The model was based on the traditional choupal system, where farmers gather in a group, mostly in the evening, to discuss village-level issues. The initiative aims to empower Indian farmers through information

and knowledge dissemination with regard to improved agricultural practices, price discovery and decision-making (Subba 2008). By providing them with timely and relevant weather information, farming know-how services, transparent price discovery and access to wider markets, e-Choupal contributes to the farming communities' capability significantly, enhancing their economic capacity. However, at present, in some countries, existing information systems do not facilitate the easy electronic data exchange relevant to agriculture development. The availability of local ICT resources and national capabilities to acquire, produce, process and disseminate information about agriculture is weak (Kalusopa 2003).

In order to make the right decisions related to day-to-day activities, the common objective of the ICT enabled initiatives mentioned above is to provide real-time information and knowledge, thus improving the agriculture production system performance of agrarian communities (Jabir 2007). By facilitating the spread of information for fishermen in Kerala, (Jensen 2007) found that price dispersion and wastage decreased with the introduction of mobile phones. This enhanced both consumer and producer welfare and made markets more efficient.

Depending on the kind of information being delivered, different delivery systems have different values, such as the availability of inputs, new seed varieties, input prices, weather information, future prices and ways of using inputs. Realising the importance of real-time information, most governments all over the world are developing innovative mechanisms to deliver information to farmers. Because the traditional agricultural extension system is being transformed by these new ICT initiatives, mobile, and Internet-based information delivery models have to be complementary to conventional extension services(Mittal and Tripathi 2009). However, appropriate network linkages with research institutes and other knowledge banks are still lacking. Timely information is necessary for the smooth flow of information to farmers through these new customized ICT models, which are a possible source of appropriate content.

Limited understanding of the impact of ICT, the behavior of farmers, and the lack of capacity to act as an enabler in adopting the technology of ICT intervention were demonstrated in several studies as a concern in the disseminating of knowledge and technology to farmers through the use of ICT (Jabir 2010).

Information and Communication (ICC) is a pilot-based centre that was established in Pakistan, in the Sialkot District of the Punjab Province. The key role of this centre is to offer farmers environmental awareness, market price forecasts and advanced information technology

applications. The ICC has taken the new knowledge to the farmers' doorstep. By collecting innovative information, the farming community initiates a strong social dialogue, which demonstrates the applicability and significance of the use of mobile phones and other technologies in the dissemination of new knowledge (Zakar and Zakar 2009). However, according to a study conducted by (Hosseini, Lashgarara et al. 2012), the poor quality of services rendered by companies and the lack of interest of the private sector in participating in the creation of rural ICT programs has been a major problem for the growth of agricultural production in developed country rural areas (Hosseini, Lashgarara et al. 2012).

Another study in the context of Malaysia showed that a lack of awareness of the use of ICT was a major issue for rural communities and farmers. While the level of ICT uses in rural communities, particularly farmers, was low due to a lack of knowledge and ability, analphabetism was another cause of farmers' inability to use ICT. Farmers were unable to communicate with relevant officers and departments to obtain information about weather forecasts, market prices or pesticides. Moreover, because of analphabetism, farmers were not willing to contact their families and friends using a cell phone (Samuel, Shah et al. 2005).

According to the literature, farmers in the Philippines have not discovered ICT tools and mobile phone use as a common alternative for knowledge sourcing. However, the reality is that in the rural households surveyed, there is at least one mobile phone owned by a family. The findings and analysis of the study showed that multiple social problems influence the use of ICTs, such as illiteracy, socio-economic status, capacity and conditions for participating (Chhachhar and Hassan 2013).

Nevertheless, the use of mobile phones in third world countries plays a critical role in improving farmers' business towards agriculture (Chhachhar and Hassan 2013). Recently, mobile communication has been seen as significant in improving farmers' access to a better understanding of the agricultural market (Goggin and Clark 2009). Nowadays, cell phones have provided farmers with an opportunity to obtain marketing information about the environment. They keep in direct touch with sales staff via this important technology and sell their products at fair prices (Aker 2011). The use of mobile phones also keeps them aware of weather forecasts issued by meteorological departments, which assists them in the application of agricultural inputs such as fertilizers and pesticides that could be affected by unforeseen disasters (Chhachhar and Hassan 2013). Mobile phones have provided farmers with new ways to connect directly and share their recent progress. Research has shown that cell phones have

saved farmers' energy and time, and eventually increased their profits. Mobile phones have given farmers the ability to connect directly with market traders and clients to sell their goods at a good price(Chhachhar and Hassan 2013).

Technology has provided farmers in rural areas with new opportunities to gain knowledge and information on issues relating to agricultural production. Moreover, the use of ICTs in agricultural extension services, particularly mobile telephone services, has provided business, environmental, transport and agricultural information to agencies and departments (Aker 2011).

The growth of social links and contact with the business community using mobile phones has led to greater social cohesion among farmers. Moreover, SMSes and voice records have brought about a change in social relations. The growing importance of these aspects is demonstrated by mobile phone-based social networking in developing countries; cell phones are seen as important for agricultural growth. This has provided networking possibilities and provides owners with the advantages of mobility and security (Goodman 2005).

Farming communities that still depend on conventional methods such as posters and voice amplifiers, face problems in selling their goods and collecting market-related information, as opposed to those where farmers use mobile phones. They are unable to collect the same amount of information and a lack of communication has been shown to be the principal cause of the problems faced by these farming communities (Chhachhar and Hassan 2013).

The recent rise in crop and food prices has also created many problems for millions of developing world citizens who are heavily dependent on agriculture and small businesses. A problem facing farmers and small businesses in many rural areas who have an inadequate communications infrastructure, is that they are unable to know the rates before they move into the market. Small farmers have a weak business infrastructure, inadequate marketing expertise and lack agricultural resources (Chhachhar and Hassan 2013).

2.2.1 Use of mobile phones for marketing information

The use of mobile phones has become increasingly popular with farmers who are able to exchange their marketing, weather and business information with one another. Thus, a mobile phone is a useful tool in providing basic information about agriculture, the weather, business and current market prices (Lio and Chun Liu 2006, Szilagyi and Herdon.M. 2006).

Farmers' began to use mobile phones in the Philippines to obtain information and advice about fertilizers via text messages, which led to an improvement in their agricultural performance. Likewise, by using a mobile phone that connects solar-powered weather stations to an insurance company, Kenyan farmers are provided with information on the cost of seeds, fertilizers, crop pesticides and bad weather. The most successful and significant reform has been in Uganda, where farmers obtain fertilizers and certified seeds that are supplied via cell phone (Kashem 2010).

The cell phone, which is critical to obtaining market information, was very difficult for small farmers to obtain in the past. Nowadays, cell phones have provided manufacturers with details and expertise on appropriate market prices and the quantities/availability of products, as well as technical advice on a specific product. This allows the producer to communicate directly with the consumer and avoid intermediary costs (Goggin and Clark 2009).

In Tanzania, market spies were deployed near cities by organisations to inform farmers using mobile phones about the latest prices of products and their availability in the market. This strategy improved market access, improved farmers' profit margins, changed market trends and provided new opportunities. The first mobile project was established in Tanzania to enable farmers to learn about development strategies, share their knowledge/experience and develop a new way to increase their income mobile phones (Chhachhar and Hassan 2013). Accessing reliable, timely information is of benefit to farmers and enhances their farming ability (Asaba, Musebe et al. 2006). The cell phone has had a positive effect on poor farmers and their communities in strengthening their place in the market chain as regards community growth. The cell phone has made it easier for farmers to engage actively in agricultural productivity and growth (Hamm 2001).

Providing farmers with a new strategy and the ability to determine whether to embrace the purchaser's price bid, technology has also allowed them to obtain price information from various sources. Farmers' success rate is expected to increase as the information flow increases with the penetration of the mobile phone network that has a significant impact on remote areas. In Ghana, traders spent many days filling trucks of banana, had to bear high transport charges and risked not fetching an appropriate price from the market when the mobile phone network was not available. Today, cell phones have not only saved traders and farmers transport costs, but have put fresh bananas on the market at a decent price (Smale and Tushemereiruwe 2007). Cell phones connect farmers to market information at appropriate times and provide reliable

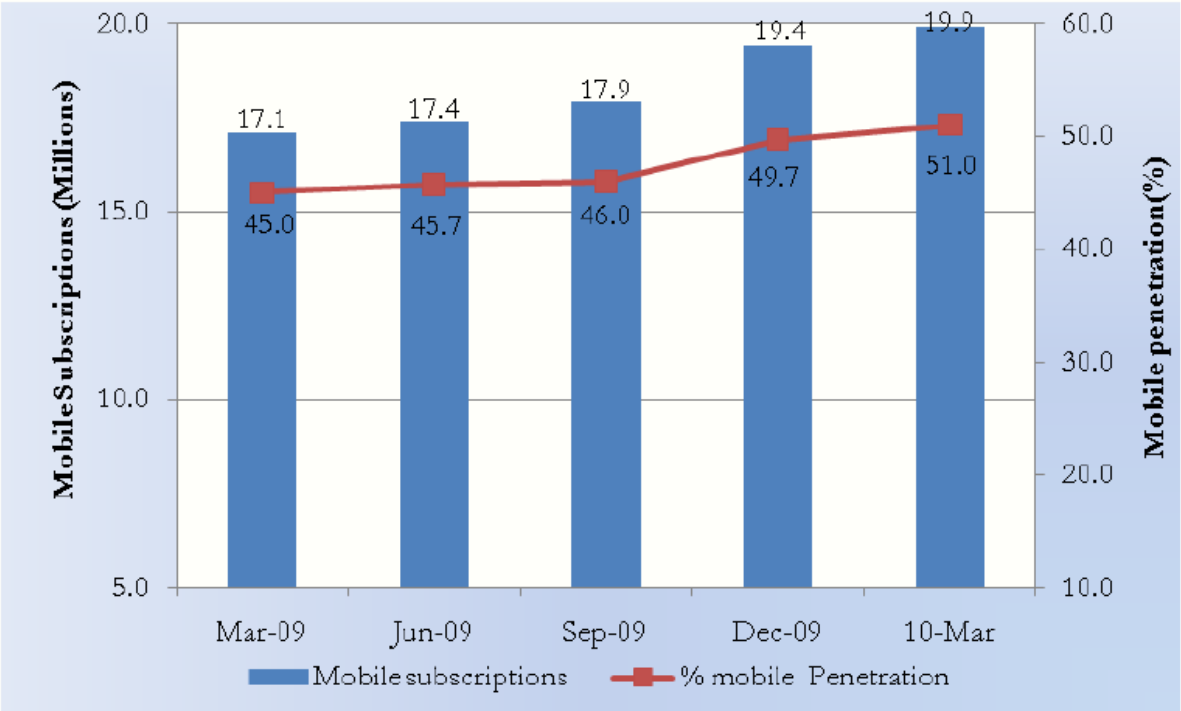
broker and customer information. The use and effect of mobile telephones in the provision of agricultural information may be calculated in terms of increased or decreased sales and the productivity of farmers (Mittal and Tripathi 2009).

The cell phone has helped farmers find ways to contact veterinary officials and collect information on communicable diseases. It has shifted mind-sets and promoted new ways of thinking about calving cattle that minimise death in stillborn calves. It has increased the cattle farmers' profits and welfare in the long term. Nowadays, many farmers contact the weather department to obtain weather information before applying pesticides to their crop (Duncombe 2011).

A study conducted in Kenya on animal health workers and farmers using mobile phones to detect and monitor livestock diseases suggested that mobile phones reduced transport costs and allowed farmers to obtain information from the authorities concerned about agriculture and livestock (KithukaJ., J. et al. 2007). Another study showed that several dairy farmers travelled many miles to the main market to find buyers that they could have found via their cell phones instead (Gichamba and Lukandu 2012). In Uganda now, the use of mobile phones by dairy farmers has provided them with ways of contacting buyers and suppliers and updating demand details. For example, they communicate with buyers by using SMS communication to sell their milk at a good price (Karamagi and Nalumansi 2009).

2.2.2 Mobile phones and weather information

Mobile phones have led to a high rate of Internet penetration in developing countries, as mobile technology has been generally adopted in most parts of the world. Figure 1 below shows Kenya's mobile penetration from May 2009 to March 2010, as reported by the Kenya Communications Commission (Waema and Ndung’u 2012).



Source: CCK, 2010

Figure 2.1: Internet penetration in Kenya from May 2009 to March 2010

In Kenya, the web-based system is used to disseminate information among farming communities via SMS, alerting farmers about the weather, prices and pesticides. This shows that the mobile phone is one of the best ways to disseminate relevant information among farmers. This method is accessible to farmers because they can purchase mobile phones more easily than other communication tools. The mobile phone is an effective medium to disseminate information to different layers of society (Harvey May and Hearn 2005).

The use of cell phones for industry, education and agricultural production has spread very rapidly in developing countries. However, the lack of signal, infrastructure and service delivery in some countries is a major problem. Moreover, it is difficult to measure the social and economic effects of this challenge (Ahmed Tareq and Elder 2009).

2.2.3 SMS and M-Agriculture

A GPS input and real-time data-acquisition sensor module, which was developed in Kenya as part of the network, established an automated fertilizer application for tree crops using mobile technology (Gichamba Amos 2012). The system comprised a decision module for deciding optimum fertilizer volume and delivery, and an output module for controlling fertilizer

application rate. The various modules inside this system were communicated through a Bluetooth network.

As a widely used agricultural app, the SMS is also used by farmers who use mobile technology to communicate with experts and systems, for example, to receive weather warnings and information on best practices in different farming sectors. Launched in 2009, The Esoko project is an agricultural messaging service, enabling Rwandan farmers to use the SMS to access the prices of various agricultural commodities. An existing SMS service provides information to farmers and extension workers on demand and supply in Uganda (Gichamba and Lukandu 2012). In Ghana, farmers in Tamale, which is more than 1,000 kilometers away, were able to learn corn and tomato prices in Accra by just sending a text message (Aker 2011).

M-learning has become common in developing countries, particularly in educational projects such as eCandle, for improving learning using technologies such as mobile devices (Rogers, Liddle et al. 2007). Mobile technology was also implemented in Malawi to warn patients to take their medications on time; a text message was sent every day to those affected by HIV and AIDS (Aker and Summer 2010). Recent advances in cellular and network technology and ubiquitous computing systems have contributed to the rapid growth of mobile health services over the last decade.

