UNIVERSITY OF NAIROBI
SCHOOL OF COMPUTING AND INFORMATICS

APPLICATION OF AMIS FOR IMPROVED ACCESS TO AGRICULTURAL MARKET INFORMATION: CASE STUDY MACHAKOS COUNTY, KENYA

SIMON MUTUKU MULWA

P54/36132/2019

Supervisor

Dr. Christopher K. Chepken

A RESEARCH PROJECT REPORT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN INFORMATION TECHNOLOGY MANAGEMENT, SCHOOL OF COMPUTING AND INFORMATICS, UNIVERSITY OF NAIROBI.

AUGUST, 2021

DECLARATION

I, Simon Mutuku Mulwa, declare that this thesis is my original work and has not been submitted for the award of degree in this or any other University.
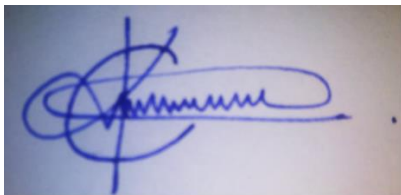
Date: *20th August 2021*

SIMON MUTUKU MULWA

(Candidate)

This thesis has been submitted for examination with my approval as the University Supervisor.

Date: _____23/08/2021_____

DR. CHRISTOPHER K. CHEPKEN

(University Supervisor)

ACKNOWLEDGEMENTS

LIST OF TABLES

LIST OF FIGURES

DEFINITION OF TERMS

AMIS - Agricultural Market Information Systems

API - Application Programming Interface

ASD - Agile Software Development

CGV - Computer Generated Voice

DOIT - Diffusion of Innovation Theory

DSSAT - Decision Support System for Agrotechnology Transfer

FAO - Food and Agriculture Organization

GDP - Gross Domestic Product

HPC - High Performance Computing

ICTs - Information Communication Technologies

IVR - Interactive Voice Response

KALRO - Kenya Agricultural and Livestock Research Organization

MAMIS - Machakos Agricultural Market Information System

MoALF&C - Ministry of Agriculture, Livestock, Fisheries and Cooperatives of Kenya

NARS - National Agricultural Research System

ODK - Automated Data Collection Kit

SMS - Short Message Service

SPSS - Statistical Package for the Social Sciences

UON - University of Nairobi

USAID - United States Agency for International Development

USSD - Unstructured Supplementary Service Data

UTAUT - Unified Theory of Acceptance and Use of Technology

WHO - World Health Organization

ABSTRACT

The importance of ICTs in agriculture have been well recognized in numerous publications and policy documents. The adoption and access to Agricultural Market Information System (AMIS) by smallholder farmers is a critical way of facilitating rural growth across the country. However, limited resources, inadequate access to and application of ICT innovations in extension service delivery in Kenya has greatly impacted effective dissemination of Agricultural Market information to Farmers within Machakos County. The Main objective of this research was to develop an integrated market information system that enhances usability of AMIS and improves access to information by smallholder farmers in Machakos County. The study was done on 124 pigeon pea and green-gram farmers from Yatta sub-county within Machakos County, Kenya. The data was collected using a pre-tested questionnaire and analyzed with Microsoft Power BI. About 91.94% of the respondents owned a phone and only 38.71% had a smartphone. 64.52% of all respondents face various constraints in internet access such as lack of knowledge on how to use internet and high cost of data bundles. Despite the constraints, 35.48% of the respondents had access to internet access. It was noted 92.74% of all respondents preferred a Swahili based AMIS because of its ease of use. A web and mobile based application with SMS module available in both English and Swahili language was developed for access to market information, weather and agronomic advisories. Agile Software Development (ASD) method was used supported by the collected data to inform system and modules design. All the test users indicated that the application was simple and easy to use yet very informative and a key milestone towards improving AMIS usability and adoption.

Key Words: ICT, Market Information, Integrated AMIS, Agri- Markets

TABLE OF CONTENTS

CHAPTER ONE: INTRODUCTION

1.1 Background of Study

1.1.0 Agriculture Sector

According to the World Bank (2019) and Fuglie et al (2019), many smallholder farmers involved completely in agriculture accounted for 31.4% towards decrease in rural poverty. The bank also acknowledged that, in rural areas agriculture still remains an important source of revenue for underprivileged and well-off households of Kenya and Africa at large. The demand for agricultural products in Kenya is growing yearly with the population that raises at an average rate of 2.27% per year. Achieving this continuously increasing demand is the biggest challenge in the agriculture sector in Kenya (Oluoch & Osida, 2015). A report by the Ministry of Agriculture, 2019 on Agricultural Sector Transformation and Growth Strategy(ASTGS) indicated that 33% of entire GDP, 60% of exports and 60% of informal employment coming from the agricultural division with crops production as the major contributor. The report further noted that, in order to transform the agriculture sector, it's important to improve the foundations of economic growth through provision of necessary innovative tools to address price volatility and better strategies towards reducing the country's dependence on food imports.

1.1.2 Agricultural Market Information Systems (AMIS)

The aim of Agricultural Market Information Systems (hereinafter referred to as AMIS) is to gather, scrutinize and distribute information on the current position and trends of agricultural market data and information. AMIS have been in use in developed countries for about a century; they were not completely promoted in most developing countries until the 1980s, while early pioneers existed in, for example, Nepal, Indonesia and Tanzania (Mawazo et.,2015). Initially, AMIS were designed primarily by the public sector, with extensive donor support. However, a number of private organizations, such as Reuters Market Light (RML) India and Esoko in Ghana have developed and implemented these systems in the 21st century. According to FAO (2017), improved MIS will potentially support all actors involved in agricultural value chains. Market information can be used by farmers to determine where to sell their products and at what price; manage their production; manage harvest and post-harvest operations, including marketing.

1.2   Research Problem

Market information is critical and fundamental for effective functioning of markets and play a significant role in promoting agricultural development among small-scale farmers and producers (Bernard et al., 2014 and FAO,2017). Lack of knowledge of sellers and buyers often lead to unfavorable effects on productivity. Timely, accurate and readily available information can assist Smallholder farmers in decision making in planting and facilitate better informed price decisions to minimize risks in market transactions (Bernard et al., 2014).

Agricultural extension services, if functioning properly, improves agricultural efficiency by providing Smallholder farmers with knowledge that helps them plan their initiatives and optimize usage of limited resources (Muyanga et al,2006). However, limited resources, inadequate access to and application of ICT innovations in the delivery of extension services across Kenya has greatly impacted effective dissemination of Agricultural Market information to farmers (Tata et al.2018).

Agricultural productivity of small-scale pigeon-peas growers in Arid and Semi-Arid areas has increased due to acceptance of enhanced technologies, Innovations & Management Practices coupled with high-yielding and early maturation varieties in the eastern regions of Kenya. However, despite the availability of market for pigeon-peas, the partaking of small-scale farmers in the market is still low Karanja et al (2019).

According to Matilda et al. (2020) the need for development of multi-stakeholder innovation platforms in Kenya to address weak linkages amongst diverse value chain actors is of paramount importance towards improving coordination of market activities and reduce transaction costs. This, study sought to address this void through development of an integrated Agricultural Market Information System (AMIS) intended to improve smallholder farmer's participation and use of AMIS.

1.3   Overall Objectives

The Main objective of this research was to develop an integrated market information system that enhances usability of AMIS and improves access to information by smallholder farmers in Machakos County, Kenya.

1.4   Specific Objectives

a) To Investigate the influence of socio-economic and technological factors on the use of AMIS by smallholder farmers in Machakos County, Kenya.

b) To Investigate the influence of language on the adoption of Agricultural Market Information System (AMIS)

c) To design and develop an Integrated Agricultural Market Information System (AMIS) for use by smallholder farmers and other stakeholders in Machakos County, Kenya.

d) To test and validate the usability of the AMIS system

1.5   Research Questions

a) What systems are currently adopted for dissemination of agricultural market information?

b) Does language influence the usability of AMIS by smallholder farmers?

c) Does the use of AMIS Improve market reach for smallholder farmers?

1.6   Proposed Solution

The solution entailed development of a web and mobile based integrated multi-stakeholder AMIS for acquisition and dissemination of Market Information. The system has modules for admin center, Registration, Markets, Crop Insurance, Agronomic & weather advisories.

1.7   Importance of the Study

The Importance of this study was to provide essential information to smallholder farmers and other stakeholders which they can utilize for making critical decisions. The study sought to improve knowledge on the impact of AMIS in the distribution of agricultural market data and information to smallholder farmers. The introduction of an integrated Swahili based AMIS was meant to help Smallholder farmers, extension officers and other stakeholders with easier access to markets and market information for improved livelihoods and food security towards sustainable agricultural transformation and food security in Kenya (ASTGS, 2019) and UN Sustainable Development Goals (SDGs) 1 & 2 (No Poverty and Zero Hunger).

1.8   Scope and Limitations

The study focused on two (2) crop Value chains; Green Grams and Pigeon Peas and targeted farmers within Machakos County located in the Eastern region of Kenya. The study focused on the potential impacts connected with improved access to an integrated Market Information by Smallholder farmers.

It was anticipated that the actions undertaken in this study could be replicated in other counties. The MAMIS application targeted android mobile phones for the application and Web-application while SMS targeted users with feature phones. The choice was informed by the low cost of mobile ownership, improved connectivity and internet access have become possible to low income earners (Wyche & Olson, 2018).