Using mobile phones to enhance access to and use of information include reducing search costs while improving agent communication and improving market efficiency. Moreover, improving business competitiveness is enhanced through increased interaction, thus enabling firms to manage delivery chains better (Chhachhar and Hassan 2013)

Jensen (2007) maintains that the implementation of mobile technology in fishing activities in Kerala, India, has led to a reduction in dispersion of fish prices and waste. He notes that fishermen's incomes rose eight per cent, market surpluses six per cent, and market prices dropped six per cent. Closely related to the results of Aker and Summer (2010), the study found that the advent of mobile phones reduced the dispersion of grain prices by 10 per cent.

In their study, Yamano and Muto (2009) found that the mobile telephone coverage was associated with a 10 per cent increase in the productivity of the banana market for farmers.

Agricultural experts from the call centre of the Kenya Farmers Helpline talk to farmers across the country about the role of mobile technology in solving various agricultural issues. The National Livestock Marketing Information System (NLMIS) operated by the livestock ministry (Markelova and Mwangi 2010) enables pastoralists and cattle traders in Kenya to use a mobile phone to track market trends.

2.2.4 Why a mobile phone over a PC?

Mobile computing devices have advantages in the developing world over using a personal computer (PC). The cost of purchasing a new cell phone is less than that of a PC, as are the recurring costs. Knowing how to use a cell phone is also simpler for computer-illiterate individuals. Thus, a mobile device is the most appropriate method for bringing technology to consumers without technical expertise. Another positive feature of cell phone is their high penetration in the developing world. Mobile phones have a comparatively higher degree of penetration compared to PCs. For example, in the first quarter of 2010, Kenya recorded a mobile phone penetration of 51% (Mwaura, Muwanika et al. 2010). In addition, mobile devices have the infrastructure for real-time interaction with multiple systems. Mobile computers offer people, an efficient route ensured by an effective and timely method of transmitting and obtaining information, which is a crucial requirement for M-Agriculture applications. However, a significant part of the population still cannot afford a mobile phone or any other electronic device that can be used for M-Agriculture, despite the high penetration of cell phones in the developing and developed world (Gichamba Amos 2012).

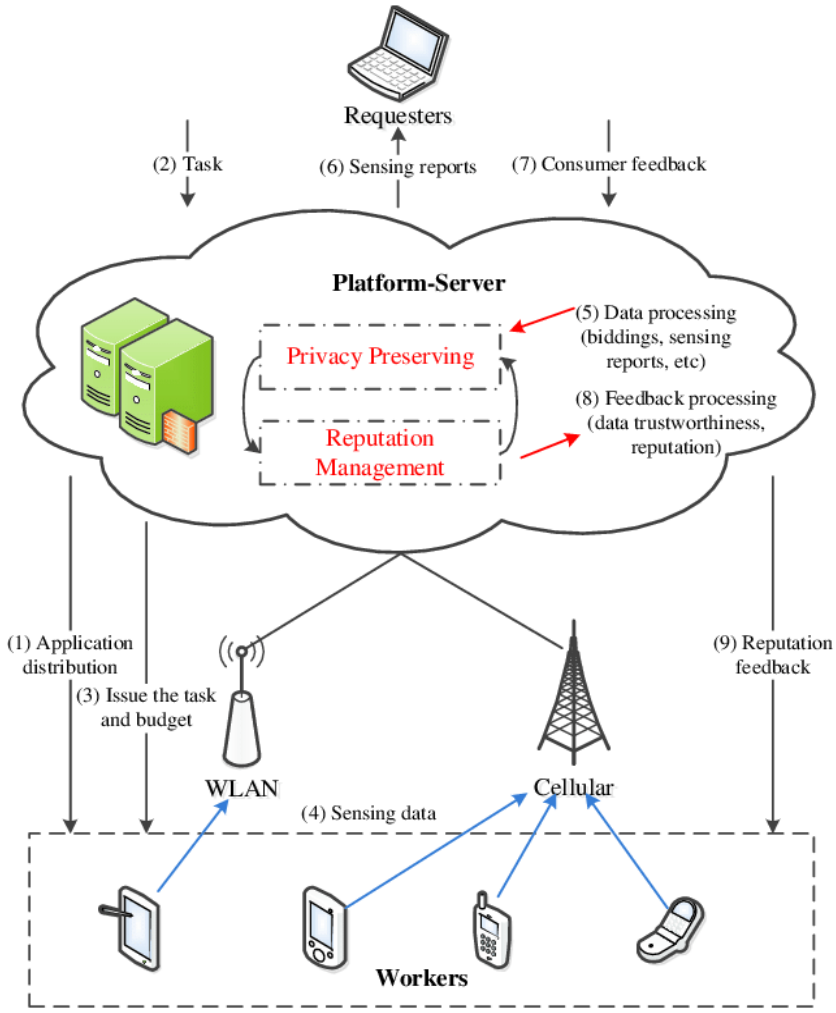
In rural areas, poor networks continue to predominate. Many telecom providers concentrate on densely populated urban areas before deploying high-quality, rural network coverage. Moreover, for most users, accessibility can be the biggest issue; but there are other challenges. Cell phones typically have small screens, small keypad areas and limited characters for input and output (for example, per SMS message).

2.2.5 Mobile Crowdsourcing

Crowdsourcing can be characterised as the outsourcing to an unknown large group of people or a collective (crowd) of simple small tasks traditionally performed by specific individuals through an open or targeted request for collaboration. It is not a modern idea and has some historical precedent. Models of crowdsourcing applied to mobile apps continuously enter new ways of solving complex problems, even using specialised mobile devices where users are not limited to stationary use (Jarczyk 2015).

Ushahidi, a popular crowdsourcing system, was developed and implemented in Kenya in disaster management and rescue missions, using mobile phones. The network has been used in activities such as rescue missions and tracking of political conflict around the world. The information is then turned into a graphical map, which can be accessed from anywhere on the Internet.

Issues, such as data quality, rewards, working modalities and contracts, contribute to crowdsourcing research. Research also involves discussions of issues of the complexity and efficiency of social mobile computing systems that indicate the relationship between meaning and crowdsourcing operations. Understanding crowdsourcing can enhance future and current applications in a way that can help automate the response of systems, tailor components and reduce uncertainty. The relationship of context awareness to crowdsourcing triggers a system engineering approach to it. It has brought a basic change to the problem-solving mechanism and a new contract between users and servers. Crowdsourcing has changed the use of mobile devices and added dimensions, such as patterns in mobility, activities and processes. Additionally, it has encouraged the usage of technologies, the advancement of user interface and social networking models. Crowdsourcing has initiated a change in the social computing landscape. The applications that have been developed have impacted healthcare, labour economics, engineering and services (Afridi 2011).



Source: (Wang, Li et al. 2016)

Figure 2.2: Crowdsourcing mobile device

2.3 SUMMARY OF MOBILE CROWDSOURCING ADOPTION MODELS

Table 2.1: Technology adoption models summary

Source: established by own study

Summary of technology adoption theories			
Authors	**Title of research article**	**Adoption Model**	**Findings**
(Nyeko and Ogenmungu 2017)	Determinants of electronic learning adoption in higher institutions of learning in Uganda: A learners' perspective	Technology-organisation-environment (TOE)	This study findings imply that the TOE can be used to analyse ELearning (EL) adoption in Universities and other HIL as relative advantage, complexity, compatibility, size, competitive intensity and regulatory environment were identified as significant predictors of EL adoption. Whereas top management support and IT/IS knowledge are insignificant predictors in the adoption of EL

Summary of technology adoption theories			
Authors	**Title of research article**	**Adoption Model**	**Findings**
(Beza;, Reidsma; et al. 2018)	Exploring farmers' intentions to adopt mobile short message service (SMS) for citizen science in agriculture.	The unified theory of acceptance and use of technology (UTAUT2)	Structural equation modelling showed that intentions to adopt mobile SMS technology for agricultural data provision were predicted by the perceived usefulness of the technology (performance expectancy), the effort needed to use the technology (effort expectancy), the cost of using the technology (price value) and the trustworthiness of the organising body (trust; e.g., organisations behind the citizen science initiative).

Summary of technology adoption theories			
Authors	**Title of research article**	**Adoption Model**	**Findings**
(wahedi, Hoshang et al. 2015)	Investigating factors influencing the acceptance and utilisation of government mobile crowdsourcing applications case study: city guard application in Abu Dhabi city	Unified theory acceptance use of technology (UTAUT)	This study sets forth to investigate the significant factors influencing the acceptance and utilisation of CityGuard application among Abu Dhabi residents and visitors. In order to do so, a model was conceptualised after studying the literature. It was found that there are four factors significantly influencing the intention to use the CityGuard application, whereas three factors influence the actual usage of the application.

Summary of technology adoption theories			
Authors	**Title of research article**	**Adoption Model**	**Findings**
(Gatara 2013)	Predicting intention to participate in mobile crowdsourcing initiatives: a study of local Kenyan communities.	Technology acceptance model (TAM)	Findings show that "self-development", "integrity", and "reputation" are the most significant predictors of "participation intention". Contrary to suggestions made in prior literature on crowdsourcing, "monetary compensation" was not found to be a key motivator. Additional findings show that "attitude" was found to be a strong mediator of the relationship between "technology anxiety" and "participation intention". Moreover, "community identification" was found to be a full moderator of the relationship between "social influence" and "participation intention"

Summary of technology adoption theories			
Authors	**Title of research article**	**Adoption Model**	**Findings**
(Okoroji 2019)	Farmers' use of mobile phone applications in Abia state, Nigeria	Technology adoption model (TAM2)	The results of this study revealed factors influencing the adoption of these applications by farmers and the usage of the current state of the mobile application. Social impact (SI), perceived usefulness (PU), information/ awareness (IA) and intent to need (ITU) positively influenced the adoption of mobile apps while perceived risk (PR) and perceived cost had a negative effect on their acceptance. Via its findings, this research contributed extensively to the literature on farmers' use of technology.

Summary of technology adoption theories			
Authors	**Title of research article**	**Adoption Model**	**Findings**
(Khatimah; and Halim 2014)	Consumers' Intention to Use e-Money in Indonesia Based on Unified Theory of Acceptance and Use of Technology (UTAUT)	Unified theory of acceptance and use of technology (UTAUT)	This study explores the unified theory of acceptance and use of technology (UTAUT). The conceptual framework of e-money transactions was reviewed to understand the behavioural intention of consumers by using four dimensions of that theory: performance expectancy, effort expectancy, social influence and facilitating condition. Furthermore, perceived risk is considered to affect the consumers' intention to use.

Summary of technology adoption theories			
Authors	**Title of research article**	**Adoption Model**	**Findings**
(Alsamydai 2014)	Adaptation of the Technology Acceptance Model to the Use of Mobile Banking Services	Technology adoption model (TAM)	It was discovered by the use of mobile banking services that the mean value of all variables was impacted in this study (4.45). From the first group, seven hypotheses were acknowledged regarding the interaction between the research model components and all the eight hypotheses. The use of mobile banking services showed a positive correlation and that a stronger correlation between each of the attitudes and a coefficient correlation value (0.377) was generated by the statistical analysis of all these components. The largest correlation was found between (perceiving ease of use) and (experience) with the correlation value (0.534).

Summary of technology adoption theories			
Authors	**Title of research article**	**Adoption Model**	**Findings**
(Frankwell W. Dulle and Minishi-Majanja 2011)	The suitability of the unified theory of acceptance and use of technology (UTAUT) model in open access adoption studies	Unified theory of acceptance and use of technology (UTAUT)	The study findings suggest support for the application of the UTAUT model in studying the adoption of open access in a research environment. Among the findings, attitude, awareness, effort expectancy and performance expectancy were established as the key determinants for the researchers' behavioural intentions of open access usage. Similarly, age, awareness, behavioural intention, facilitating conditions and social influence were found to affect researchers' actual usage of open access significantly. These factors should, therefore, be considered in the planning and implementation of open access projects.

Summary of technology adoption theories			
Authors	**Title of research article**	**Adoption Model**	**Findings**
(Marjan Ghofranfarid and Rezaei 2018)	Rural households' renewable energy usage intention in Iran: Extending the unified theory of acceptance and use of technology	The unified theory of acceptance and use of technology (UTAUT)	This research work tests a model about the intention of using renewable energy sources at the rural household level in Iran. The model focuses on the unified theory of acceptance and use of technology (UTAUT). The researchers identified four variables—perceived behavioural control, awareness, relative advantage, and moral norms. The findings not only provide evidence for the five mediated paths in the cognitive processing of intention of using renewable energy but also provide support to investment decisions for developing renewable energy in the rural areas of Iran and other developing countries.

Summary of technology adoption theories			
Authors	**Title of research article**	**Adoption Model**	**Findings**
(Shatat 2017)	Factors affecting the adoption and usage of online services in Oman	Technology adoption model (TAM2) and the theory of reasoned action (TRA)	This study identifies key influential factors such as usefulness, ease of use, cultural and social issues, awareness, trustworthiness, security, and privacy. The findings of this research show that there is a significant relationship between usefulness, ease of use, and trustworthiness with the adoption and use of online services in Oman. The results clarify the main factors that influence the decision of Omanis and other residents to adopt and use the online services that are provided by many firms in the Sultanate of Oman.

Summary of technology adoption theories			
Authors	**Title of research article**	**Adoption Model**	**Findings**
(Feng 2012)	Faculty Adoption and Utilisation of Online Instruction in Higher Education: A Study Based on the Unified Theory of Acceptance and Use of Technology	The unified theory of acceptance and use of technology (UTAUT)	The analysis results indicate that performance expectancy, effort expectancy, and social influence have a significant positive influence on the intention to use continuously, facilitating conditions and on the level of use. At the same time, the research results also suggest that the influence of social influence on the intention to use continuously will be moderated by gender, experience and age.

Summary of technology adoption theories			
Authors	**Title of research article**	**Adoption Model**	**Findings**
(Aljowaidi 2015)	A study of e-commerce adoption using TOE framework in Saudi retailers: firm motivations, implementation, and benefits	Technology-organisation-environment (TOE)	An effective management technique by most companies to address the internal challenges and difficulties associated with introducing e-commerce to the transition process. Although retailers were prepared to accept e-commerce as seen in this study, progress on implementation in the country was slow and very early, concentrating largely on circumstantial impediments to better grasp the very core of the Saudi economy. This study constitutes a significant conceptual contribution to the development and implementation of the TOE system in understanding e-commerce adoption and in supporting the explanations for the successes and failures found. The use of this definition was expected as it justifies similar remarks in similar economies in the region and the developing world as a whole.

Summary of technology adoption theories			
Authors	**Title of research article**	**Adoption Model**	**Findings**
(Seethamraju and Diatha 2018)	Adoption of Digital Payments by Small Retail Stores	Technology-organisation-environment (TOE)	Using a qualitative methodology and the technology-organisation-environment framework, this study showed that a perceived loss of control, costs of technologies, customer's low socio-economic background, suppliers influence, tax and security implications, bureaucracy, and a lack of trust in the regulatory and external environment are challenges. In addition, poor physical and digital infrastructure, inadequate access to and poor reliability of digital technologies, and the costs are constraining the adoption of digital technologies.

Summary of technology adoption theories			
Authors	**Title of research article**	**Adoption Model**	**Findings**
(Chen and Salmanian 2017)	User Acceptance in the Sharing Economy: An Explanatory Study of Transportation Network Companies in China Based on UTAUT2	UTAUT2	In this study, user acceptance is defined as the intention to use Transportation Network Companies (TNC) and the actual use of TNC. The state of the art user acceptance model UTAUT2 is used in this research with an explanatory purpose and a deductive approach. The UTAUT2 model consists of factors related to user acceptance, such as performance expectancy, effort expectancy, social influence, facilitating conditions, hedonic motivation, price value, and habit. These factors were individually tested with simple linear regression to determine their influence on user acceptance.

(Aljowaidi 2015)	A study of e-commerce adoption using TOE framework in Saudi retailers: firm motivations, implementation, and benefits.	Technology-organisation-environment (TOE)	The study identifies a number of factors as important motivations for the adoption and implementation of e-commerce. Firstly, it identifies improved operational efficiency and the enhancement of marketing as motivators for e-commerce adoption and implementation. The study, however, shows that retailers are willing to adopt e-commerce, and that most organisations have a good management approach to handling the internal constraints and challenges of the process of change associated with e-commerce implementation. However, the progress of implementation in the country is slow and only at a very early stage. This is mostly based on contextual impediments. Furthermore, the socio-cultural belief systems were found to constitute a major influence on the slow progress towards the implementation of the technology. Moreover, the study found that family affiliations and the tribal system in the country have a significant influence

Summary of technology adoption theories			
Authors	**Title of research article**	**Adoption Model**	**Findings**
			on organisational structure and culture.
(Meer 2018)	The Internet Antenna of Silicon Savannah: How start-ups perceive the impact of internet services on the Nairobi business environment and enterprise development challenges	Technology adoption model (TAM2)	Adapted versions of the new venture creation model and the extended technology acceptance model shape the basis for understanding the perceptions of the Nairobi business environment, Internet services, online education programs, online marketing platforms, and online venture capital websites. Internet services are strongly perceived to contribute to market access, whereas the impact on human capital and competitiveness is recognised to a lesser extent. While it is the most pressing development challenge, access to capital has not improved because of Internet services.

Summary of technology adoption theories			
Authors	**Title of research article**	**Adoption Model**	**Findings**
(Chiu, Chen et al. 2017)	An Integrated Perspective of TOE Framework and Innovation Diffusion in Broadband Mobile Applications Adoption by Enterprises	Technology-organisation-environment (TOE) and Diffusion of Innovations (DOI)	In terms of technology context, relative advantage and compatibility showed significant results in line with the research results that rely on communication tools. Trialability has reached a significant level. Organisation context significantly affected the adoption of broadband mobile applications. Environment context has a significant effect on the adoption of broadband mobile application.
(Maryam, Maarop et al. 2015)	Factors Influencing Customers' Engagement in Social Media for Co-creation in the Fashion Industry Of Saudi Arabia	Technology adoption model (TAM3)	The findings indicate that social influence has a positive effect on the intention to participate in social media for co-creation purposes, whether directly or indirectly, through affecting customer learning value, social integrative value, and hedonic value experiences, as well as through perceived usefulness and perceived ease of use.

Summary of technology adoption theories			
Authors	**Title of research article**	**Adoption Model**	**Findings**
(Demoulin and Djelassi 2016)	An integrated model of self-service technology (SST) usage in a retail context	Technology adoption Model (TAM3)	The results demonstrate that in addition to previous usage behavior, situational factors influence customers' decisions to use SSTs during a specific shopping trip and the perceived behavioural control is the most important determinant of behavioural intention, followed by perceived usefulness, need for interaction and perceived ease of use and enjoyment.

2.4 CONCLUSION

Despite all the advantages of using mobile phones and mobile crowdsourcing globally in agriculture, especially in crop production, the critical and realistic question remains: How do we empower farmers in rural areas with accurate, on time and valuable information with regard to crop production and decision making? There is a need to keep highlighting the truth that every year, in rural areas of Africa, and South-Kivu in particular, thousands of farmers face the same challenges and ask themselves the same question: How do we produce a good crop for the current planting season?

One of the most critical factors of agricultural development is the management of crop production, as poor crop production at the beginning of the food production chain is luckily to jeopardize the entire food chain.

The next chapter will provide an explanation of the approaches and methods used in the study, the research design for conducting the research, the proposed research model and the hypotheses to be tested. How the data were collected and analysed will also be covered in the chapter.

CHAPTER 3

STUDY DESIGN AND METHODS

3.1 OVERVIEW OF THE ASSESSMENT

This chapter describes the methods applied in conducting the empirical study. Figure 3.1 below illustrates the methods used for collecting the information required to complete the study. The diagram includes the whole process followed including the preparation, the scheduling of meetings with the authorities from different farmers collectives, the assembling of the letters of consent, the selection of the samples, the capturing, analysis and interpretation of the data and the final report that is presented in Chapters 4 and 5.

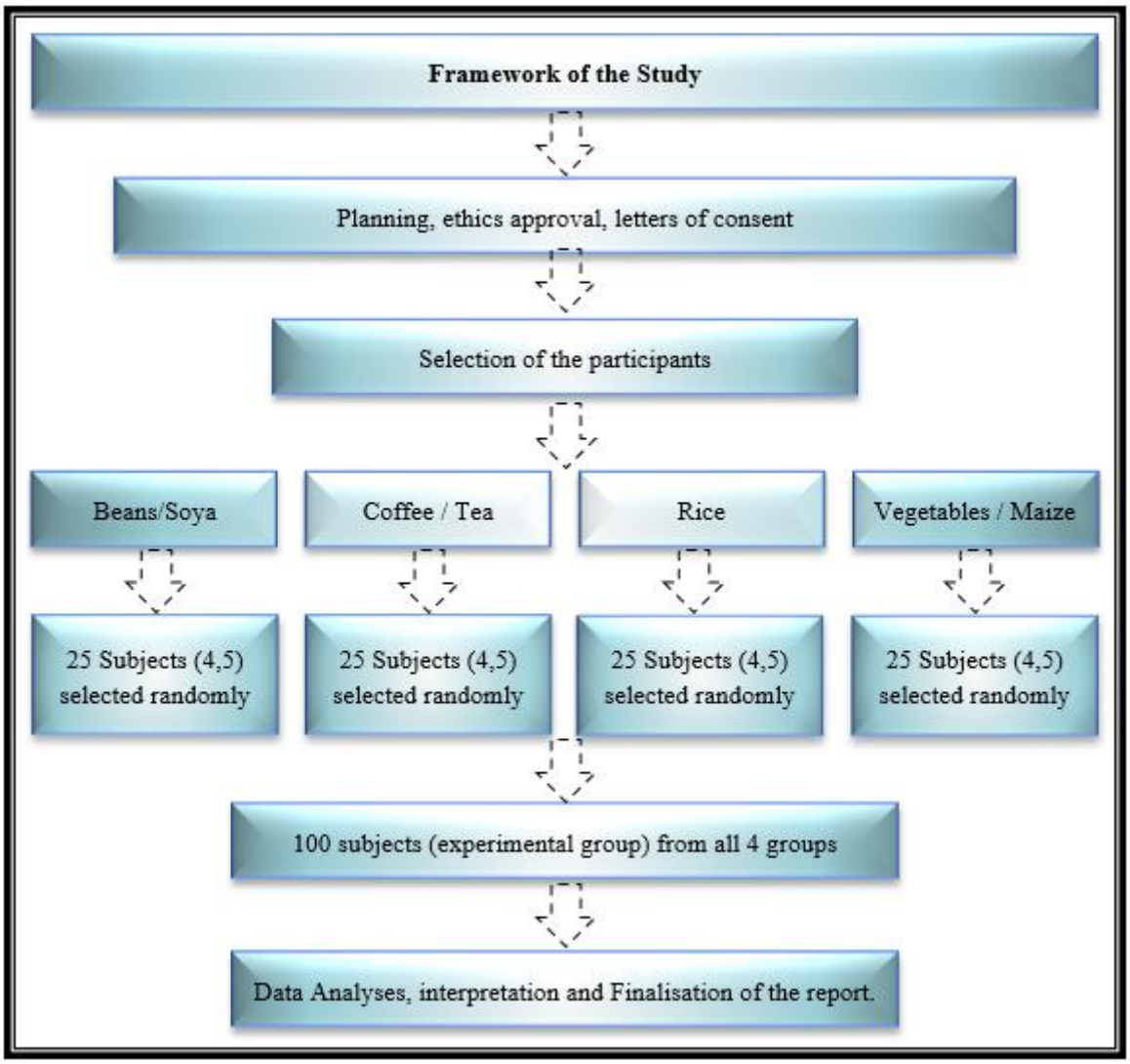


Figure 3.1: Framework of the study in Chapters 3, 4 and 5
Source: established by own study

3.2 PLANNING AND ADMINISTRATION

3.2.1 Geographic demarcation

Located in the extreme east of the Democratic Republic of the Congo (DRC), South Kivu Province covers 65,070 square kilometres and has a population of 5,772 million. The province was created in 1989, when the existing Kivu Province was divided into three parts to create the South-Kivu, North-Kivu and Maniema Provinces. South-Kivu borders the provinces of North-Kivu to the North, the Maniema to the West, and Katanga to the South. It borders the countries of Rwanda, Burundi, and Tanzania in the east, as illustrated in Figure 3.2.

The province is characterised by two bimodal cycles of rainy seasons, which occur from March to May and from September to December, accompanied by two short dry seasons from June to August and from January to February. According to the Köppen climate system classification, the area's climate can be categorised as tropical because of its altitude. The present annual average temperature is from 25 to 27° C and the average monthly temperature is from 21 to 23° C, with the annual rainfall ranging from 800 mm (Ruzizi Plain, eastern part) to 2650 mm (mountain areas, western part) (Munyuli T.M.B. 2016).

Source: (Munyuli T.M.B. 2016)

Figure 3.2: Map showing the studied country including South-Kivu Province

3.2.2 Description of South-Kivu Province

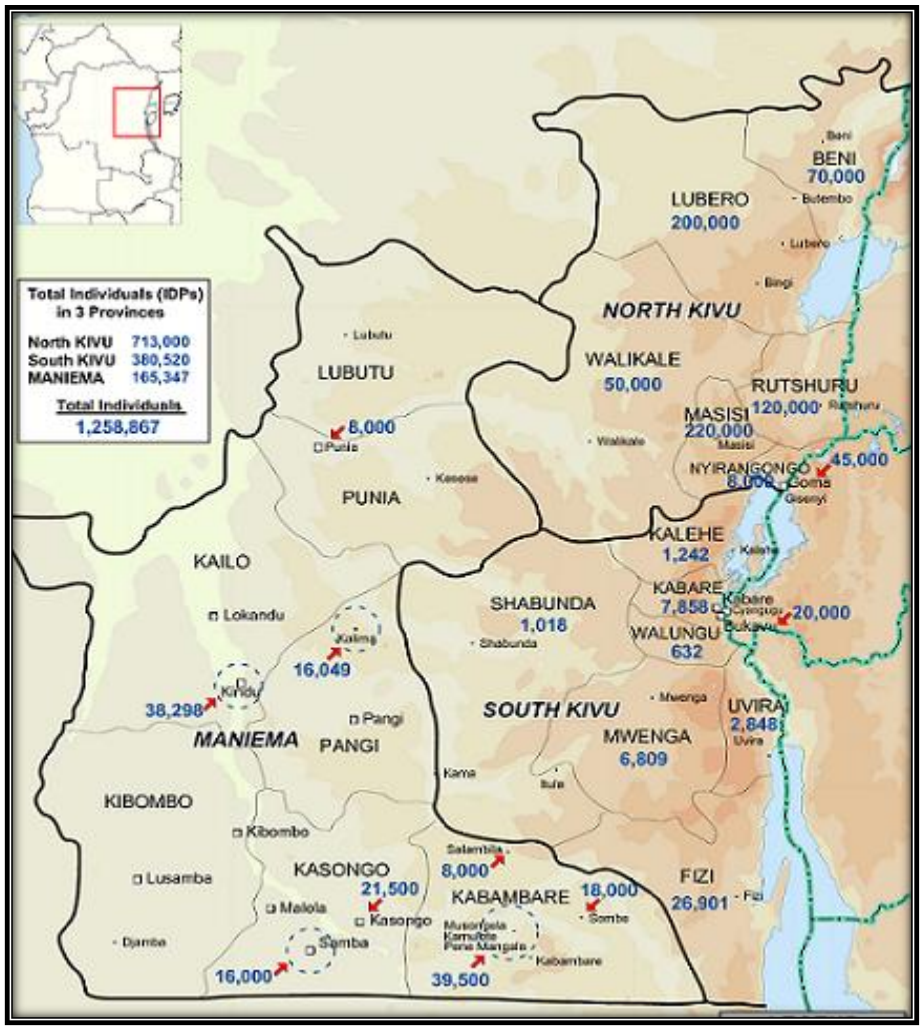
South Kivu province covers an area of 65,070 square kilometres. The province is made up administratively of eight territories (Kabare, Kalehe, Walungu, Idjwi, Mwenga, Shabunda, Fizi and Uvira). The investigative survey was performed in three territories (Kabare, Kalehe, Walungu) between April and June 2019.

The geographic area of the province provides extraordinary biodiversity, a pleasant climate, and a habitat for a rich and diverse animal life. The plant life is lush involving rainforests, open woodland trees and savannah grassland. The sky is spectacular with galleries of clouds. South

Kivu is characterised by mostly lush equatorial vegetation and land stretching from high mountainous and plateau areas reaching nearly 3,500 m along the western shore of Lake Kivu and descending west to a less densely populated lowland plateau at around 500 m and equatorial forest territory (Munyuli T.M.B. 2016). In reality, the climate of the region is complex and determined mainly by wind speed, rainfall patterns, altitude.

The variability in the weather is determined by the beginning date of the seasonal cycle (starting date of the runoff), the number of seasonal days per month and the sum of semi-dry months during the rainy season. Soils (ferrisols, ferrasols, acrisols, and nitisols) primarily originate from volcanic sources. An increasing decrease in the fertility levels of these soils and extreme soil erosion are frequently reported in slippery and hilly areas. Knowledge accessibility and land degradation are among the major constraints for food production in South Kivu Province.