CHAPTER TWO: LITERATURE REVIEW

2.0   Introduction

The current growth trajectory of the world's population will exceed the 9 billion mark by 2050, and thus a need for increase in agricultural production to meet these surplus food demand (UNDP, 2015; Saravanan & Suchiradipta, 2018). ICT innovations pose a significant contribution towards addressing this universal food needs (Tata et al.2018). ICTs can succor by collecting, documenting, storing and sharing reliable, high quality and accurate information on Markets and market information; relaying information for research and growth initiatives; publishing knowledge to farmers and bringing various stakeholders together on a single platform (FAO, 2017 & Gwademba et al.2019). Attaining this target demands improvements on the entire agricultural production chain through the restoration of enervated soil, adhering to proper guidelines of using pesticides and adoption of climate smart varieties or breeds (Gwademba et al.2019). There is an obligation to meaningfully improve the quality of extension delivery to support agriculture through adoption and use of ICTs. The adoption of ICTs will enhance the capacity and reach of extension workers in disseminating accurate and timely information to reduce transaction charges, and contributing to improved efficiency in decision making and better rural revenues (Rao, 2007).

2.1   Theoretical Review

This study was mainly informed by combining the theory Unified Theory of Acceptance and Use of Technology (UTAUT) and Diffusion of Innovation (DOI) Theory, which pushes to explain user's intents to use ICT innovations and consequently leading to adoption. UTAUT consists of four (4) key constructs theorized to influence usage intention and behavior. UTAUT was developed by reviewing constructs of eight (8) models to explain behavior on usage of information systems. These earlier models are; acceptance model (TAM), theory of reasoned action, technology motivational model, theory of planned behavior, a combined theory of planned behavior/technology acceptance model, diffusion of innovations theory, model of personal computer use, and social cognitive theory, (Venkatesh, 2012). The paradigms theorized by UTAUT for anticipating usage behavior of Information Systems are; Performance expectancy, Social Influence, Enabling conditions and Effort Expectancy (Venkatesh, 2012).
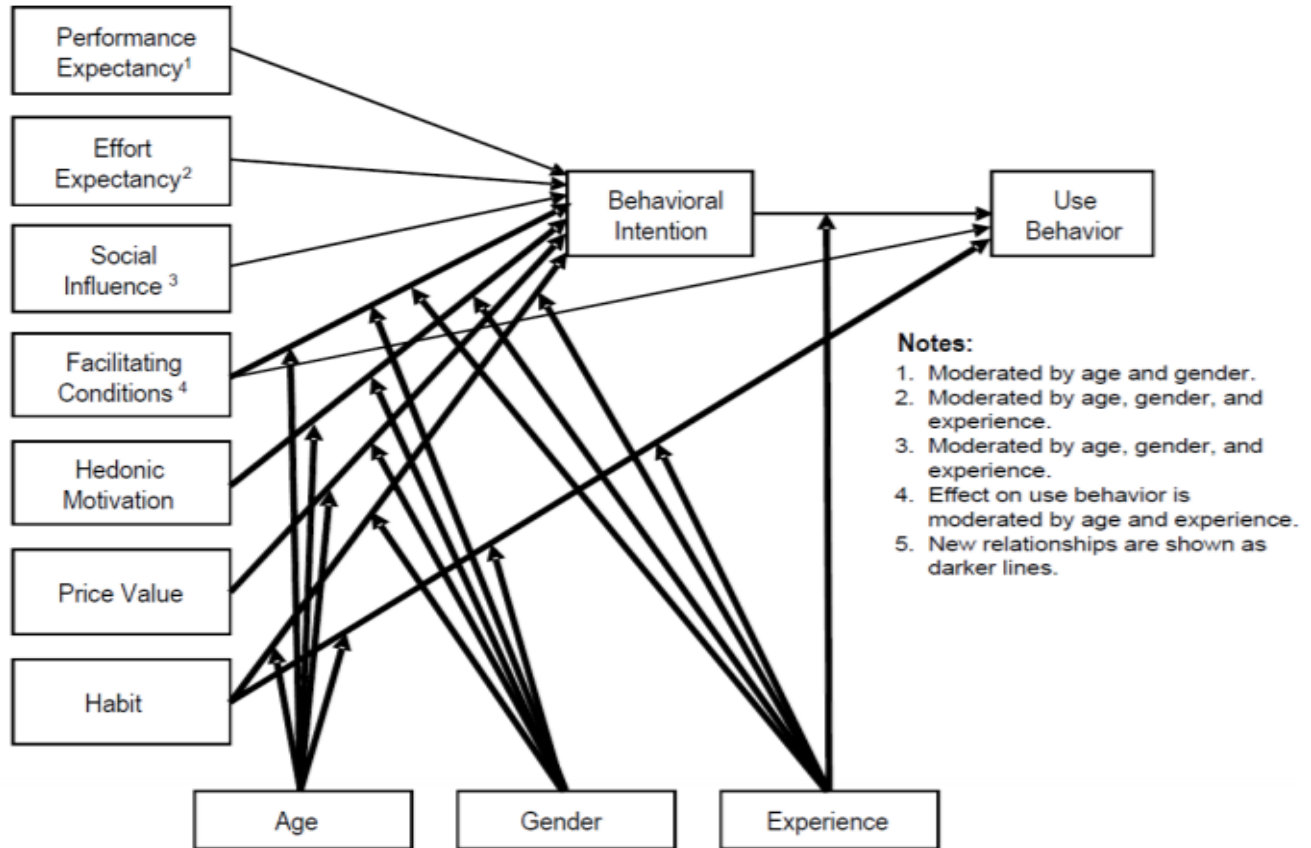
Figure 2.1: UTAUT2 (Venkatesh et al., 2012)

Rogers, (2003) noted that diffusion of innovation theory deals with the development process of innovations characterized by six (6) stages of need, through research, development and commercialization of innovation through dissemination and adoption of the innovation by the intended end users. Diffusion method entails an innovation been transferred through specific channels over time by the intended end users (Rogers,2003). Diffusion of innovation has four (4) major elements as identified by Rogers (2003) and Apleni, Anele & Smuts, Hanlie (2020). An innovation is an option or object that is seen as new by an individual or an improvement over the existing; communication channels are means by which information for a specific innovation or technology are publicized, time is Rate of adoption relative to speed in which members adopt an innovation and social system is a category of individuals, informal groups or organizations that are affianced in solving a common problem to achieve a common goal (Apleni, Anele & Smuts, Hanlie,2020).

Among the many theories, the DOI dominated the theory and practice of agricultural extension systems all over the world Peshin et al (2009). Diffusion of innovation happens when a new idea is accepted by an individual or a collection of people over a period contingent on the existence of communication channels and structure of the social system (Roger,2003 and Peshin et al.2009).

Detailed studies by Peshin et al., (2009) and Kahenya et al., (2014) showed the appropriateness of UTAUT and DOI theories in predicting users' use of ICT in Extension services.
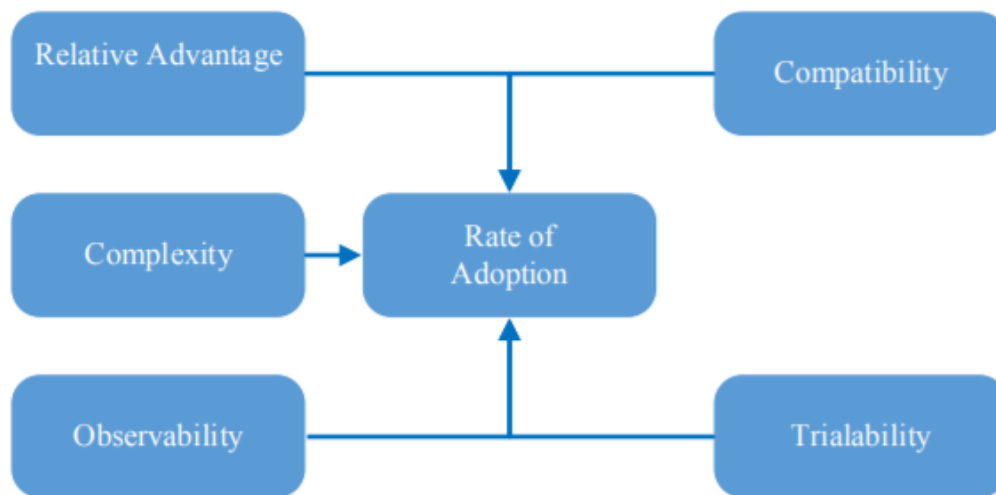
Figure 2.2: Diffusion of Innovation Theory (DOI) Rogers (1995) and Alomeer (2015)

2.2   Review of Empirical Studies

2.2.1   ICTs for Agriculture in Kenya

Kenyan farmers have limited access to extension services which has contributed to a higher ratio of extension officers to farmers coupled with large areas of coverage. According to NASEP (2012), the current ratio is 1 to 1000 against the recommended FAO ratio of 1 to 400 of extension officers to farmers respectively. These circumstances have inhibited most farmers from keeping-up with the changes in technological innovations in agriculture. This has posed a significant challenge for government extension officers to reach all farmers within their county. This is despite agricultural extension being highlighted as a critical agent for transforming farming into modern precision agriculture (FAO, 2017).

Conferring credibility to declarations by Bachhav (2012), it is accepted that the use of ICTs in delivery of agricultural extension services is vital in disseminating integrated climate smart Technology, Innovation and Management Practices towards achieving food security alongside bridging farmers with

other stakeholders in the agricultural sector. Some of these key stakeholders include; agro-processors, input dealers, marketers and microfinance financial institutions. According to (Gwademba et al.2019) this inform farmers on where to buy farm inputs, markets and sell their merchandises. Various frameworks show that AMIS can be designed to gather, process, analyze and distribute information on the state and trends of agricultural markets (Galtier etal.2014). Therefore, formal and informal markets are important for selling products as source of finance for investments and it has been recognized that farmers will opt for profitable transactions if they obtain dependable market information on the predominant market conditions(Chogou,2012).