Along with soil degradation, sediments on the hilly side, chemical runoff from the agricultural landscape raises the degree of contamination of the edges of water bodies (rivers, Lake Kivu) and marshlands/wetlands (seasonal flood lands). However, these marginal areas are also important for the reproduction (breeding) of many species of fish. The marshlands are mostly situated either at the edge of the bodies of water or in the lower hills (Munyuli T.M.B. 2016). Agricultural subsistence crops include fruit crops (avocado, mango, citrus, mandarin orange and pineapple, for example), industrial crops (tea, cotton, coffee and palm oil, for example.), legume crops (peas, beans and soybeans, for example), cereal crops (rice, sorghum and maize, for example) and vegetable crops (eggplant, tomato, cob, amaranth and cucurbit, for example). After endless conflicts, farmers have not been receiving government assistance for cash crop production; they have to do all they can to survive. Among post-conflict adaptation measures, some farmers have targeted certain crops as cash/commercial crops to increase their income and maintain their livelihoods (Munyuli et al., 2018).



Source: (Kabamba and Malumalu 2016)

Figure 3.3: Map of South Kivu Province showing territories (Kabare, Kalehe, Walungu) where sites of research were chosen.

3.2.3 Identifying the farmer's collectives.

The researcher approached the provincial office of the Ministry of Agriculture and Rural Development in the province of South Kivu to explain the purpose of the study and to request the participation of appropriate farmers' collectives. Several farmers' collectives were suggested, including those in the Kabare, Kalehe and Walungu territories of South Kivu Province. The researcher conducted a general survey of the 12 farmers' collectives in the three territories and met the respective collectives' president as a way of identifying the six collectives where the research was to be conducted. The researcher settled on the collectives of Nyalubuze and Bideka for the territories of Walungu, the collectives of Cirunga and Muduku for the territories of Kabare, and the collectives of Mbinga-North and Mbinga-South for the territories of Kalehe, respectively. Initially, the researcher obtained oral permission for the data collection from each collective's president after thoroughly explaining the purpose of the

research to the authorities. The participant selection criteria were based on the interest, approachability, and responsiveness shown by each president, the number of farmers who were part of the collective, and the proximity of selected collectives to both the researcher and the fieldworkers. The verbal permission necessitated two preparatory meetings on 28 December 2018 and 04 January 2019 with the collective presidents once a week to plan how the study was to be conducted and the meetings were held.

3.3 PERMISSION TO CONDUCT THE COMPARATIVE STUDY

3.3.1 Meetings with the presidents of the selected collectives

The management of all six collectives signed letters of permission on the second of March, the sixth of March, and the thirtieth of March 2019 (Annexures A, B, and C), marking the commencement of the programme. One meeting was held with farmers from all six collective to discuss the technology acceptance model and social demographic questionnaires. During these meetings, the farmers and fieldworkers ensured that all parties understood the roles the research team would play in answering the questionnaires. The research project letter (Annexure D) and consent letters (Annexure E) were handed to those who attended the meetings and sent to the farmers not present but who agreed to be part of the research.

The application was made available to the farmers at the beginning of the planting season to be used throughout this period in order to access their technology acceptance level at the end of the harvest season.

3.3.2 Ethical considerations

The Vaal University of Technology Ethics Committee endorsed the study. Following the existing policy for research protocol, the required documents were submitted to the institution. In the letters of informed consent (Annexure E) distributed to farmers by the offices of the respective collectives' presidents, the aspect of intellectual property rights was addressed. In each letter, an assurance was made to each collective that all responses would be kept private and confidential and would be used only for research and the future benefits of DRC farming development.

3.3.3 Recruitment and training of fieldworkers

The researcher recruited nine Universite Evangelique en Afrique (UEA) students. The advert was placed on the student information board, requesting applications from agronomy students with Mashi and Swahili-speaking backgrounds who were interested in participating in the research. The five students in the third year of the diploma course and four studying for the Bachelor of Science (BSc) Degree were chosen and trained in completing questionnaires by the researcher at the University. Fortunately, there was no dropout and all nine students participated in the data collection. The choice of fieldworkers was appropriate from a language perspective, as the target population of the study was Mashi and Swahili speaking. Thus, the same fieldworkers were recruited to assist in translating the questionnaires orally whenever necessary, as nearly all the respondents' households used Mashi and Swahili.

3.3.4 Intellectual property rights

The information produced was reported for the Master of Technology (Information, Communications and Technology) qualification. The intellectual property rights of this study belong to the VUT.

3.4 STUDY POPULATION AND SAMPLE SELECTION

All the data were collected from the farmers' households that were the target population, which was part of the respective farmers' collectives. The sample comprised specific households of the target population, which was part of the selected farmers' collectives.

A preliminary group of farmers was randomly selected from the six collectives and a purposive sample of hundred and fifty (n=150) subjects, which included all the farmers with completed consent forms, was also selected from the farmer's collectives in the South-Kivu province.

Based on the criteria for selection, the Walungu territory comprised forty-one (n=41) household respondents, the Kalehe territory, comprised forty-one (n=41) household respondents, and the Kabare district comprised eighteen (n=18) respondents.

Consent forms for measuring their technology acceptance level and social demographics had been signed by the farmers. All the selected farmers from all six selected farmers' collectives were interviewed about their use of the framework for mobile crowdsourcing.

3.5 RESEARCH DESIGN

The common method used by researchers in experimental cross-sectional surveys assessing daily access to agricultural information, livelihood conditions, and the technology acceptance level of a group of people has been described as a snapshot of the population about which they gather data (Lavrakas 2008). This type of quantitative study design includes questionnaires that gather socio-demographic data and information about the participants' acceptance of technology. However, the research approach used in conducting the study focused on two types of data sources:

- External Sources: Knowledge and information obtained from analysing the literature relevant to the study and its goals. This was also used to develop the layout of the analysis.
- Primary Source: Data used to construct the final study questionnaire that was distributed to farmers from selected communities, including the following phases:

Phase 1: Pre-testing of the tools applied.

The purpose of phase 1 was to test the questionnaires used in the study on randomly selected farmers from the three selected farmers collectives. As some of the farmers were not able to respond to the Technology acceptance model questionnaire (TAMQs) personally, field workers were required to complete the process. Conducting a preliminary tool-testing phase was critical to the study and administering the questionnaires prepared the fieldworkers for the assessment. This phase enabled the research team to adjust their approach to administering the TAMQs wherever necessary.

Phase 2: Determining the information sharing and data accessibility status.

Initially, the purpose of this phase was to assess farmers from the six farming collectives by understanding their daily and weekly information sharing and data access patterns based on the data collected in the socio-demographic and agricultural information frequency questionnaires. The aim was to find averages by means of the household and collectives surveys as a basis for possible solutions and remedial action regarding the prevailing conditions among the targeted population.

Phase 3: Determining the technology acceptance status.

The purpose of this phase was to determine the levels of technology acceptance of the farmers from the selected collectives through the following categories: perceived usefulness, perceived ease-of-use, quality factors, and experience of the proposed mobile crowdsourcing model.

3.6 DATA COLLECTION

The procedures for the above-mentioned three phases of the study were conducted as follows:

3.6.1 Preliminary testing of tools used in the study.

The preliminary testing was conducted from the eight to the twelve of April 2018. The methods and instruments to be applied in the research were partly pre-determined at the proposal stage and discussed in Chapter 1 of this research report. The researcher selected the TAMQs in consultation with the supervisor. The apparatus used in the study consisted of socio-demographic questions and the TAMQs. Thanks are due to the Esoko team (Ghana and Rwanda) and the International Institute of Tropical Agriculture (IITA) KALAMBO (South-Kivu) for validating the Technology acceptance model (TAM) questionnaires, which were employed as tools for the field study and relevant for use within the South-Kivu Province. The mobile application used was provided by Esoko. The purpose of the preliminary exercise was to pre-test the questionnaires used in the study on randomly selected farmers in the designated collectives. Figure 3.4 below shows the application used in the study.

3.6.2 Determining the information sharing and data accessibility patterns.

For this phase, the purpose was to assess the information sharing patterns of farmers' collectives using socio-demographic questionnaires and technology acceptance model questionnaires.

3.6.2.1 Socio-demographic questionnaire

The questions in the socio-demographic part of the questionnaire (Annexure F) asked farmers for general and personal information, such as gender, family status, age, and information accessibility. Where the need arose for a follow-up consultation or call to complete the questionnaires, the fieldworker would contact the respective household.

The use of the socio-demographic survey questionnaire helped the researcher in assessing the kind of family and collective backgrounds to which the farmers or target population belonged.

3.6.2.2 Technology acceptance model questionnaires (TAMQs)

The technology acceptance model (TAM) proposes that user acceptance and usage of a technology is determined by five key attitudinal components: quality factors (QF), perceived ease of use (PEOU), perceived usefulness (PU), experience (EXP), attitude (At) and behavioral intention to use (BI).

Perceived usefulness of technology reflects the benefits a person believes that technology can bring to their work performance, whereas perceived ease of use reflects the effort required to adopt and use the technology (Alsamydai 2014 ; Davis., Bagozzi. et al. 1989).

After being exposed to the mobile crowdsourcing platform (through the Esoko app) for over 6 months, the TAM questionnaire (Annexure G) requested the farmer to state his/her acceptance level of technology and determine whether the TAM could adequately explain their adoption and use of the proposed solution.

The purpose of the TAM in this study was to review the technology acceptance level for farmers in rural areas using a mobile crowdsourcing portal.

Table 3.1: Survey questionnaire statements related to variables.
Source: established by own study

Construct	Items	Sources
Demographics information	User location, family role, gender, age, status, information accessibility, preferred method of accessing information, expert's input on crop production	
The quality factors (QF)	QF 1:To what extent does information quality affect your acceptance/use of mobile application services QF 2: To what extent does service quality affect your acceptance/use of mobile application services QF 3: To what extent does systems quality affect your acceptance/use of mobile application services	(Alsamydai 2014)

Construct	Items	Sources
	QF 4: To what extent do quality factors affect your perceived ease of use of mobile application services QF 5: To what extent do quality factors affect your acceptance/use of mobile application services	
Perceived ease of use (PEOU) of mobile crowdsourcing	PEOU 1: To what extent does perceived ease of use affect your perceived usefulness PEOU 2: To what extent does perceived ease of use affect your experience to use mobile application services PEOU 3: To what extent does perceived ease of use affect your perceived ability to use mobile application services PEOU 4: To what extent does perceived ease of use affect your acceptance to use mobile application services	(Alsamydai 2014)
Perceived usefulness (PU) of mobile crowdsourcing	PU 1: To what extent does perceived usefulness affect your behavioural intention to use mobile application services PU2: To what extent does perceived usefulness affect your acceptance to use mobile application services	(Alsamydai 2014)
Experience (E)	E1: To what extent does experience affect your perceived usefulness to use mobile application services E2: To what extent does experience affect your attitude toward using mobile application services E3: To what extent does experience affect your acceptance to use mobile application services	(Alsamydai 2014)
Attitude	1. To what extent does your attitude affect your behavioural intention to use mobile application services 2. To what extent does your attitude affect your acceptance to use mobile application services	(Alsamydai 2014)

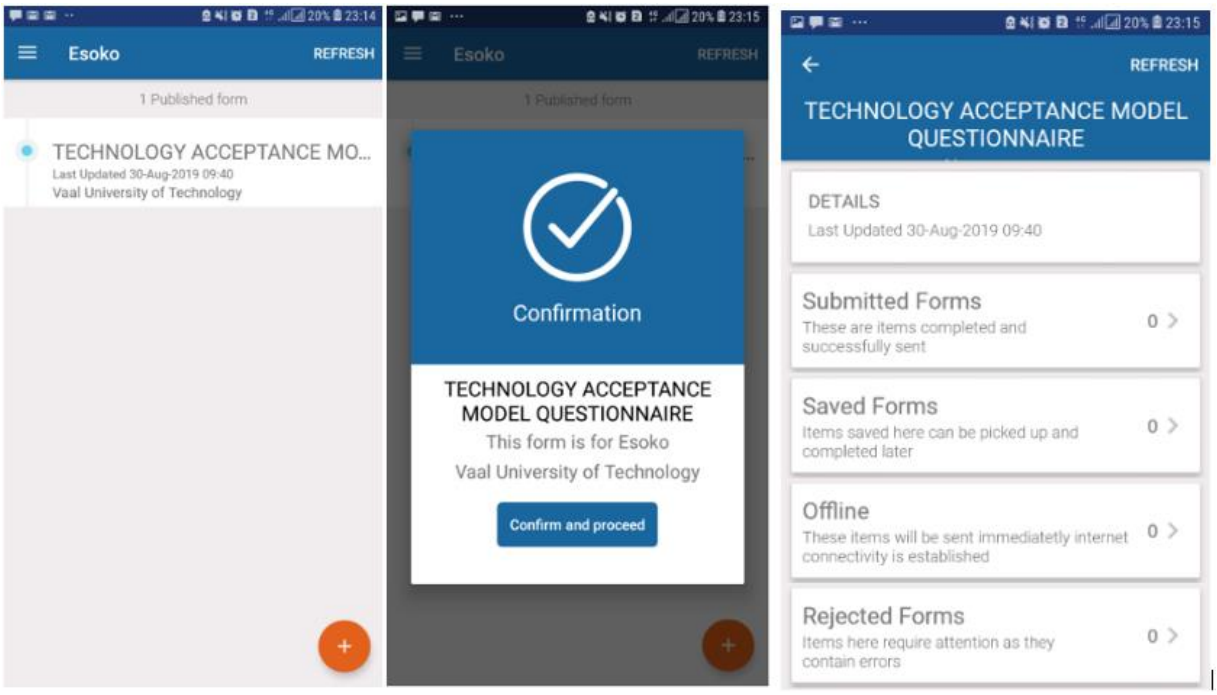
Construct	Items	Sources
Behavioural intention	1. To what extent does behavioural intention affect your acceptance to use mobile application services 2. To what extent does your behavioural intention towards mobile banking affect your acceptance to use mobile application services	(Alsamydai 2014)

3.6.3 Criteria for admissibility of data

3.6.3.1 Validity and reliability

Alsamydai (2014) provided the validated technology acceptance model questionnaires (TAMQs) considered suitable for the situation in the South-Kivu Province. The TAMQs have been used in various surveys similar to this study, although each research topic is the only one of its kind investigating a specific objective. Achieving maximum reliability and validity for the questionnaires was essential to the main objective of the study. According to Kalton. and Schuman. (1982), the findings from questionnaires are convincingly valid if those results are reasonably or logically consistent. The stability and accuracy of the instruments employed in this study have frequently been validated in many different investigations relating to the TAM. The validated TAMQs are adaptable for use where all farmers' groupings in different circumstances are sampled, and their application in other countries has been confirmed in similar studies. In this study, all the TAMQ had face validity, implying that when users are presented with new technology, several factors influence their decision about how and when they will use it (Davis., Bagozzi. et al. 1989).