According to Magesa et al (2015) rural farmers usually depend on available local markets and travelers to buy their farm produce. Zarmai et al. (2014) confirmed this by stating that in the agricultural sector, timely and accurate information aids farmers in making accurate decisions to sustain growth and thus the importance of information communication technology in offering proper extension services.

2.2.2 Agricultural Extension in Kenya

Agricultural extension means the transfer and exchange of agricultural information, knowledge, technologies, innovations and accurate advisory provision to farmers for optimal agricultural yields (Kavita, Kavita & Nester, Muthoni,2018). The government of Kenya has adopted several means of extension service delivery which have included the progressive Training and Visit (T&V), farmer Common Interest Groups (CIGs) and Farmer Field Schools (FFS) among others. The devolution of agriculture and consequently the provision of extension services to Kenyan local governments has abetted farmers in their requests for agricultural innovation (Kigatiira, Mberia and Wangula, 2018).

The need for personalized and location specific agricultural information to farmers has been emphasized in a study by Kigatiira, Mberia and Wangula, (2018) in Meru County where they established that although extension officers admitted to disseminate information on marketing, farmers declared that they did not receive such information. It is this reason that this study seeks to develop a web and mobile based Agricultural Market Information System (*AMIS)* with SMS support for provision of accurate, personalized and timely information to Smallholder farmers.

2.2.3 Agricultural Information for Sustainable Development

There is a clear assertion by Muyanga and Jayne (2006) that extension systems which do not meaningfully contribute to improving the lives of farmers is unsuitable. In Kenya, information repacking is undertaken by the Agricultural Information Resource Centre (AIRC) under Ministry of Agriculture (MoALF&C) which seeks to re-package information in indigenous languages, however it is overwhelmed by the numerous languages spoken in Kenya totaling forty-two (42). Kavita, Kavita & Nester, Muthoni (2018) noted that, with vigorous adult education programmes, rural farmers are becoming more literate making it possible for information systems to present information in the national language (Kiswahili) for easier use by majority of farmers. It is this possibility that draws attention to the development of Agricultural Market Information System (AMIS) featuring one of Kenya's national language (Kiswahili).

2.2.4 Market Information Systems

According to Galtier et al (2014), an AMIS collects, stores, analyses and disseminates prices and other relevant information to various stakeholders including farmers, processors, traders interested in agricultural products. USAID (2013) described AMIS as a set of integrated and coordinated processes and tools to gather and distribute agricultural market information and services to farmers, traders, food-processors, government departments and other stakeholders. AMIS are usually developed to promote clarity of markets by providing up-to-date price information to farmers who were unable to obtain market prices due to isolated rural locations and lack of access to actors in other value chains. Matilda et al (2020) noted that smallholder farmers are usually confronted with decisions on market participation and subsequently choose of marketing channels for their produce. Zoltner (2013) identifies that marketing information systems have different business models, different system architectures and technologies, however they typically share similar architectures similar to Figure 2: Marketing Information System Architecture (Nilashan, 2012)
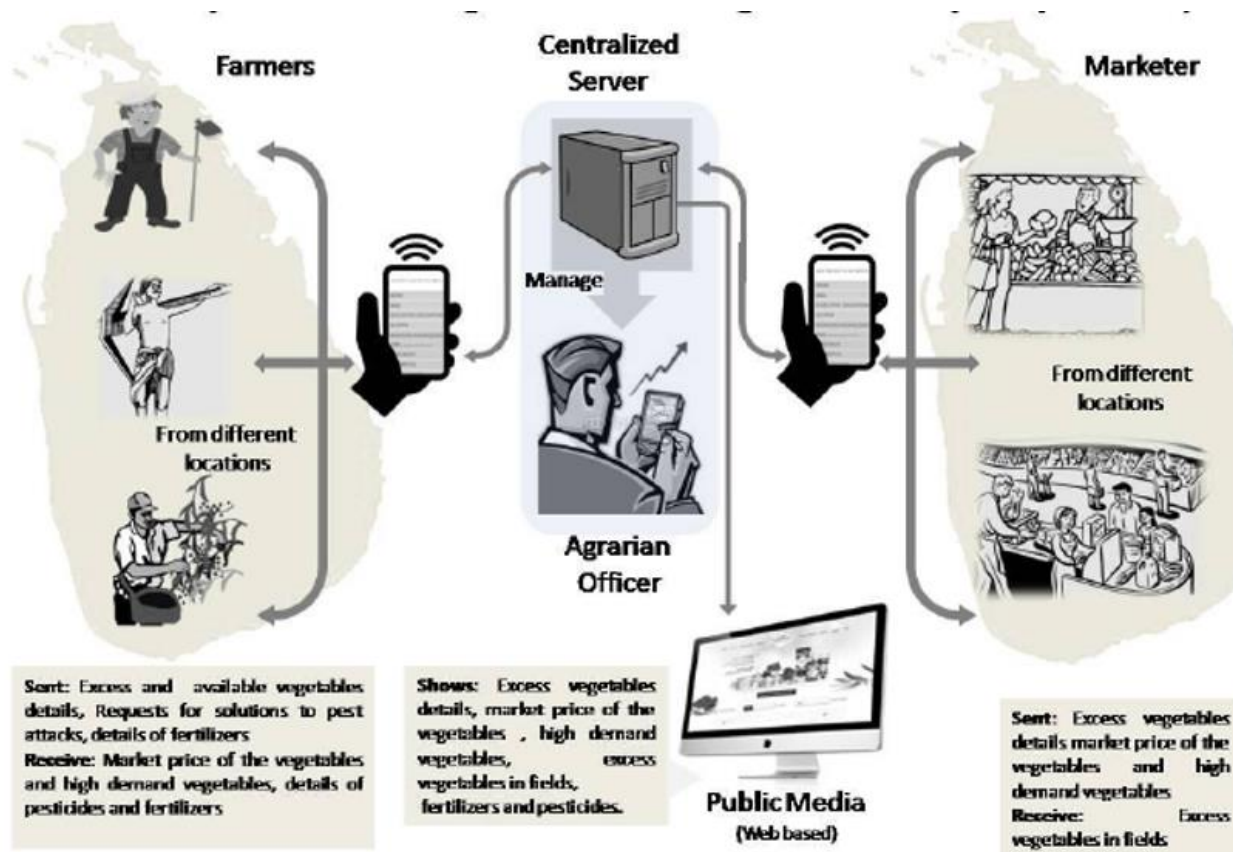
Figure 2.3: Marketing Information System Architecture (Nilashan, 2012)

2.2.5 Existing Market Information Systems

A study conducted by USAID (2013) identified several MIS systems within the continent. The list of MIS covered by the study are as follows: Agricultural Marketing Information Services - Cameron, Kenya Agricultural Commodity Exchange (KACE), AMITSA - East Africa, Esoko - Many Countries in Africa, Livestock Market Information System – Ethiopia, Mfarm – Kenya, Nokia Life Tools – Nigeria, Infotrade Market Information Services – Uganda, Lima Links – Zambia, Regional Agriculture Trade Intelligence Network – RATIN East Africa, Zambia National Farmers Union – ZNFU – Zambia.

MIS type	MIS name	Country
Public MIS	Cocoa and Coffee Market Information System ("Systeme d'information des Filieres Cacao et Café", SIF)	Cameroon
	The Mozambique Information System for Agricultural Markets (SIMA)	Mozambique
	The Zambia Agricultural Market Information Centre (AMIC)	Zambia
	The Ethiopia Commodity Exchange (ECX) Market Information Section	Ethiopia
Farmer-based organization MIS	Agricultural Markets Observatory ("Observatoire du Marché Agricole", OMA)	Mali
	Zambia National Farmers' Union SMS MIS (ZNFU 4455)	Zambia
	Vegetable market information service ("Service d'information Economique des Legumes", SIEL)	Madagascar
	National Association of Professional Agricultural Organizations (ANOPACI)	Cote d'Ivoire
Private MIS	Kenya Agricultural Commodity Exchange (KACE)	Kenya
	Esoko	Ghana
MIS type	**MIS name**	**Country**
	Malawi Agricultural Commodity Exchange (MACE)	Malawi
	Infotrade	Uganda
Trader- and NGO-based MIS	The Rice Observatory ("Observatoire du Riz", OdR)	Madagascar
	Regional Agricultural Trade Intelligence Network (RATIN)	Kenya and East Africa

Figure 2.4: Existing Market information systems in Kenya and across Africa
Source: Chiatoh M & Gyau A. 2016

MIS Type	MIS Name	Data collection methods	Information disseminated	ICT used	Funding strategies
Public MIS	SIF Cameroon	Interviews	CIF and FOB prices	Radio, website and bulletins	Government, donors
	SIMA Mozambique	Interviews, observation by reporters	Prices, availability, product flow, transport costs	Weekly bulletin, radio, email, website, notice boards	Government, donors
	AMIC Zambia	Interviews	Prices and exchange rates.	Radio and email	Government, donors
	ECX Ethiopia	By product of transactions on the exchange	Date, time, grade, price and volume traded	Website, radio, TV, Electronic ticker board, print media, SMS, toll-free phone	Government, donors members' contributions
Farmer organization based MIS	OMA Mali	Interviews, observation by reporters	Prices	Bulletins, television, radio, website, email.	Government, donors, proceeds from its services, grants.
	ZNFU 4455 Zambia	Telephone interviews	Price	SMS, website, magazine, radio.	Government, donors, users' subscription.
	SIEL Madagascar	Interviews, observation by reporters	Prices and quantities exchanged	Notice board, newspapers and radio	FERT, FIFATA
	ANOPACI Ivory Coast	Interviews	Prices, quality, quantity, market trends	Radio, billboards, website.	Members' contributions, donors
Private MIS	KACE Kenya	Interviews, observation by reporters	Price and availability	Market resource centres, SMS, IVR, Internet database system, radio.	Shareholders, proceeds from activities,

Figure 2.5: Summary of elements of conduct of various MIS developed and implemented in Kenya and across the world.
Source: Chiatoh M & Gyau A. 2016

2.2.5.0 Technologies Implemented in AMIS

Kenyan Marketing information systems have adopted the uses of various technologies like; Mobile applications, IVR, SMS and USSD (Zoltner, 2013).

2.2.5.1 Unstructured Supplementary Service Data (USSD)

USSD is defined as a real-time messaging service between mobile devices and server-based applications across a network offering service to basic feature phones and smart-phones (Zhou et al.2015).

2.2.5.2 Short Message Service (SMS)

Trogo et al. (2015) identifies short messaging service (SMS) as a messaging service used for alerts meant to provide farmers with precise information.

2.2.5.3 Interactive Voice Response

Interactive Voice Response (IVR) is a system that utilizes computer generated voice (CGV) to respond to requests from a telephone caller. IVR systems enables users to access information by dialing a number to establish connection and communication with a server (Inam et al.2017)

2.2.5.4 Mobile Application

Mobile application is a program that runs on mobile devices (phones and tablets) and undertakes specific tasks for the individual user. it is a new and fast emerging division of the Information and Communication Technology (Islam et al,2010).

2.2.6   Gaps and Limitations

By reviewing the existing AMIS in Kenya, the researcher noted the following gaps and limitations: -

2.2.6.0 Language Barrier

According to (Parmar et al.2018), most of agricultural information is inscribed in English which is not easily understood by farmers in Africa. Lonyangapuo (2016) noted that many African smallholder farmers are illiterate and cannot read or write in English and thus content availed in English is not useful to them.

2.2.6.1 Accuracy of Collected Data

Current AMIS systems rely on enumerators in data collection and this is subject to having a lot of inconsistencies brought about by lack of adequate time and resources in collecting and processing market information.

2.2.6.2 Lack of Additional Services

According to Galtier et al (2014) the provision of additional services (warehouse management systems, credit information, agricultural advice, enterprise marketing, insurance etc.) can improve the use of MIS-disseminated information by eliminating constraints faced by market players.

2.2.6.3 Poor Business Models

Most of the currently available MIS systems are fully dependent on donor funding and thus don't have clear sustainability frameworks after the funding is exhausted USAID (2013) and Chiatoh M & Gyau A. (2016).

2.2.6.4 Data Gathering for Statistical Purposes

Many developing countries have developed AMIS but these systems have not achieved the desired user satisfactory levels since mostly they contain data that is meant for statistical purposes and minimal services meant to bring financial benefits to small holder farming communities (Shepherd,2001).

2.2.7   Conclusion

Different scholars (e.g. Wildt et al., 2006; Torero, 2011; Zarmai et al.,2014; Magesa et al.,2015; Macire Kante, Robert Oboko, Christopher Chepken (2018) concurs that access to ICT innovations by rural farmers encourages agricultural production since agriculture contributes greatly to a countries GDP towards national food security. Introduction of a system that can deliver reliable, high quality market information through available and affordable ICT technologies is a key player towards adoption and use by the intended end-users (Islam et al,2010). According to USAID (2013), Galtier et al (2014), Karoney, B. K. (2016) & Chiatoh M & Gyau (2016), to address these Gaps the following key recommendations ought to be adopted;

2.2.7.1 Data & Information Accuracy

The data provided by these AMIS systems ought to be timely and accurate for better consumption by the target stakeholders. This can be achieved by use of big data analytics in analyzing the collected data and providing highly insightful information. Some of the existing MIS i.e. RATIN provides market data that is in complex format and not consumable by Smallholder farmers. The proposed AMIS system will utilize Application Programming Interface (API) to already verified simple data for better accuracy and easier consumption by farmers.

2.2.7.2 Sustainable Business Models

Donors and other development partners ought to transformation from providing funds that support MIS systems and offer funding focused on helping MIS systems make concrete progress at developing

revenue streams for better sustainability. USAID (2013) noted that, AMIS success will largely be influenced by providing poor smallholder farmers with services that empower them to intensify their incomes and thus merit for any paid subscriptions. The proposed AMIS system will be hosted for free at a government datacenter at Kenya Agricultural and Livestock Research Organization (KALRO) as a way of reducing the cost of operating the system.

2.2.7.3 Provision of Additional Services

AMIS systems ought to adapt and provide additional services like; Agronomic advisories, weather forecast, Price index, market opportunities, credit and insurance information which in turn can improve their use.

2.2.7.4 Language Barrier

Language is key in the development of agriculture in Kenya and how it is employed governs the success of this sector in contributing to the national economy. The integration of local language in the mobile services have been of immense use by the farmers (Lonyangapuo, 2016). This research will purpose to develop an agricultural market information platform featuring one of Kenya's national language (Kiswahili) for easier use by majority of farmers.

2.3   Summary

Availing market information to Smallholder farmers creates opportunities for providing better trade within the AMIS. In conclusion, there is research gap in Kenya agricultural market information system, which emanates from development of AMIS not intended for Smallholder farmers. AMIS developed in Kenya do not factor language and complexity of information availed to Smallholder farmers. This research seeks to propose a method of enhancing AMIS usability through the use of Integrated Market information system for smallholder farmers in Machakos County, Kenya.

2.4 Conceptual Framework (CF)

Camp (2001) identifies CF is the organization by which the researcher believes will best explain the natural development of the phenomenon to be studied. CF is the researcher's way of clarifying how the research problem would be explored through a consolidated way of focusing on the problem under study (Adom et al (2018).

Figure 2.6: CF showing relationship between the dependent and independent variables under study.
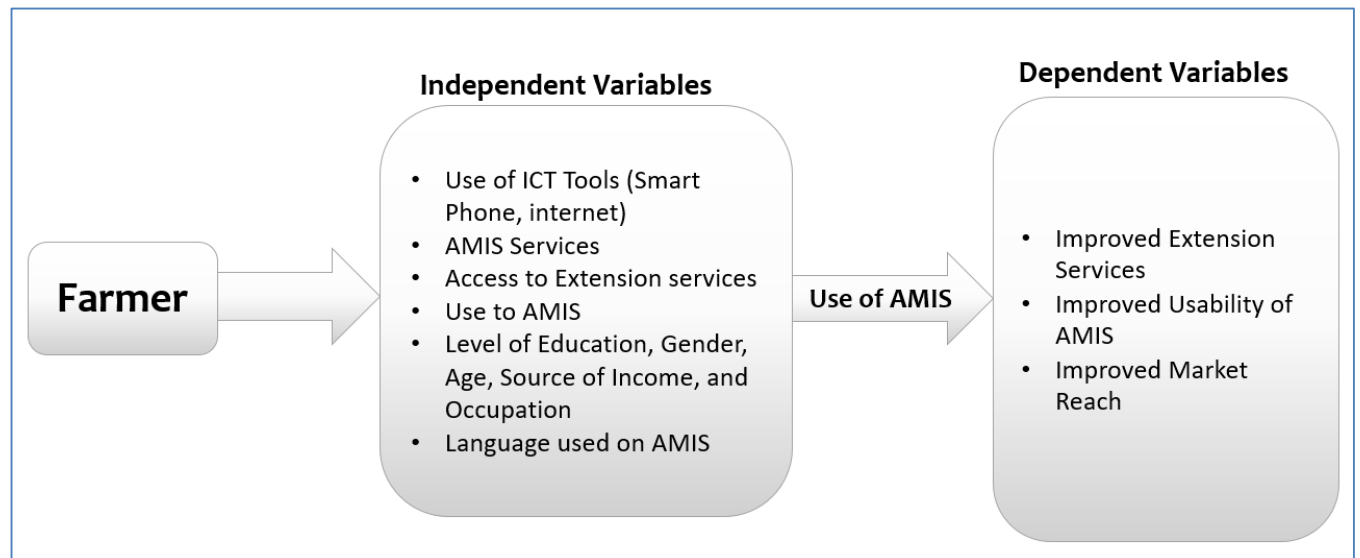
Source*: Author*

2.4.0 Independent Variables

- Use of ICT Tools (Smart Phone, internet)
- Use to AMIS
- Services offered on AMIS
- Access to Extension officers
- Level of Education, Gender, Age, Source of Income, and Occupation
- Language used on AMIS

2.4.1 Dependent Variables

- Improved Extension Services
- Improved Usability of AMIS
- Improved Market Reach

CHAPTER THREE: RESEARCH METHODOLOGY

3.0   Introduction

This study seeks to develop a web and mobile based Agricultural Market Information System (*AMIS)* for select value chains through provision of timely information on local markets, Agronomic advisories, weather Advisory, credit and Insurance. According to Avison and Fitzgerald (1995), chapter three (3) methodology, is based on a philosophical paradigm backed up by a compendium of methods, procedures, techniques, models, tools and documentation aids with an overall goal of achieving the researcher's objectives. This chapter reflects on the software methodology and research design used in the research.