Various methods to ensure reliable access to information for farmers in the rural area as well as the TAM have already been discussed extensively in the literature review in Chapter 2. The methods used were surveyed questionnaires supported by the Esoko platform as shown in Figure 3.4 below.



Source: establish by own study

Figure 3.4: The mobile application used for the evaluation (TAM and sociodemographic questionnaire).

To determine the internal consistency of multiple variables, Cronbach's alpha was utilised to assess construct reliability. Cronbach's alpha is frequently utilised by researchers to measure the internal consistency or reliability of a survey when it consists of multiple Likert-type questions.

Quantifying the core consistency for all of the study's constructs, Alwan and Al-Zu'bi (2016) agreed that a reliability test score of 0.5 or higher indicates substantial accuracy and reliability.

To evaluate the underlying constructs of the study objects, factor analysis was used through principal component analysis (PCA) using varimax rotation to assess the validity of each construct (18 items).

To ascertain the appropriateness of the factor analysis, Kaiser-Meyer-
Olkin (KMO) and Bartlett's test of sphericity were used to assess sampling adequacy and sphe ricity, respectively.

3.6.4 Quantitative analysis of the data

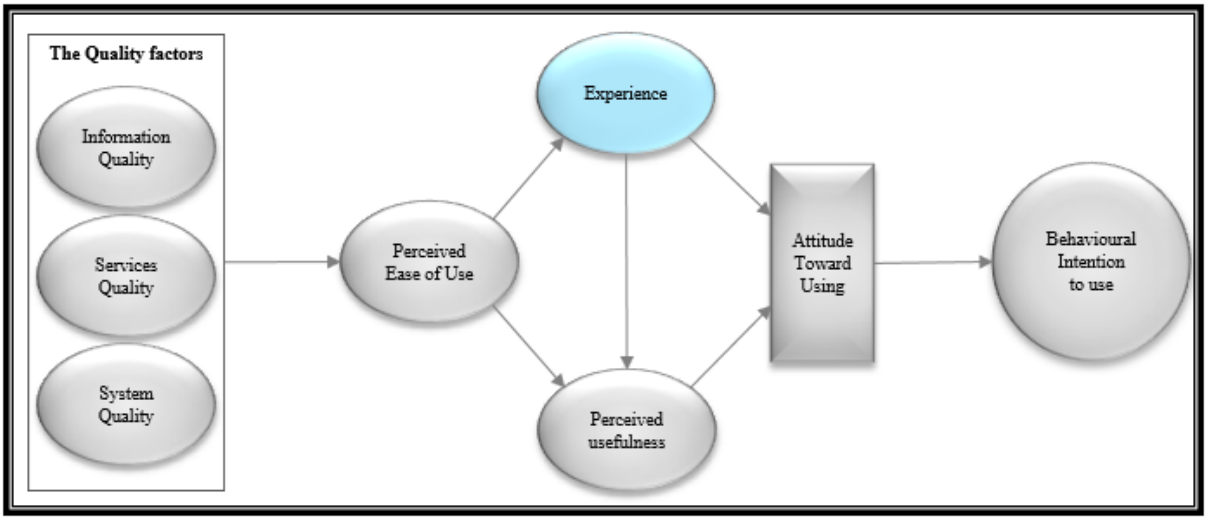
Section A of the questionnaire gathered data about the participants' background, capturing demographic information including gender, age, village name, role in the family, civil status, information accessibility and agricultural decision-making. All of the respondents had access to mobile devices. Although not being part of the purpose of the study, the demographic data was intended to describe the demographic variables of the sample.

Pearson's correlation coefficient is used to examine the statistical relationship between variables. Correlations calculated can be interpreted as follows: If $r = 1$, the correlation is said to be perfect positive. If $r = -1$, the correlation is said to be perfect negative. If $r = 0$, the variables X and Y are said to be uncorrelated. If $0 < r \geq 0.4$, there is a low correlation. If $0.4 \leq r < 0.7$, this indicates a moderate correlation. If $0.7 \leq r < 1$, this indicates a high correlation. The value of correlation coefficients nearer to +1 or -1 can be interpreted as a very high positive or negative correlation and nearing zero is considered as very low (Gupta and Kapoor 2014)

Finally, a series of regression analysis is conducted to test the relationship between each set of variables (Liao 2015). To predict the unknown values of the variable from the identified multiple variables, multiple regression analysis was considered in this research study. Multiple regression analysis was also used to develop a model that can establish the associations between each of the independent variables and the dependent variable based on the data collected in this study.

3.6.5 Proposed research model

In this study, the model was mainly centered on the TAM presented by Alsamydai (2014), In addition to the model suggested by (Davis., Bagozzi. et al. 1989)), the factors (Quality Factors, Perceived ease of use, Perceived Usefulness, Experience, Attitude and Behavioral intention) affecting the usage of banking services and the continued use of the electronic payments model were included in the research model. Thus, the research model was modified as follows:



Source: Davis., Bagozzi. et al. (1989), Alsamydai (2014)

Figure 3.5: Technology acceptance model (TAM)

3.6.6 Research hypothesis

The following factors were explored to ascertain their impact on the mobile crowdsourcing culture: quality factors; perceived ease of use; experience; perceived usefulness; attitude toward using; behavioural intention to use.

- H1: Quality factors positively influence the perceived ease of use, and the level of significant use is equal or less than 0.05 for acceptance of the hypothesis
- H2: Perceived ease of use positively influences experience, and the level of significant use is equal or less than 0.05 for acceptance of the hypothesis
- H3: Perceived ease of use positively influences perceived usefulness and the level of significant use is equal or less than 0.05 for acceptance of the hypothesis
- H4: Perceived usefulness positively influences attitude toward using, and the level of significant use is equal or less than 0.05 for acceptance of the hypothesis.
- H5: Experience positively influences perceived usefulness, and the level of significant use is equal or less than 0.05 for acceptance of the hypothesis
- H6: Experience positively influences attitude, and the level of significant use is equal or less than 0.05 for acceptance of the hypothesis
- H7, attitude toward using positively influences behavioural intention to use, and the level of significant use is equal or less than 0.05 for acceptance of the hypothesis.

3.7 DATA CAPTURING AND ANALYSIS

Following the fieldwork, the researcher and a fieldworker re-checked whether all data were accurately completed in the appropriate columns and arranged each set of questionnaires for the researcher's use in data capturing. In total, thirty-four (34) sets of questions were accurately completed, and the researcher captured the data on Microsoft Excel spreadsheets. The help of Universite Evangelique en Afrique (UEA) in analysing the findings about the collectives' access to information was appreciated. The socio-demographic and TAM questionnaires were also captured on the Microsoft Excel spreadsheet and analysed by the Statistical Package for the Social Sciences (SPSS) to enable the researcher to interpret the socio-demographic and agricultural data concerning the access to information status of the farmers' collectives. The researcher used the statistical data for drawing up tables and graphs to calculate the percentages where necessary for the interpretation and for illustrating inconsistencies linked to the access to information status of the experimental population of the collectives' farmers.

TAM was also used as an analysis tool in this study; so, operationally the defined variables refer to the explanation provided by Alsamydai (2014) and Davis., Bagozzi. et al. (1989). The variables used in the study model are defined as follow:

- **Quality Factor**: this factor is divided into three areas explained below.

  a) Information Quality

  According to Shih and Fang (2004), Information quality is a result of the information system, although previous research has shown that assessing system quality influences information quality (Gelik, Eray et al. 2011). In addition, the data provides an evaluation of the effects of site use. The perceived quality of information on the Internet is determined by the consumers' expectations of it. The perceived usefulness (PU), perceived ease of use (PEOU), attitude toward mobile crowdsourcing services, and use acceptance are all thought to be affected by perceived service quality.

b) Service quality:

According to Alsamydai, yousif et al. (2012), In the literature, service quality in the form of both offline and online services has gotten a lot of coverage. In general, service quality is characterised as the consumer's assessment of service expectations versus service delivery. Customers make a subjective distinction between the level of service they offer and what they actually get, according to (Parasuraman, V.A Zeithaml et al. (1985), (Gefen 2000)). The cumulative utility received by the service recipient defines the service quality (Alsamydai, yousif et al. 2012). In the online context, e-service quality has been described as a web-based or interactive service that delivers on the Internet (Ghash 2004), involving overall customer assessment and judgment of e-service delivery in the virtual marketplace. (Rowley 2006). According to Alsamydai, Yousif, et al. (2012), service efficiency, perceived usefulness (PU), customer satisfaction, and the consistency of dealing with e-banking services all have significant relationships.

c) System quality,

This refers to the information system's ability to execute transactions. Information system output has been assessed using system quality measures. The efficiency of an information system is determined by its supporting functions (Gelik, Eray et al. 2011).

- **Perceived ease of use (PEOU)** is the degree to which a person believes the use of a particular system is effortless. (Kumar, Janssen et al. 2019)

- **Perceived usefulness (PU)** is the degree to which a person believes that using a particular system would enhance his or her job (Davis., Bagozzi. et al. (1989)

- **Experience (Exp)** usually influences a customer's usage. The extent to which a mobile experience affects a variety of users is a topic that involves an examination of applicable technical support (Alsamydai (2014).

- **Attitude toward using (AT)** is defined as a constructive or undesirable estimation of objects, events, people, activities, ideas, or just about everything in the natural environment. The attitudes and expectations towards mobile crowdsourcing applications are also affected by the perceived utility of the project (Alsamydai 2014).

- **Behavioral Intention to Use (IT)** is defined as the amount of strength needed to implement a particular behavior. It refers to the dedication of a person to conduct a certain action in the future (Alsamydai 2014). (Casañeda, Martínez et al. 2007) consider it as an early prognosticator of an individual's behaviour.

3.8 STUDY OBJECTIVE

Specialists and farmers are concerned about certain problems in the field of technological innovation. Firstly, there is the problem of how to make farmers accept the latest technology that would help them access better levels of products and services. Secondly, the intervention of law is needed for the development of technology for farmers who try to cope with adopting new technologies.

- This study focused on the implementation of a technological model and its application to a variety of topics relating to mobile crowdsourcing as a means to improve the crop production of farmers in rural areas. The analysis shed light on the transition in the same direction of this model and its applications, and discussed the web crowdsourcing approach under the following objectives:
- Adaptation of the mobile crowdsourcing platform adoption model
- Finding the possibility for farmers in rural areas to devise a model for embracing technology to use mobile crowdsourcing services in crop production.
- Determining the role of specific factors, such as quality (information, services, and system) and focusing on perceived usability and perceived usefulness
- Considering the effect of perceived ease of use, familiarity, and perceived utility on attitudes towards the usage of mobile crowdsourcing services
- Finding out how behavioural attitudes reflect each of the behavioural expectations and their effect on mobile crowdsourcing.

3.9 CONCLUSION

Chapter 3 has focused on the procedures followed to collect data from the sample during the research intervention. The assumption was that the findings resulting from the statistical data analysis in all survey questionnaires would identify insufficient information sharing and data accessibility patterns. The data collection was aimed at acquiring knowledge regarding the data

accessibility of collectives' farmers. The results of the assessment of the data accessibility status through a mobile crowdsourcing system will be presented and discussed in Chapter 4 with the ultimate objective of the study being to suggest possible solutions in Chapter 5.

CHAPTER 4

RESULTS AND FINDINGS

4.1 INTRODUCTION

Chapter 4 highlights the results of the analysis of data gathered by using a survey questionnaire that was based on the research questions presented in Chapter 1. The IBM Statistical Package for the Social Sciences (SPSS) version 25 was used for the quantitative analysis. The survey was divided into three sections. The first section was the demographic information including province, gender, age group, role in the family, marital status and information accessibility. The second section was based on the research purpose, which was to investigate the farmers' perceptions of mobile crowdsourcing in crop production in rural areas. The questionnaire used a 5 – point Likert scales ranging from 1(Strongly disagree) to 5 (Strongly agree) for every item. The answers were then processed in response to the questions posed in Chapter 1.

4.2 RESPONSE RATE

Out of the hundred and fifty (150) respondents that made up the sample, which was conveniently selected, a hundred and twenty-five (125) respondents returned the surveys. The returned survey percentage is calculated as the number of returned surveys divided by the sample size multiplied by 100 (Mavletova 2013). The response rate was 83.1%; however, fifteen (15) surveys were found to be incomplete and ten (10) farmers withdrew from the survey, even after signing the consent form. Therefore, these were removed from the analysis.

Thus, 100 surveys representing 66.7 % of the sample were analysed. Response rates are important when a study's purpose is to generalise the results to a larger population (Rindfuss, Choe et al. 2015). Moreover, the average response rate for a questionnaire completed electronically is one that is between 30 and 40 percent (Hardigan, Popovici et al. (2016). Petrovčič, Petrič et al. (2016) agree that if the response rate is less than 30 percent, the results are in question. Therefore, as the response rate of the survey was 66.7 %, the data was considered acceptable for analysis.

4.3 RELIABILITY TEST RESULTS

To determine the internal consistency of multiple variables, Cronbach's alpha was utilised to assess construct reliability. Cronbach's alpha is frequently utilised by researchers to measure the internal consistency or reliability of a survey when it consists of multiple Likert-type questions. Quantifying the core consistency among all the constructs of a study, Alwan and Al-Zu'bi (2016) in their study approved that the rule of thumb for the reliability test is that 0.5 or higher represents consistency and reliability. The results presented in Table 4.1 below indicated that the Cronbach's α for all constructs in this study were very reliable as the values exceeded 0.70.

Table 4.1: Reliability statistics for study constructs
Source: established by own study

Construct	No of Items	Cronbach's α
Perceived ease of use (PEOU)	4	0.775
Perceived usefulness (PU)	2	0.727
Attitude toward using (ATT)	2	0.889
Behavioral Intention to Use (BI)	2	0.878
The Quality Factors (QF)	5	0.789
Experience (EXP)	3	0.778

4.4 VALIDITY TEST RESULTS

To evaluate the underlying constructs of the study objects, factor analysis was used by principal component analysis (PCA) using varimax rotation to assess the validity of each construct (18 items).

To ascertain the appropriateness of the factor analysis, Kaiser-Meyer-Olkin (KMO) and Bartlett's test of sphericity were used to assess sampling adequacy and sphericity, respectively. The analytical factor was significant because the findings had a 95 percent level of significance of = 0,05.