3.1   Methodology for System Development

3.1.1   Agile Software Development (ASD)

Kumar & Bhatia (2012) identified Agile Methodologies as a collection of software development techniques that are centered on iterative and incremental development. According to Ahmed et al (2010) these methodologies are used for better software quality in less time by ensuring better organization, limited documentation and reduced time to deploy. ASD allows easy start and achievable similarities to the expected product and incrementally improve the specification throughout the life of the development. According to Malik (2011), ASD emphases on communication among all stakeholders, reaffirmations with continuous integration and feedback.
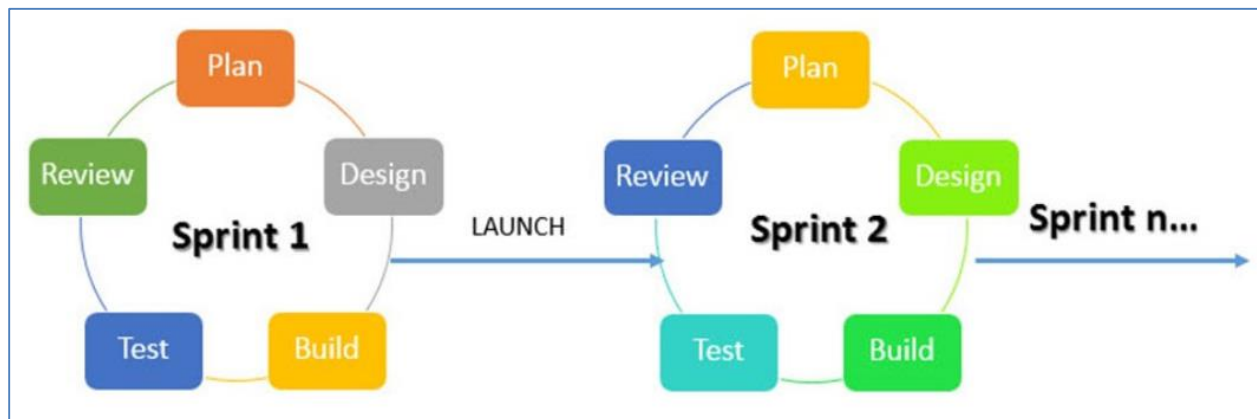
Figure 3.1: Diagram illustrates how agile development methodologies are implemented.

3.1.1.1 Agile

Ihenacho (2014) refers Agile to a collection of software development methods which have common requirement of involving the client's in providing solutions.

3.1.1.2 SCRUM

Jeff Sutherland established Scrum in 1993 with an objective of been a development and management methodology that adopts the philosophies of Agile methodology. Scrum is an outline for software development used to manage projects, products and system development. Its strategy emphasizes on a flexible all-inclusive approach where development teams work as a unit to achieve the target (Pham et al., 2011).

3.1.1.3 Software Development Life Cycle (SDLC)

SDLC is referred as phases of work undertaken by system analysts and programmers in developing systems (Adi, 2015).

3.1.2 Programming Tools

The proposed system was developed using React with NodeJS for the user interface (UI), .Net Core v5 and SQL Server 2019 express edition for database. The tools were selected since they are open-source, support cross-platform, high performance and free support from online community. React offers better styling standards and better native tooling capable of converting UI in native mobile and desktop application. The .Net Core Entity framework is object relational management framework is database independent and can be easily migrated into any database be it NoSQL or RDBMS. Applications developed using these tools will be easily deployed to containers thus reducing the need for bare metal infrastructure and operating systems. Scalability can be achieved by use of container orchestration services like Kubernetes. Proposed web server for the application is Nginx a popular and free high availability server with load balancing capabilities.

3.1.2.1 Language Translator API

A study by Milam (2019), showed that Google language translator has significantly improved to offer wider range of translations. The researcher utilized google translation API to automatically translate key components of the system without distorting or altering the meaning.

3.1.3 Conceptual Architecture of Proposed System

The MAMIS application featured the following functional modules

i.   **Registration** - This forms the first step where a user has to register to access the application. The registration details are then saved in the back-end database and a username is automatically generated.

ii. **Login** - This module allows different users (admin, farmer or trader) to login into the system with the option of logging-out.

iii. **Language Translation** – This Section allows users to change language options between English and Swahili during registration and log-on for preference in using the system.

iv. **Agro-Weather Advisory** – Users of category farmers view this module and access agro-weather information.

v.   **Market Information** – All other users except the admin can view this module and access market information.

vi. **Credit & Insurance Services** – Only user of category farmer can view this module.

vii. **Administration Center** – Only the admin user can view this module and manage back-end resources like user's accounts.

viii. **SMS Service** – This module can only be viewed by the admin and is used for sending advisories to registered users of category farmer.

ix. **3rd party integration** – This module is used by admin user in case of Api integrations with external applications.

The application was developed with respect to non-functional requirements like security, scalability, accessibility, availability and maintainability to guarantee better service offerings.

Figure 3.2: Conceptual architecture of proposed Integrated Multi-Stakeholder system
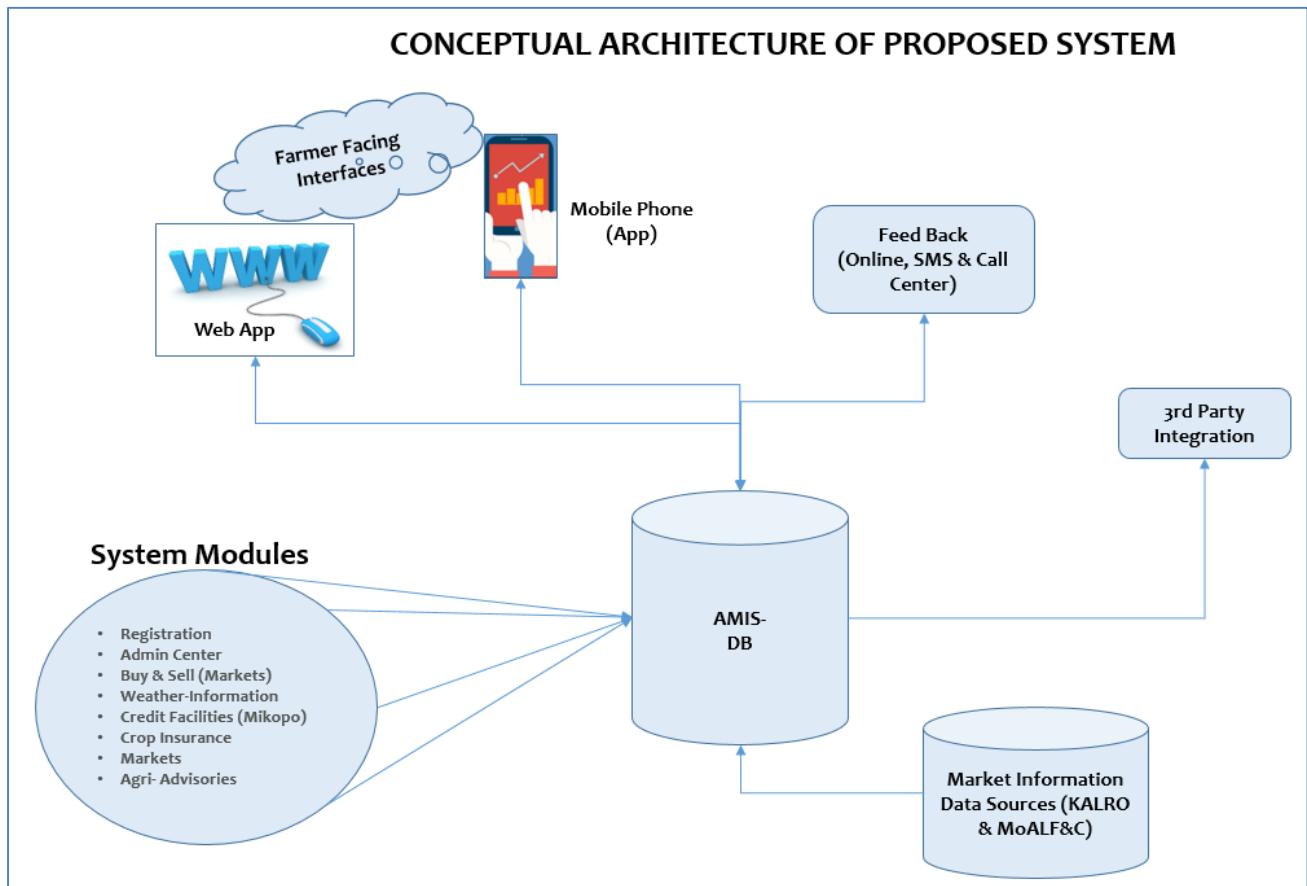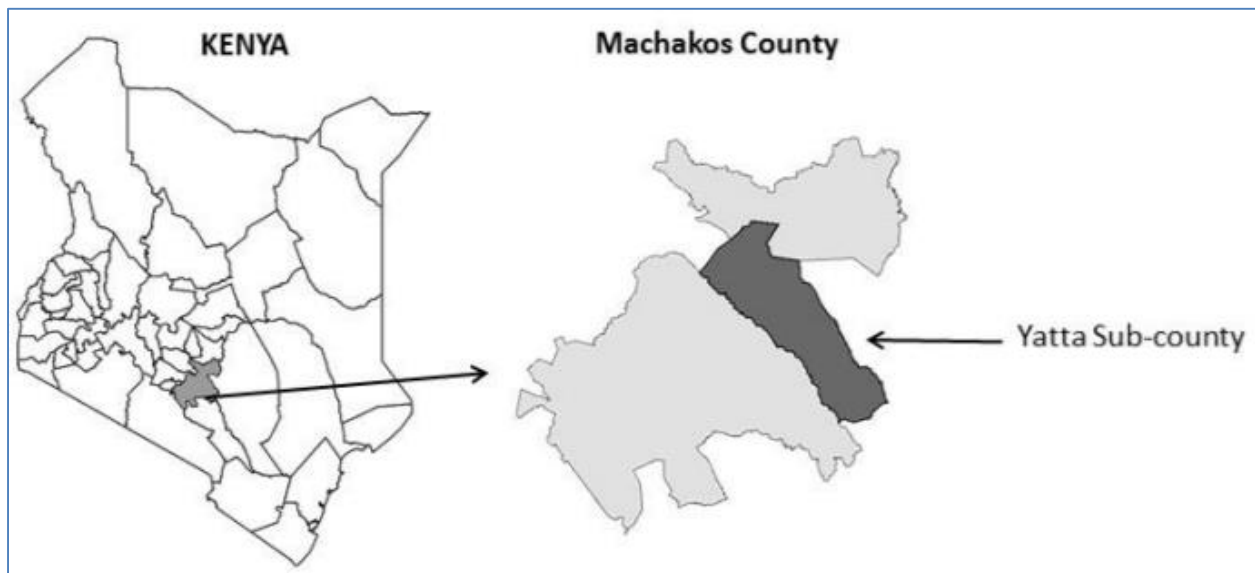

Source: *Author*

3.2   Methodology for data collection
3.2.1   Location of Study

The study was carried out in Yatta sub-county (Ikombe and Katangi Wards) within Machakos County as shown in figure 3.3.