As shown in Table 4.2 below, the estimated chi-square was 15834.834 with 412 degrees of freedom, which is important at 0.000 level of significance. The Kaiser Meyer Olkin statistic

was 0.769, which supports the factor analysis in this research, as it is greater than 0.50. The factor analysis of the questionnaires on farmers' awareness of the adoption of mobile crowdsourcing in crop production was therefore considered a suitable technique for further analysis of the data. Table 4.3 shows that six factors were extracted based on varimax rotation with Kaiser Normalisation.

Table 4.2: Sample adequacy

Source: established by own study

Kaiser_Meyer_Olkin Measure of Sampling Adequacy		**.769**
Bartlett's Test of Sphericity	**Approx. Chi-square**	15834.834
	Df	412
	Sig.	.000

Six factors with eigenvalues equal or greater than one was extracted from the eighteen items used in the study. These factors explained the variability of the farmers' perceptions of the adoption of mobile crowdsourcing in crop production for farmers in rural areas.

The matrix investigates the association between the specified variables included in each component and each of the extracted factors. The variable with the highest values in each row is chosen as part of the respective factor. In each of the rows, the values are highlighted to combine the eighteen elements into six core factors. In Table 4.4, the loading factor has been highlighted. These variables will validate the measurement of the items. Only one construct is fulfilled and accurate.

Table 4.3: Factor loadings

Source: established by own study

Rotated Component Matrix						
Variables	**QF**	**PEOU**	**EXP**	**PU**	**AT**	**BI**
QF1	.823					
QF2	.843					
QF3	.728					
QF4	.679					
QF5	.590					
PEOU1		.898				
PEOU2		.861				
PEOU3		.788				
PEOU4		.578				
EXP1			.914			
EXP2			.923			
EXP3			.844			
PU1				.898		
PU2				.851		
AT1					.588	
AT2					.798	
BI1						.816
BI2						.866

Extraction Method: Principal Component Analysis

Rotation Method: Varimax with Kaiser Normalization.

Legends:

QF: Quality factor,

PEOU: Perceive ease of use,

EXP: Experience,

PU: Perceive usefulness,

AT: Attitude,

BI: Behavioural Intention.

4.5 QUANTITATIVE ANALYSIS

To achieve the observed objectives of the study, the data were analysed. In the next section of this report, the data is presented as they appeared in different parts of the questionnaire (Appendices C and D). According to Simpson (2015), evaluating the frequency distribution for each variable to evaluate the numerical value representing the total number of responses for the variable under study is a useful first step in the analysis of quantitative data. Throughout the analysis of the questionnaire results, frequency distribution was used.

4.5.1 Section A: Participants' demographic information

To investigate the participants' background, section A of the questionnaire (refer to Appendix C) captured their demographic information, including gender, age, village name, role in the family, civil status, information accessibility and decision making. The descriptive results are indicated utilising a frequency table. The analysis was carried out based on the 100 completed surveys that were properly filled. All of the respondents had access to mobile devices. Although demographic information was not part of the purpose of the study, this set of data was intended to describe the demographic variables of the sample. In term of gender, seventy (70%) were female and thirty (30%) were male.

Table 4.4: Users' demographic information
Source: established by own study

Category	Item	Frequency	Percentage (%)
Gender			
	Male	30	30
	Female	70	70
District/province			
Walungu	Nyalubuze	21	21
	Bideka	20	20
Kalehe	Mbinga North	20	20
	Mbinga South	21	21
Kabare	Muduku	8	8

Category	Item	Frequency	Percentage (%)
	Cirunga	10	10
Age group			
	20 - 25	4	4
	26 - 30	16	16
	31 - 35	23	23
	36 - 40	10	10
	41 - 45	14	14
	46 - 50	18	18
	51 - 55	8	8
	56 - 60	4	4
	Over 60	3	3
Role in the family			
	Father	30	30
	Mother	67	67
	Grandfather	0	0
	Grandmother	3	3
Marital Status			
	Single	0	0
	Married	91	91
	Widowed	9	9
Information accessibility			
	Cell phone (SMS)	25	25
	Cell phone(call)	75	75
	Cell phone with Internet connect	0	0
	Extension Officer	0	0

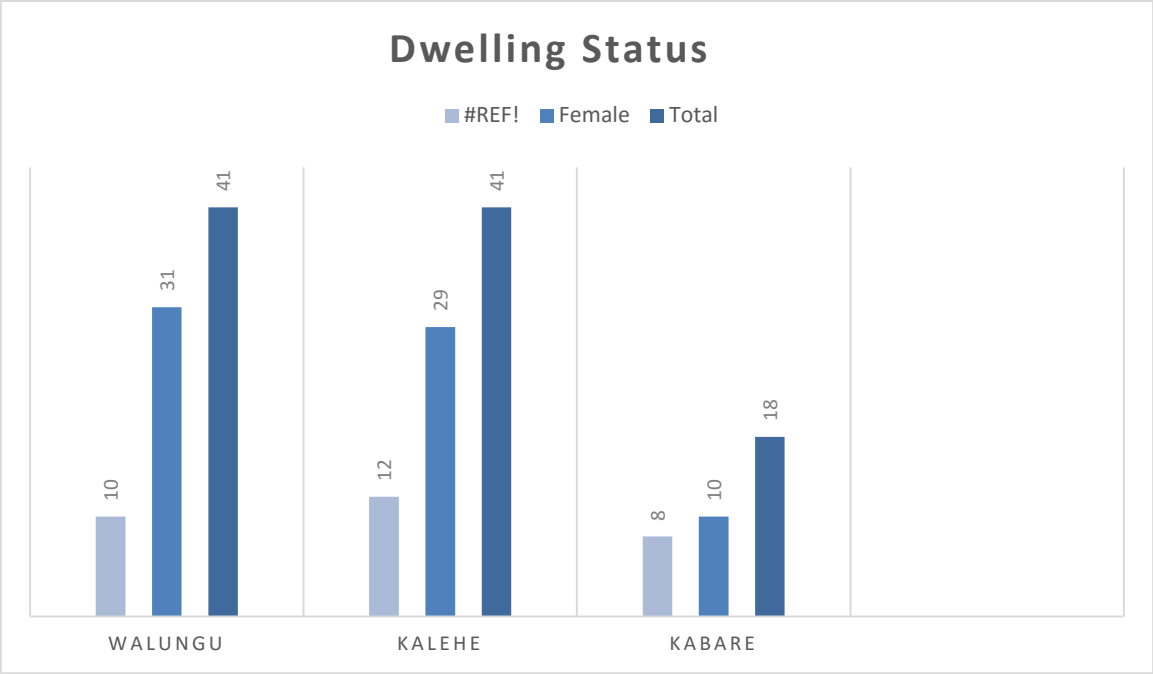
Category	Item	Frequency	Percentage (%)
	Laptop with an internet connection	0	0
	Radio	2	2
	Other, specify	0	0
Preferred method of accessing information			
	Radio	82	82
	Television	40	40
	Newspaper	0	0
	Input dealer (NGOs, agriculture agencies)	93	93
	Internet	2	2
	Other progressive farmers	70	70

4.5.1.1 Dwelling Status

This study was conducted in the eastern part of the Democratic Republic of Congo (DRC). Moreover, it was carried out in the province of South-Kivu where three districts/collectives were randomly selected: Kabare, Walungu and Kalehe.

In each district, two (2) villages were randomly selected to take part in the study:

- For the Collective of Kabare, 8% of the respondents originated from the village of Muduku, and 10% of the respondents came from the village of Cirunga.
- For the collective of Kalehe, 20% of the correspondent came from the village of Mbinga North, and 21% came from the village of Mbinga South.
- For the collective of Walungu, 21% came from the village of Nyalubuse, and 20% came from the village of Bideka

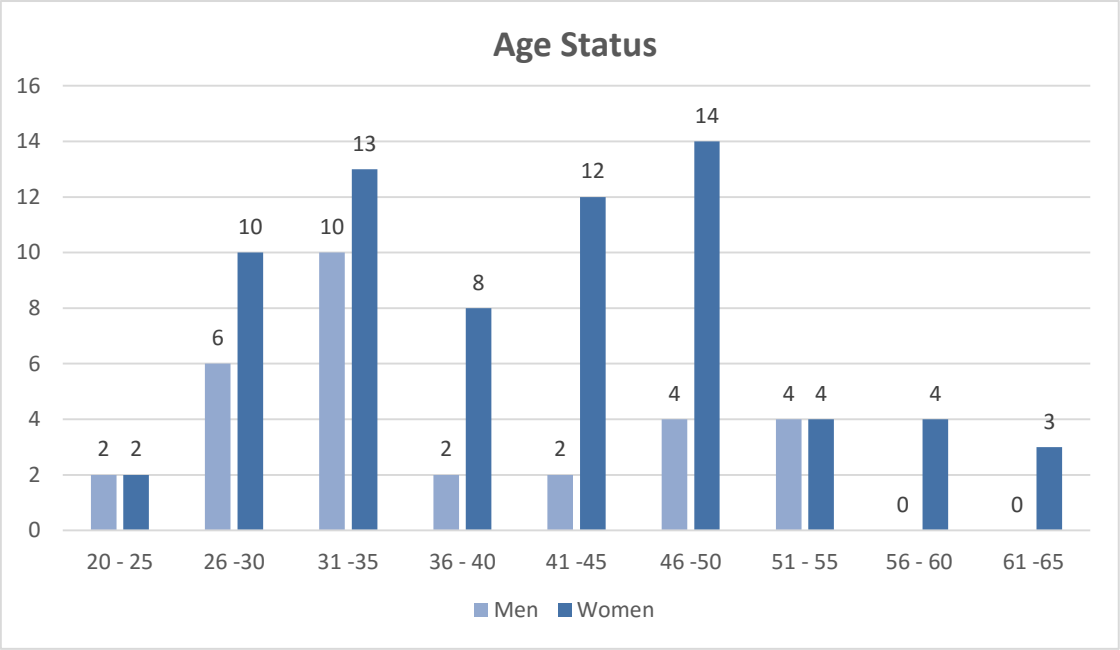


Source: established by own study
Figure 4.1: Dwelling status

4.5.1.2 Age

In relation to age, 4% of the respondents were between 20 and 25 years old, 16.0 % were between 26 and 30 years old whereas 23.0% were between 31 and 35 years old. 10.0 % were between 36 and 40 years old, 14.0 % were between 41 and 45 years old, 18.0% were between 46 and 50 years old, 8.0% were between 51 and 55 years old, 4.0% were between 56 and 60 years old whereas 3.0% were over 60 years old.

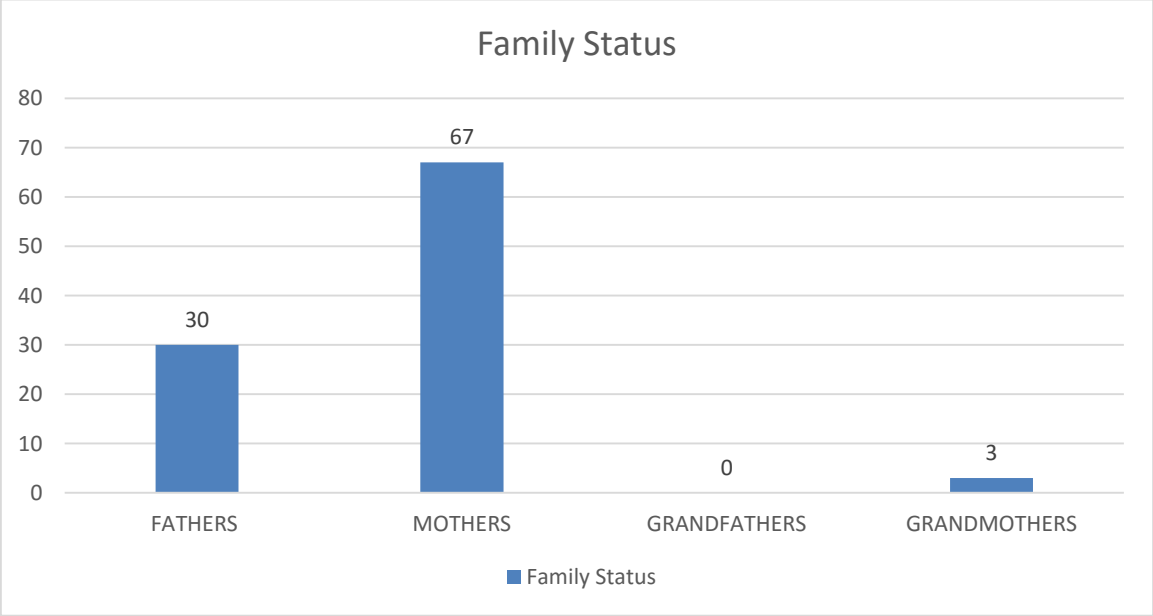
The higher percentages were linked to the ages of those who were younger. In this regard, the relationship between people's age and mobile crowdsourcing adoption was discovered to support Ameme's (2015) as well as Alwan's and Al-. Zu'bi's (2016) studies. Elderly participants are less likely than young people to use mobile crowdsourcing.



Source: established by own study
Figure 4.2: Age status

4.5.1.3 Family Role

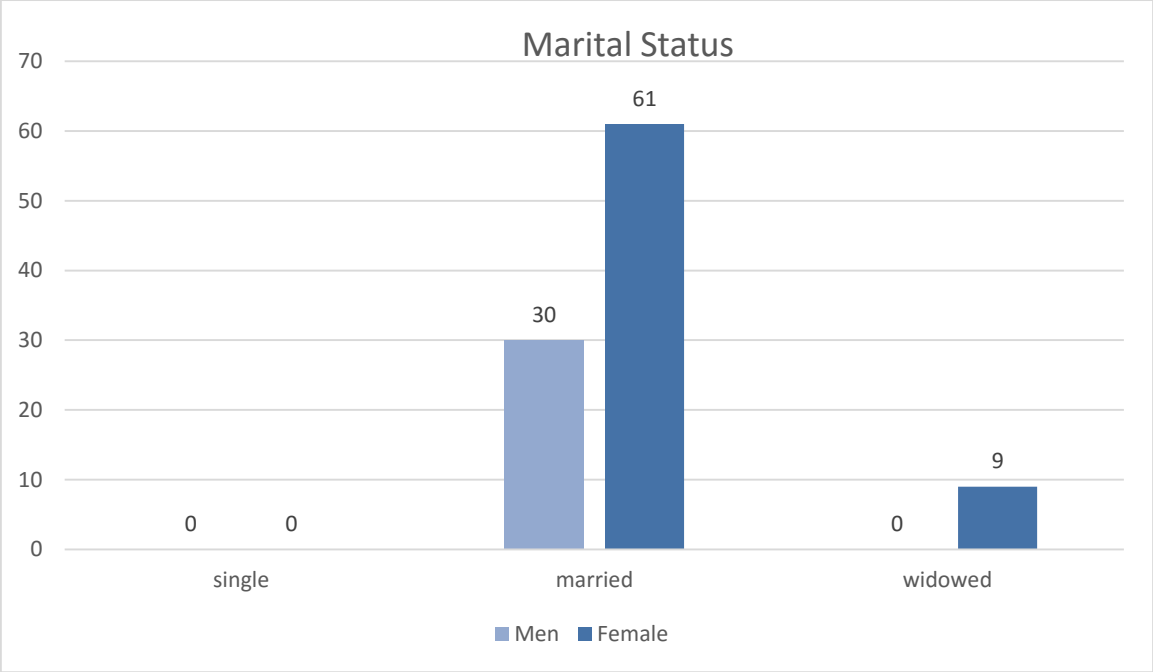
In terms of family role, thirty (30%) of the respondents were fathers, sixty-seven (67%) of the respondents were mothers and three (3%) of the respondents were grandmothers. The higher percentage was associated with mothers who are dominant in the three provinces where the study was conducted.



Source: established by own study
Figure 4.3: Family status

4.5.1.4 Civil Status

In terms of civil status, thirty (30%) males, sixty-one (61%) of the females were married and nine (9%) were widows. The higher percentage was associated with married female who were dominant and were likely to adopt the use of mobile crowdsourcing. In her study "The technology adoption behavior of women farmers", Ogunlana (2007) argues that women farmers easily adopt innovations and technology that can enhance their economic status.



Source: established by own study

Figure 4.4: Civil status

4.6 CORRELATION

Based on the research objectives, the Pearson correlation coefficient was conducted to evaluate the proposed framework and establish if there was any relationship between the technology adoption factors. Table 4.5 below shows that there was a significant positive correlation between all six (6) factors of users' perception of the adoption of mobile crowdsourcing for farmers in rural areas (quality factors, perceived ease of use, perceived usefulness, experience, attitude, behavioural intention).

The main purpose of this study was to evaluate the proposed theoretical framework and determine if there was any association amongst the factors of adopting mobile crowdsourcing.

To achieve that, the Pearson correlation coefficient was used. Table 4.5 below shows that there was a positive correlation coefficient between all variables used in the framework representing mobile crowdsourcing in crop production for farmers in rural areas.

As shown in Table 4.5, the correlation coefficients(r) of this study ranged from r = 0.704 to r = 0.889. In other words, it ranged from moderate to very strong.

Table 4.5: Correlation coefficient

Source: established by own study

	QF	PEOU	EXP	PU	AT	BI
The quality factors	1	.789* N=100				
Perceived ease of use		1	.704* N=100	.785* N=100		
Perceived usefulness				1	.727* N=100	
Experience			1	.766* N=100	.749* N=100	
Attitude toward using					1	.889* N=100
Behavioural intention to use						1

*Correlation is significant at 0.05 level.

The results corroborate the relationship between the variables obtained from the TAM of mobile crowdsourcing. The findings are consistent with those of a previous study (Alsamydai 2014) that found that perceived usefulness and perceived ease of use predicted users' intentions.

4.7 HYPOTHESES TESTING RESULTS

The purpose of the study was to investigate and determine the effect of the TAM conceptual model construct on the adoption of mobile crowdsourcing in crop production for farmers in rural areas.

Following the footsteps of previous research papers, a multiple regression test was done to measure the degree of influence of independent constructs on the dependent construct.

4.7.1 Regression analysis

To predict the unknown values of the variable from the identified multiple variables, multiple regression analysis was considered for the research study. Multiple regression analysis was also used to develop a model that can establish the association amongst the independent variables and dependent variable based on the collected data of this study. Table 4.6 below presents the model summary of the predictors that are relevant for the R and R-Square. These are the predictors of a mobile crowdsourcing model. The model variables included quality factors, perceived ease of use, perceived usefulness, experience, attitude toward using and behavioural intention to use. R is the view of the Pearson correlation coefficient. The correlation coefficient R that forms the square root of R-Square indicated the extent of the impact of multiple independent factors associated with the individual dependent variable. R ranged from 0 to 1 and Table 4.6 below shows that R=0.691, which suggested a solid relationship between the many independent factors and the intention to adopt mobile crowdsourcing.

According to the results shown below, R-Square was 0.831 and from that, it can interpret that 83% of the variance in mobile crowdsourcing in crop production could be predicted from the independent variables. Another unidentified determinant accounted for the remaining 17%, which was the amount of unexplained variance within the dependent variable.

Table 4.6: Regression analysis: model summary
Source: established by own study

Model	Test	F	Results
Regression		40.015	0.000
	R		0.691
	R-square		0.831
	Adjusted R_square		0.465
	Std error of the estimate		0.54438

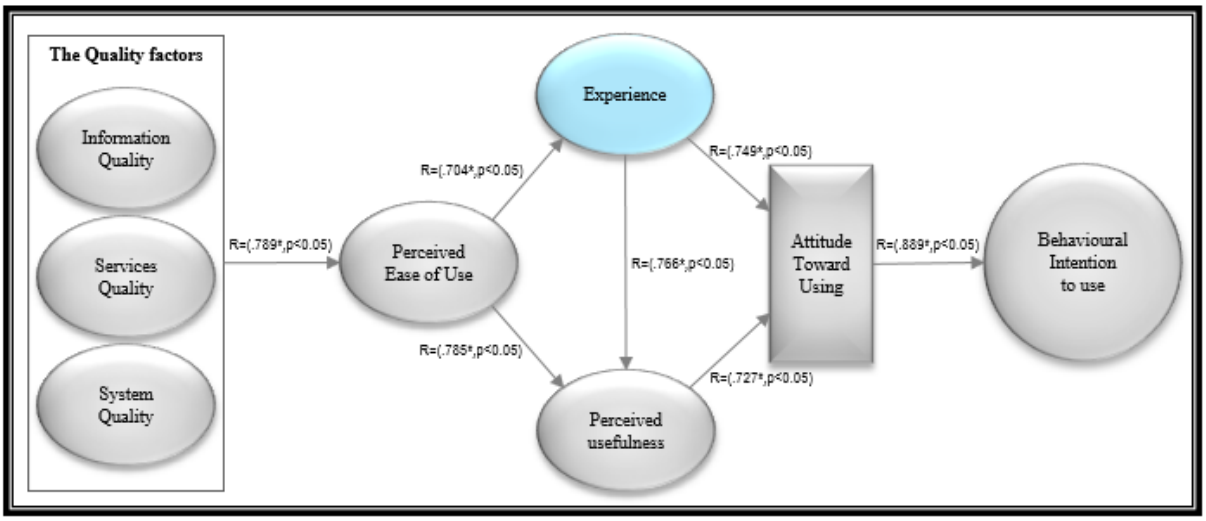
Table 4.7: Regression coefficient

Source: established by own study

Variables		Beta	Sig
Quality factors ⇨	Perceived ease of use	.406	.005
Perceived ease of use ⇨	Experience	.721	.005
Perceived ease of use ⇨	Perceived usefulness	.447	.005
Perceived usefulness ⇨	Attitude toward using	.992	.005
Experience ⇨	Perceived usefulness	.851	.005
Experience ⇨	Attitude toward using	.402	.005
Attitude toward using ⇨	Behavioural intention to use	.304	.005

4.8 FINAL RESEARCH MODEL

Based on the research study results described in Chapter 4, Figure 4.5 below depicts the final research model that could be used by farmers to adopt mobile crowdsourcing.



Source: established by own study

Figure 4.5: The final research model

4.8.1 Evaluation of hypotheses

The following factors are discussed to ascertain their impact on a mobile crowdsourcing culture: quality factors; perceived ease of use; experience; perceived usefulness; attitude toward using; and behavioural intention to use.

4.8.1.1 Quality Factors

H1: Quality factors have a positive influence on perceived ease of use, with a beta value of 0.406 and a significant level of 0.05. This hypothesis is **supported.**

The results implied that quality factors are key in the perceived ease of use of mobile crowdsourcing in crop production.

4.8.1.2 Perceived ease of use

H2: Perceived ease of use positively influences experience, with a beta value of 0.721 and a significant level of less than 0.05. This hypothesis is **supported.**

The results implied that perceived ease of use is key in the adoption of mobile crowdsourcing in crop production for farmers in rural areas.

4.8.1.3 Perceived ease of use

H3: Perceived ease of use positively influences perceived usefulness with a beta value of 0.447 and a significant level of less than 0.05. The hypothesis is **supported.**

The results implied that perceived ease of use is key in the adoption of mobile crowdsourcing in crop production for farmers in rural areas.

4.8.1.4 Perceived usefulness

H4: Perceived usefulness positively influences the attitude toward using with a beta value of 0.992 and a significant level of less than 0.05. The hypothesis is **supported.**

The results implied that perceived usefulness is key in the attitude toward using mobile crowdsourcing in crop production for farmers in rural areas.

4.8.1.5 Experience

H5: Experience positively influences perceived usefulness with a beta value of 0.851** and a significant level of less than 0.05. The hypothesis is **supported.**

The results implied that the experience is key to the adoption of mobile crowdsourcing in crop production for farmers in rural areas.

4.8.1.6 Experience

H6: Experience positively influences attitude toward using with a beta value of 0.402 and a significant level of less than 0.05. The hypothesis is **supported**.

The results implied that the experience is key to the adoption of mobile crowdsourcing in crop production for farmers in rural areas.

4.8.1.7 Attitude toward using.

H7: Attitude toward using positively influences behavioural intention to use with a beta value of 0.304 and a significant level of less than 0.05. The hypothesis is **supported**.

The results implied that the attitude toward using support is key to behavioural intention to use mobile crowdsourcing in crop production for farmers in rural areas.

4.9 CONCLUSION

This chapter presented and evaluated the collected data; moreover, it discussed the study's statistical findings. While 70 % of respondents were female and fell between the ages of 20 and 62, the remaining 30% were male and fell between the ages of 20 and 65.

The participants viewed the use of mobile crowdsourcing as useful and user-friendly. In addition, their attitude towards it was positive. Furthermore, they had experienced it as being clearly organised and straightforward.

To assess the relationship between farmers' perceptions of mobile crowdsourcing in rural areas, a Pearson correlation analysis was conducted, and the results revealed that all variables were correlated. Furthermore, the degree of path coefficient between the factors was calculated to determine which factors influenced the perceived usefulness of mobile crowdsourcing. The

results showed that the farmers perceived it as useful and they intended to adopt mobile crowdsourcing. Moreover, the results demonstrated the link between the various factors.

In the next chapter, a summary, recommendations and conclusion based on the discussed results in this chapter will be presented.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

The previous chapter dealt with the results of the research study that were displayed in both tabular and figure format. To ensure that there was no ambiguity or misunderstanding of the results, the findings were discussed in detail. Moreover, the importance of the research study relating to the use of mobile crowdsourcing in crop production for farmers in rural areas was examined. This chapter concludes the research report, makes recommendation based on the study results and highlights areas for future research.

5.1 CONCLUSION

The aim of this research study was to examine farmers' understanding about the use of mobile crowdsourcing in crop production in rural areas of South Kivu. The research report used an adapted TAM theoretical structure to address research questions and achieve the objectives of the study. The research study was performed only within the agricultural sector in the province of South Kivu, the Democratic Republic of Congo. The demographic data were used to demonstrate the type of population that participated in research study. This data did not directly affect the factors that determined the acceptance of crowdsourcing by the participants. Based on the research results, conclusions about the attainment of the research objectives of the study are presented in the following section of this chapter.

5.1.1 Research Objectives

1. **To study the topic of mobile crowdsourcing in agriculture as it appears in the literature and investigate what has been done to improve information sharing systems for agrarian communities**

The literature review indicated that there is not much research conducted in terms of determining factors influencing mobile crowdsourcing in crop production for farmers in rural areas. Moreover, adoption models in this regard are minimal. Most of the research articles focused on explaining the concept of mobile crowdsourcing and its implementation worldwide. In addition, the literature explained how it has been used by agrarian communities. However, the studies reviewed did not provide models or describe determinants that positively influence the adoption of mobile crowdsourcing to improve the crop production of farmers in rural areas.

2. **To determine the factors that influence the adoption of mobile crowdsourcing technology in crop production for farmers in rural areas**

Research question 1 and the above objective were answered using regression analysis on the hypotheses constructs with regard to the determinants that had a positive influence on the adoption of mobile crowdsourcing in crop production for farmers in rural areas. The following factors were found to have a positive influence on the adoption of mobile crowdsourcing in crop production for farmers in rural areas: quality factors, perceived ease of use, perceived usefulness, experience and attitude.

3. **To propose a mobile crowdsourcing framework for the adoption of an information-sharing system**

To achieve this objective, Pearson correlation coefficients were employed to measure the correlation or relationship effectiveness amongst the factors of adopting mobile crowdsourcing in crop production for farmers in rural areas and intention to adopt.

In addition to the correlation between the factors (quality factors, perceived ease of use, perceived usefulness, experience and attitude), the degree of path coefficient between the perceived factors and intention to adopt was calculated.

The proposed model was devised in the following contexts: technology, the environment and the organisation. These have an impact on mobile crowdsourcing with regard to improving information sharing systems in rural agrarian communities in South Kivu. The relationship of the factors in these contexts was determined to confirm their supposed relationship with intention to adopt mobile crowdsourcing. Based on the above-mentioned outcomes, the research study achieved the established objective.

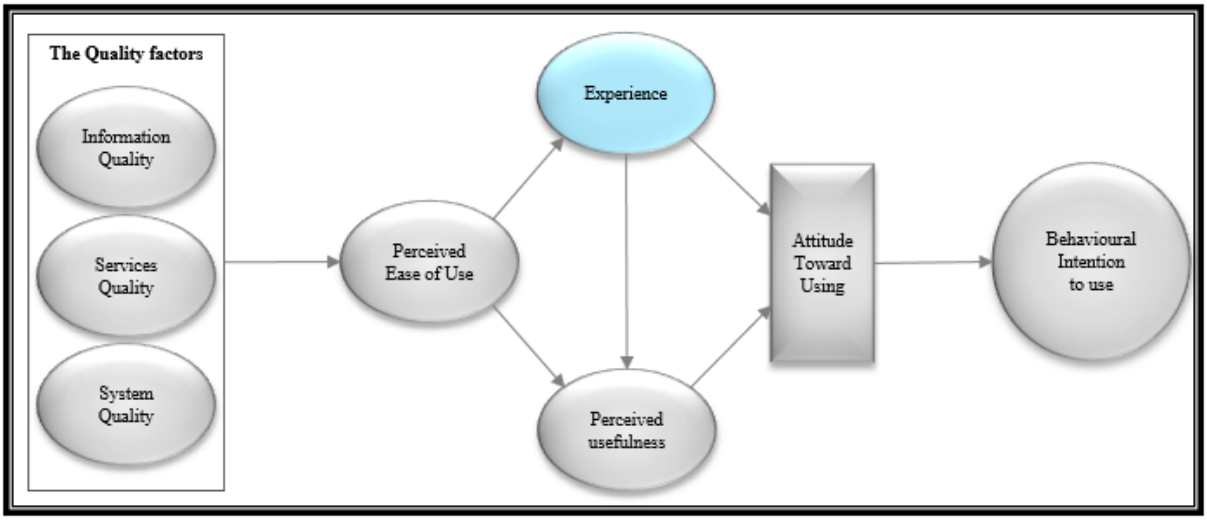
4. **To measure the effectiveness of the framework for the adoption of mobile crowdsourcing in crop production**

To achieve this objective, multiple variables, were utilised to determine internal consistency and to assess construct reliability. Achieving the maximum reliability and validity of the questionnaires was essential to the main objective of the study.