Figure 3.3: Map showing the Study Area (Yatta Sub-County)

*Source***:** Eidt, & Pant, Laxmi & Hickey, Gordon. (2020)

3.2.2 Sample size Population

The entire set of cases from which researcher sample is drawn is referred as the population (Shakerdoost H, 2016). This study targets a population of crop farmers in Machakos County, Kenya. The study entailed a population size of one hundred and eighty (180) Green Grams & Pigeon Peas Farmers.

Sample size determined using Slovin's formula: $n = N / (1 + Ne^2)$ people: $180 / (1 + 180 * 0.05 * 0.05) = 124$

3.2.3 Purposive or Judgmental Sampling

Purposive sampling is an approach in which exact persons or events are selected consciously in order to provide critical data that cannot be obtained from other selections (Shakerdoost H, 2016). The study adopted a purposive sampling technique for the target users.

3.2.4 Select Sampling Frame

According to Shakerdoost, (2016) a sampling frame is a list of the definite cases from which a sample is to be drawn. The frame must undoubtedly be a representation of the population under study. The study's sample frame was from Yatta sub-county in Machakos targeting two wards (2) namely; Ikombe and Katangi. The study site was informed by the fact that the targeted value chains (Green Grams & Pigeon Peas) are grown in these agro-ecological zones (AEZ).

3.3 Research Design

Wausi, (2009) defined research design as steady steps which are undertaken to tie research questions to data collection, analysis, and interpretation in a logical and consistent way. This research used the key research approaches of qualitative and quantitative. Qualitative and quantitative research helped investigate the research topic by addressing different research questions and an experimental method for design and development of integrated AMIS platform. The study used interview and questionnaire as the primary techniques and methods for data collection.

3.3.1 Interviews & Questionnaires

According to Wohlin et al (2011), the principal means of collecting qualitative or quantitative data are interviews or questionnaires. They are done by taking a sample from the study population and results analyzed to derive evocative and explanatory conclusions. This study adopted automated data collection kit (ODK) based questionnaire with a blend of open and closed-ended questions.

3.3.2 Methodology for Data Analysis and Data Presentation

Lutabingwa et al (2007) stated that, after data processing, the researcher needs to proceed to the data analysis process. This research used Statistical Package for the Social Sciences (SPSS) and Microsoft Power BI for data analysis and presented in Tables and Charts.

3.3.3 Ethical Consideration

Protecting human beings by adoption and application of suitable ethical principles is very key while undertaking any research (Binti Mohd Arifin, Siti Roshaidai, 2018). Abrar et al (2019) defined ethics as the code of right and wrong conduct. He further explained that, in the context of research, ethics is defined as the code of appropriate conduct to protect and respect the participant's welfare, dignity, and rights. Abrar et al (2019) further noted that the need for informed consent, protection, confidentiality and anonymity of participants. Through informed consent, research participants took part in the research project willingly and fully understand the study obligations and consequences from their involvement. This study observed all ethical considerations during the study period by obtaining consent from each respondent.

<div align="center">**CHAPTER FOUR: DATA ANALYSIS, PRESENTATION AND**</div>
<div align="center">**INTERPRETATION**</div>

4.0   Introduction

This chapter offers the analysis and interpretation of the data obtained from the respondents in the study guided by the main objective of developing an integrated market information system that enhances usability of AMIS and improves access to information by smallholder farmers in Machakos County.

4.1   Demographic Analysis

This section entailed analysis of the respondents' gender, age, occupation, source of income and level of education as per the filled questionnaires.

4.1.1   Gender

The research pursued to establish gender of the respondents on the application of AMIS for improved access to agricultural market information. The findings are presented in the Figure 4.1.

Figure 4.1: Gender of respondents
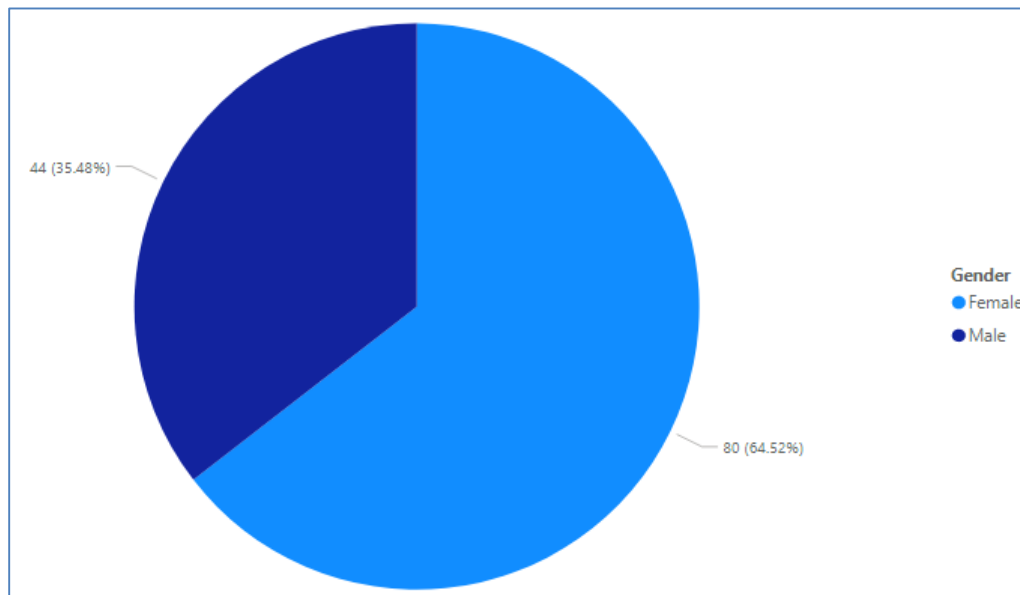
The researcher established that out of the 125 respondents interviewed, 64.52 percent were female while 35.48 percent were male. According to Otieno (2019) Women encompass half or more of the cumulative agricultural sector labour force in Kenya.

4.1.2 Age

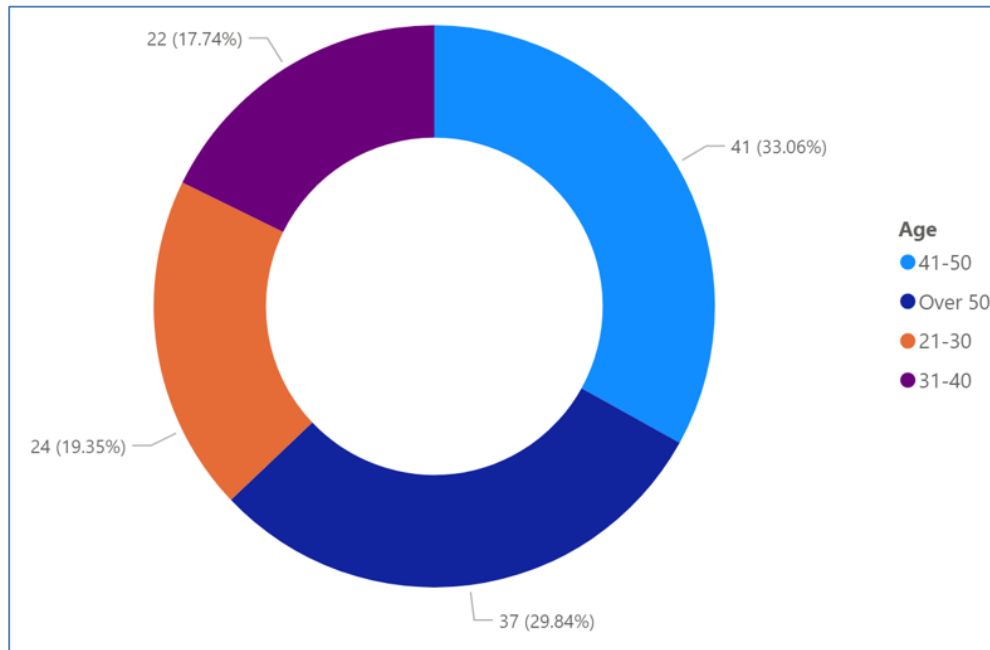The study established the age of the respondents on the application of AMIS for improved access to agricultural market information. The findings are offered in the Figure 4.2.

Figure 4.2: Age of respondents

The results in Figure 4.2 indicated that 33.06 percent of the respondents interviewed were between 41 - 50 year while 29.84 percent were over 50 years old. An additional 19.35 percent were between 21 – 30 years, 17.74 percent of their farmers interviewed were between 31 – 40 years and no record for any farmer below 20 years old.

The findings indicated that all the farmers were above 21 years old. Majority of the respondents were between ages 41 – 50 years old, followed by those over 50 years. This was followed by those between 21 – 30 years' old which forms the young and energetic youth. Those between ages 31 – 40 were the least could be because they are characterized by migration to urban centers for white collar jobs.

4.1.3 Occupation

The study established the main occupation of the respondents on the application of AMIS for improved access to agricultural market information. The outcomes are presented in the Figure 4.3.

Figure 4.3: Occupation of respondents

The researcher established that 93.55 percent of the respondent's main occupation was farming, 3.23 percent had some business, 2.42 percent were also professionals while 0.8 percent were students. The findings indicate that some farmers are also running business, attending school or employed professionals as a way of substituting returns from farming.

4.1.4 Source of Income

The study purposed to establish the Source of income for respondents on the application of AMIS for improved access to agricultural market information. The findings are presented in the Figure 4.4.
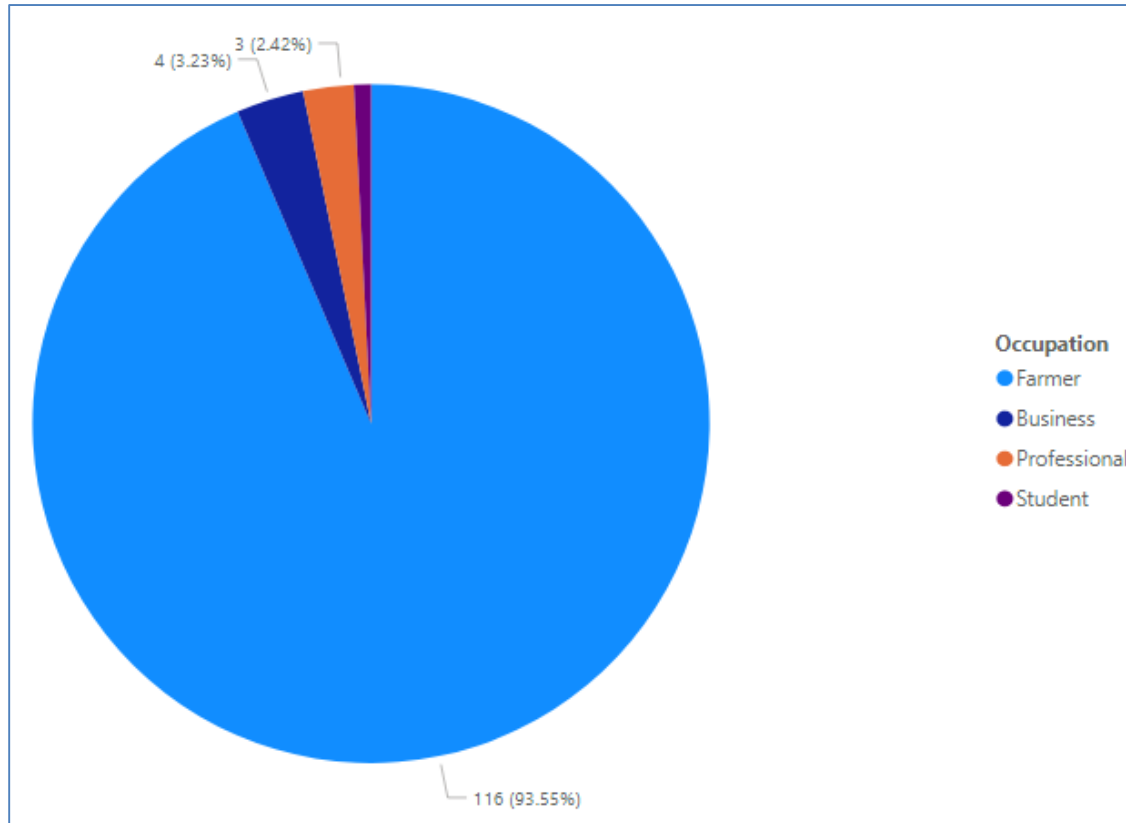
Figure 4.4: Source of Income of respondents
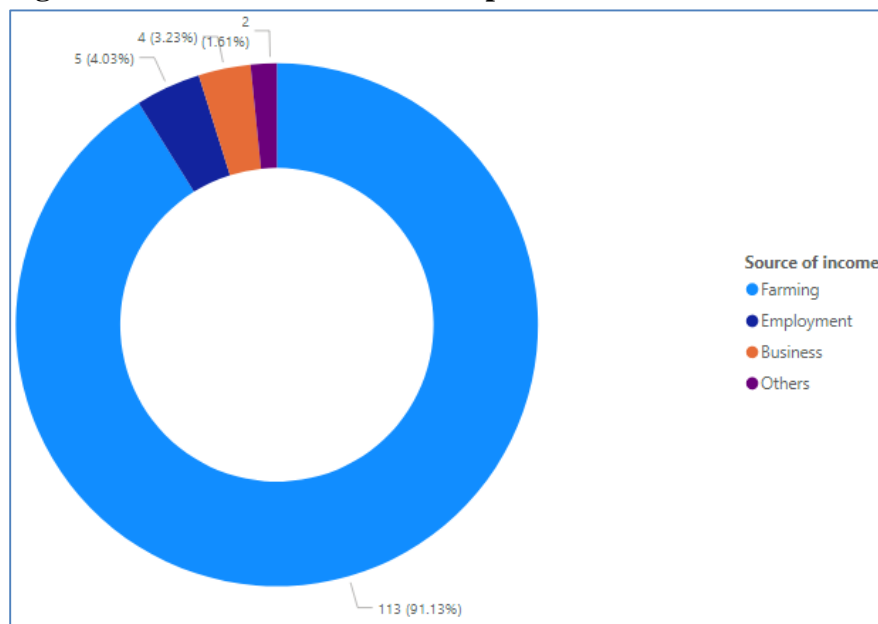
The researcher established that 91.13 percent of the respondents had farming as their main source of income. The study further indicated that few respondents had alternate source of income with 4.03 percent on employment, 3.23 percent on operated business while 1.61 percent indicated as other sources. This could be owed to the fact that many farmers in rural areas rely entirely on farming as a source of income FAO (2017).

4.1.5   Level of Education

The study sought to establish the level of education for respondents on the application of AMIS for improved access to agricultural market information. The results are presented in table 4.1

Table 4.1: Level of Education of respondents

Level of Education	Frequency	Percentage
Primary school	87	70.16
High school	31	25
Diploma	6	4.84
Bachelor's degree	0	0
Post-graduate	0	0
Total	**124**	**100.0**

The researcher established that 70.16 percent of the respondents interviewed had primary education and 25 percent had acquired high school education. The study further indicated that 4.84

percent had a diploma while no respondents had attained Bachelor's degree or Post-graduate. The reason for the low attainment of Diploma or degree can be linked to several factors.

i.   Majority of persons with diploma and degree migrate to urban centers for white collar jobs.

ii.   The social norm that you don't need to be learned to be a farmer

Most of the farmers in the rural areas of Kenya have attained at least primary and secondary education as evidenced by the study where more than 95 percent of the respondents had attained primary school level. The government of Kenya through established free and compulsory primary education since 2003 and this has equipped farmers with basic knowledge on the use of ICT tools.

4.2   Mobile Phone Ownership

The study sought to establish the Mobile Phone Ownership for respondents on the application of AMIS for improved access to agricultural market information. The outcomes are showed in Figure 4.5