Factor analysis was used through the principal component analysis (PCA) to assess the validity of each construct. Varimax rotation was used to determine the underlying constructs of the study items. The Pearson coefficient was used to measure the correlation or relationship effectiveness among the factors of adopting mobile crowdsourcing and intention to adopt. The results demonstrated a link between the various factors. Consequently, there was a positive relationship between the perceived factors of adopting mobile crowdsourcing and the intent to adopt. In addition to the correlation between the factors, the degree of path coefficient between the perceived factors and intention to adopt was calculated.

5. **To recommend a model for the adoption of mobile crowdsourcing technology**

After assessing the outcome from the research hypotheses testing, a model was recommended for use in crop production in rural areas that would involve adopting mobile crowdsourcing to improve access to information on the part of the agrarian community. The final recommended model or framework, which is shown in Figure 4.7 below, comprised the variables from the TAM model. The research objective was achieved, as the final model was determined.



Source: Researcher

Figure 5.1: The final recommended model

5.2 LIMITATIONS OF THE STUDY

Like other research studies, this study is not without limitations. The sample size was one of the limitations, as the total participants equated to 100, which excluded the possibility of generalising the findings to all the farmers' collectives in South Kivu Province. However further research is encouraged to obtain a wider audience. It will be advisable to increase the sample

size to maximise the significance concerning the exactness and generalisability of the study. The study was conducted on farmers' collectives in South Kivu province only and it excluded other provinces and countries.

However, meaningful discoveries were revealed in this study about the farmers'issues, touching on their intention to use a mobile crowdsourcing portal, despite possible boundaries. Firstly, the purposive method selected the study sample from only a small sector of farmers' collectives in South Kivu. Secondly, the results of the research were based on data that was collected from farmers who had used the mobile crowdsourcing portal for over 6 months and had sufficient experience of it. These restrictions may impede the generalisation of the findings to all farmers in South Kivu.

Another limitation was that the literature review did not include studies written in languages other than English. The researcher concentrated on literature that was written in English.

5.3 RECOMMENDATION/SUGGESTED FUTURE WORKS

- There has been little research, according to the literature review, to evaluate the determinants affecting mobile crowdsourcing in crop production for farmers in rural areas. Most of the studies are centered on describing mobile crowdsourcing rather than providing reasons for its adoption. Further research needs to be done to evaluate determinants that affect the adoption of mobile crowdsourcing in crop production for farmers in rural areas.
- According to the literature, mobile crowdsourcing is not explored by many farmers and not viewed as a key element in changing the user's behavior towards the use of the mobile crowdsourcing model within their collectives. More study is required on how to adopt and maintain reasonable mobile crowdsourcing in farmers' collectives and villages.
- More research should be undertaken using a different data collection method and different environments to ensure that gaps in knowledge about mobile crowdsourcing are identified and mitigated. This will also improve the current perspective as indicated by using the questionnaire instrument.
- It is recommended that the existing study be conducted using a larger sample, with an extensive understanding of the proposed model. A study of the farmers' intent to use the

prototype needs to be performed. Additional research about the determining factor associated with both the model of mobile crowdsourcing and farmers' behavioural intentions to use the model is needed.

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ANNEXURES

ANNEXURE A: INFORMED CONSENT

Vaal University of Technology

INFORMED CONSENT: MOBILE CROWDSOURCING IN CROP PRODUCTION FOR FARMERS IN RURAL AREAS

Title of the program: Assessing the technology acceptance level for agrarians' farmer's communities using the Technology acceptance model (TMA).

Name .....

I, the farmer/ legal representative ..... (Full names in print), have read the details of the program, or have listened to the oral explanation thereof, and declare that I understand it I have been given or had the opportunity to discuss relevant aspects with the researcher and declare that I voluntarily participate in the project. I hereby give consent to participate in the project and fully understand what is required from me.

Signature ..... date.....

Address.....

.....

.....

Telephone

ANNEXURE B: LETTER OF CONSENT

RESEARCH PROJECT ON INFORMED CONSENT: MOBILE CROWDSOURCING IN CROP PRODUCTION FOR FARMERS IN RURAL AREAS.

Researcher Name: IE Kahasha
Contact Details: irkahasha@gmail.com
Supervisor Name: T Zuva
Contact details: zuvat@vut.ac.za

Dear Esoko,

Welcome and thank you for taking the time out of your other commitments to read this email. My name is Emmanuella Iranga Kahasha, I am a student at the Vaal University of Technology in Gauteng province, South Africa. We are starting a mobile Crowdsourcing research project and we are asking for your voluntary participation (farmers using your mobile application as well as yourself) to make this work a great success. this project is planned to add value to the daily activities for farmers in rural areas through the integration of modern and traditional information sharing approaches.

WHAT IS THIS PROJECT?

The major objective of this project is to conduct an experimental study under controlled conditions to determine how easy access to information through the adoption of technologies such as mobile applications for the agrarian community in rural areas is likely to enhance agriculture development.

this research aims to design and develop a crowdsourcing agricultural portal framework that is going to be used to improve the easy access to information for the agrarian communities.

The assessment will form the pilot study for the impending intervention mainly focusing on designing and developing a mobile crowdsourcing agricultural portal framework out of integrating traditional and modern information-sharing methods not only to improve the

agriculture development sector when it comes to crop production but also offer them more than one source to obtain information that they need.

All efforts are intended to ensure agriculture production throughout the entire value chain will yield expected results.

WHY IS THE PROJECT IMPORTANT?

Facing increased challenges in recent decades smallholder farmers in the developing countries have seen their incomes put under pressure from rising input costs, increased competition from large-scale farming operations, and pressure from supply chain intermediaries that provide immediate payment in exchange for significant price reductions. Furthermore, consumers are demanding enterprises to source their inputs from sustainable providers which puts pressure on smallholders to comply with standards they do not always fully understand. Meanwhile, market penetration for smartphones along with broadband coverage continues to expand offering unprecedented opportunities for innovators to utilize mobile technology to promote sustainable livelihoods (mFarmer, 2019). Therefore, this project is aimed at finding sustainable solutions to improving the information-sharing methods for the agrarian community in rural areas and ensuring food security for eliminating inputs waste and poor outcomes at the end of the harvest season by integrating indigenous and modern information-sharing methods.

PROCEDURE

The project will take place over two weeks. farmers will be requested to sign an informed consent letter to show your approval of the project.

WHAT WILL BE MEASURED IN THE PROJECT?

We will be measuring the Technology acceptance level of farmers using the Technology acceptance model (TMA).

TMA is one of the most popular research models to predict the use and acceptance of information systems and technology by individual users Davis., Bagozzi. et al. (1989).

- Quality Factors

- Perceived ease of use (PEOU): Perceived ease of use is the degree to which a person assumes it would be effortless to use a specific program, Davis., Bagozzi. Eth et al. (1989).

- Perceived usefulness (PU): the degree to which a person believes that using a particular system would enhance his or her job Davis., Bagozzi. et al. (1989)
- Experience(Exp): According to Alsamydai (2014) experience generally influences a customer's usage, the degree to which a mobile experience affects a user's varied and it is a subject in which the particular technical support being examined.
- Attitude toward using (AT): defined as a constructive or undesirable estimation of objects, events, people, activities, ideas, or just about everything in the natural environment. It was found that the attitudes and intentions towards mobile crowdsourcing applications were both influenced by the customer's perceived usefulness Alsamydai (2014)
- Behavioral Intention to Use (IT): Defined as the amount of strength one plans to implement a particular behaviour. It refers to the dedication of a person to conduct or not follow a certain action in the future Alsamydai (2014). Casañeda, Muñoz-Leiva et al. (2007) was considered an early prognosticator of an individual's behaviors.

These measurements will indicate the farmer's status in adopting the proposed solution.

WHO MAY PARTICIPATE?

This study will include farmers: women and men from rural areas who are currently subscribed and have been using your Mobile Application for over three months minimum.

WHAT DO WE EXPECT OF YOU?

- We need to know the number of farmers who are currently using your application and the number of farmers taking part in the research.
- We need to know the age and gender of farmers.
- You will be asked to sign a form giving consent to participate in the project which is also attached to this letter.
- Each farmer will be questioned in detail about their technology acceptance model(mandatory) as well as general questions regarding farming methods and agriculture inputs(optional).

If you have any questions about the project, please do not hesitate to contact me.

Thank you for your participation.

Iranga E. Kahasha
Researcher

ANNEXURE C: SOCIO-DEMOGRAPHIC QUESTIONNAIRES

Vaal University of Technology

SOCIO-DEMOGRAPHIC QUESTIONNAIRE: RURAL FARMERS COMMUNITY

This questionnaire covers certain aspects of your life, including work and personal details, lifestyle, and a social life that is relevant to agriculture development in rural areas. The answers to these questions will be kept strictly confidential and the information will not be identifiable from any reports and publications.

1. GENERAL INFORMATION

Subject number.....

Please answer all questions by marking the correct answer with **X,** except where otherwise indicated.

Where do you live?

Village name:	District name
----------	----------

1. PERSONAL INFORMATION

2.1 Your role in the family

Mother	Grandmother	Father	Grandfather	other, specify .....

2.2 How old are you? .....Years

2.3 Gender ..... (F/M)

2.4 Are you?

Single	Married	Divorced	Widowed	Other specify .....

4 WORK STATUS AND INCOME

4.1 Are you currently employed?

IF YES, go to question 4.3

4.2 If NO, how would you describe your current status (tick one box only)?

Unemployed	Retired	Housewife	Student	Other Specify .....

4.3 If **YES** (question 4. 1) is your current job a: …….

4.4 What is the total income in the household per month?

< 50$	$50-$100	$101-$150	$151-$200	$201-$250	> $250

4.5 Please specify the monthly income in the household (if willing) .....

4.6 How often does it happen that you have access to information regarding crops, fertilizer, weather pattern and soil conditions?

Never	Seldom	Sometimes	Often	Always

4.7 How much money is spent on gaining information on crops and fertilizer (Tick only one box?)

$ 0- $ 50	$51- $100	$101- $150	$151- $200	$201-$250	>$250	I do not know

5 EDUCATION AND LANGUAGE

5.1 What is your highest educational level?

Illiterate	junior high school	secondary/senior secondary	graduate and above

5.2 What language is spoken mostly in the house?

French	Swahili	Mashi	Other Specify .....

6 Information accessibility

6.1 Where do you mostly get off your information?

Radio	
Television	
Cell phone (SMS)	
Cell phone(call)	
Cell phone with internet connect	
Laptop with an internet connection	
Other, specify	

6.2 What are you preferred method of accessing information? (Select all that applied)

radio	television	Newspaper	Input dealer (NGOs, agriculture agencies)	internet	Other progressive farmers

ANNEXURE D: TECHNOLOGY ACCEPTANCE MODEL QUESTIONNAIRE

VAAL UNIVERSITY OF TECHNOLOGY

TECHNOLOGY ACCEPTANCE MODEL QUESTIONNAIRE

1. First Dimension: The Quality Factors

	Strongly Disagree	Disagree	Neutral	Disagree	Strongly Agree
1. To what extent does information quality affect your acceptance use of mobile application service					
2. To what extent do service quality affect your acceptance use of mobile application service					
3. To what extent do systems quality affect your acceptance use mobile application service					
4. To what extent do quality factors affect your perceived ease of use mobile application service					
5. To what extent do quality factors affect your acceptance use mobile application service					

2. Second Dimension: Perceived ease of use (PEOU)

	Strongly Disagree	Disagree	Neutral	Disagree	Strongly Agree
1.To what extent do perceive ease of use affect your perceived usefulness.					
2.To what extent do perceive ease of use affect your experience to use mobile application services					
3.To what extent do perceive ease of use affect your perceived usefulness to use mobile application services.					
4.To what extent do perceive ease of use affect your acceptance to use mobile application services.					

3. Third Dimension: Experience

	Strongly Disagree	Disagree	Neutral	Disagree	Strongly Agree
1. To what extent do experience affect perceived usefulness to use mobile application services					
2. To what extent do experience affect your attitude toward using mobile application services					

4. Fourth Dimension: Perceived Usefulness (PU)

	Strongly Disagree	Disagree	Neutral	Disagree	Strongly Agree
1.To what extent does your perceived usefulness affect your behavioural intention to use mobile application services.					
2.To what extent does your perceived usefulness affect your acceptance to use mobile application service					

5. Fifth Dimension: Attitude

	Strongly Disagree	Disagree	Neutral	Disagree	Strongly Agree
1.To what extent does your attitude affect your behavioural intention to acceptance use mobile application service					
2. To what extent does your attitude affect your acceptance to use mobile application services					

6. Sixth dimension: Behavioural intention

	Strongly Disagree	Disagree	Neutral	Disagree	Strongly Agree
1. To what extent do behavioural intention affect your acceptance to use mobile application services					
2. Your behavioural intention toward mobile banking affect your acceptance to use mobile application services					

Thank you very much for your co-operation. We appreciate the time.

ANNEXURE E: LANGUAGE CERTIFICATE

ONE STOP SOLUTION
Professional Editing Services

Language Editing

It is hereby certified that this thesis has been proofread and edited for spelling, grammar and punctuation by a professional English language editor

Client

KAHASHA IRANGA EMMANUELLA (209044837)

MOBILE CROWDSOURCING IN CROP PRODUCTION FOR FARMERS IN RURAL AREAS OF THE SOUTH KIVU (DRC)

Research Thesis Submitted for the Degree of Magister Technologiae in Information Technology
in the Department of Information and Communications Technology,
Faculty of Applied and Computer Sciences
Vaal University of Technology

Editor

Dr. M.L. Klos
Name

Signature

25 February 2021
Date

I cannot guarantee that the changes that I have suggested have been implemented
nor do I take responsibility for any other changes or additions that may have been made subsequently.

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