Figure 4.5: Mobile Phone Ownership by respondents
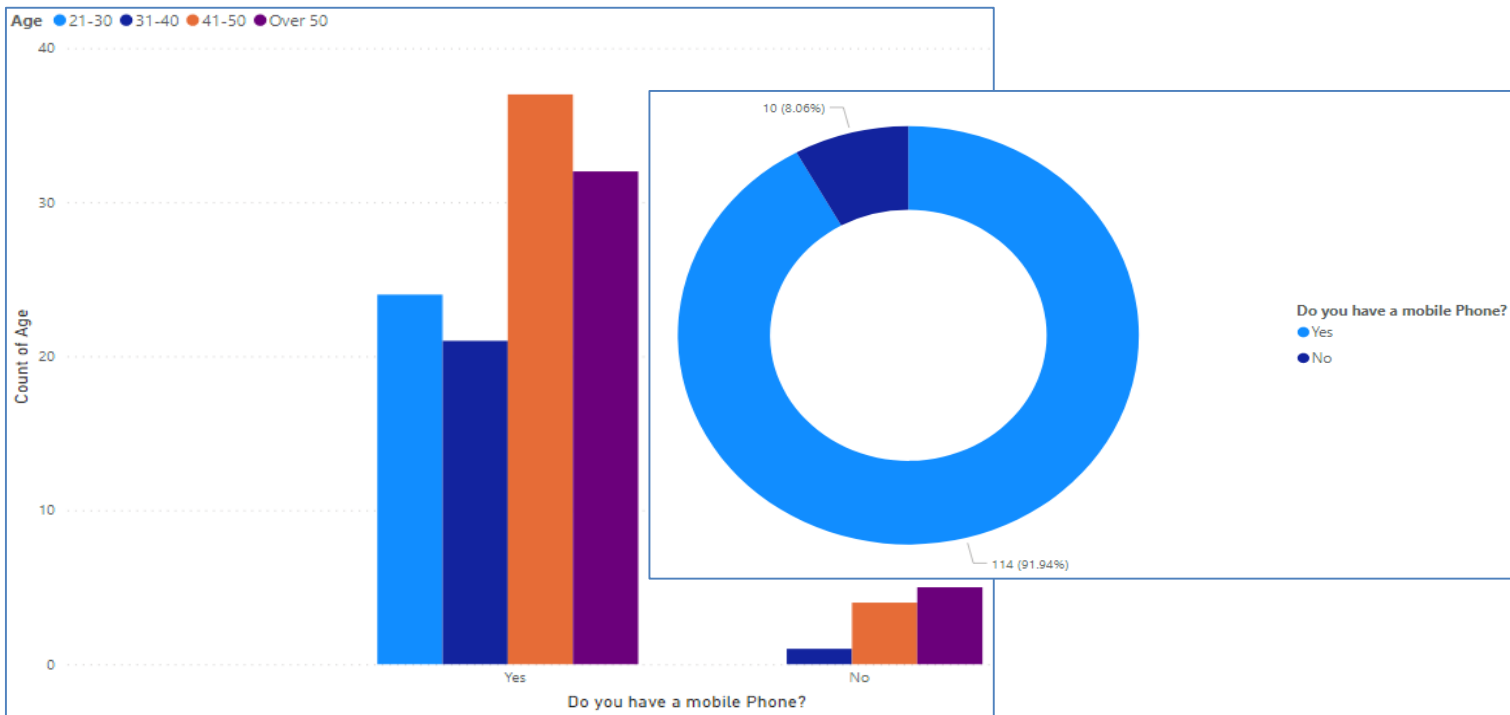
The researcher established that 91.94 percent of the respondents had access to a phone and only 8.06 percent did own a mobile phone. Further findings showed that majority of those who did have phones where between the ages of 41 – 50 and 50 years and above. According to World Bank (2019), mobile phone cellular subscription stood at 104 percent which is in line with the research finding giving farmers opportunities to access online based ICT systems.

4.2.1   Smartphone Ownership

The study identified the Smartphone Ownership for respondents on the application of AMIS for improved access to agricultural market information. The findings are offered in Figure 4.6.

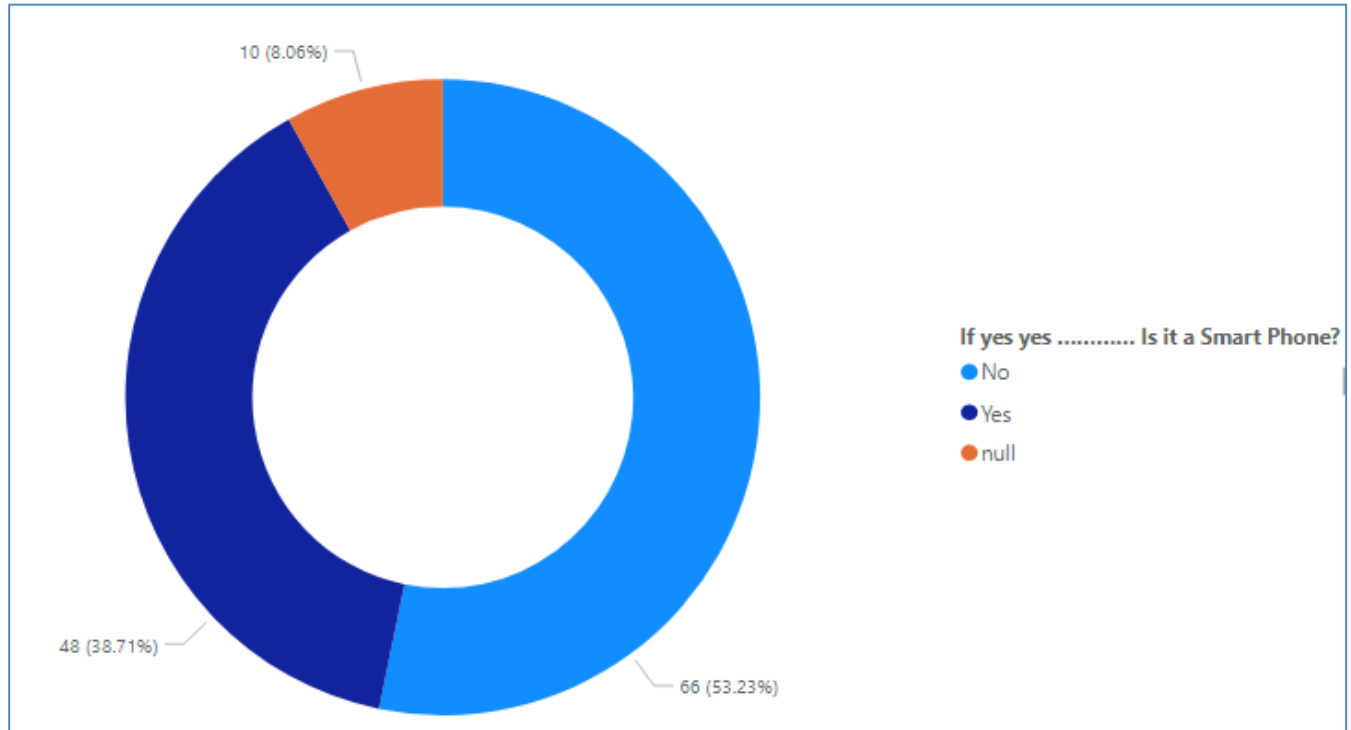**Figure 4.6: Smartphone ownership by respondents**

The study established that 53.23 percent of the respondents did not have a smart phone and 38.71 percent had a smart phone. A study by Pew Research (2017) established that 80% of adults in Kenya stated owned a mobile phone, with 30% owning a smartphone while 50% owned a basic feature phone. The percentage of farmers with smart phone is increasing presenting an opportunity for ICT based agricultural solutions.

4.2.2 Access to Internet

The study sought to establish access to internet for respondents on the application of AMIS for improved access to agricultural market information. The findings are presented in Figure 4.7

Figure 4.7: Access to Internet by respondents
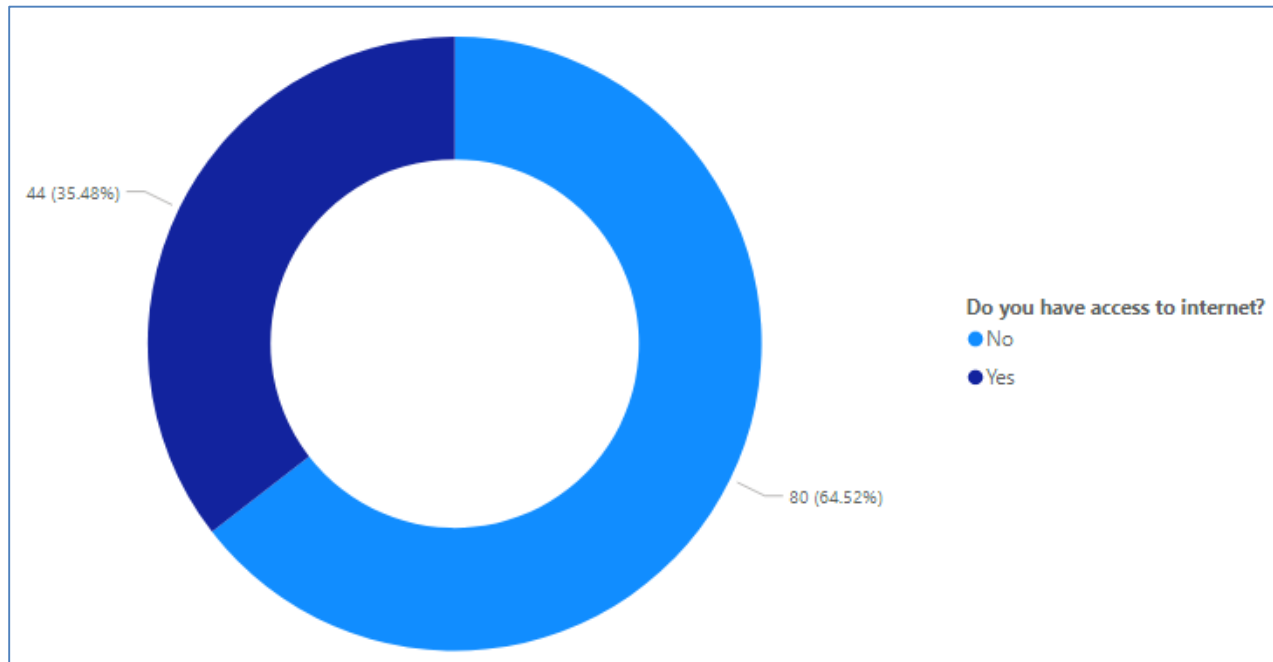
The study identified that 64.52 percent of the interviewed respondents had no internet access and only 35.48 percent had access. Further finding implied that some farmers had smart phones but could not access internet due to various reasons as outlined below.

   i.   Lack of Knowledge on how to use internet on their smart phone

  ii.   Lack of data bundles

 iii.   High cost of accessing internet services

 iv.   Lack of Credit on their phones

4.3 To Investigate the influence of socio-economic and technological factors on the use of AMIS by smallholder farmers in Machakos County.

The first objective of this study was to investigate the influence of socio-economic and technological factors on the use of AMIS by smallholder farmers in Machakos County, Kenya. The influence of socio-economic and technological factors was evaluated by analyzing the responses for 124 respondents based on gender, age, occupation, source of income, education and their response on whether they use of AMIS. The findings are presented in Figure 4.8

Figure 4.8: Relationship between Gender and Use of AMIS
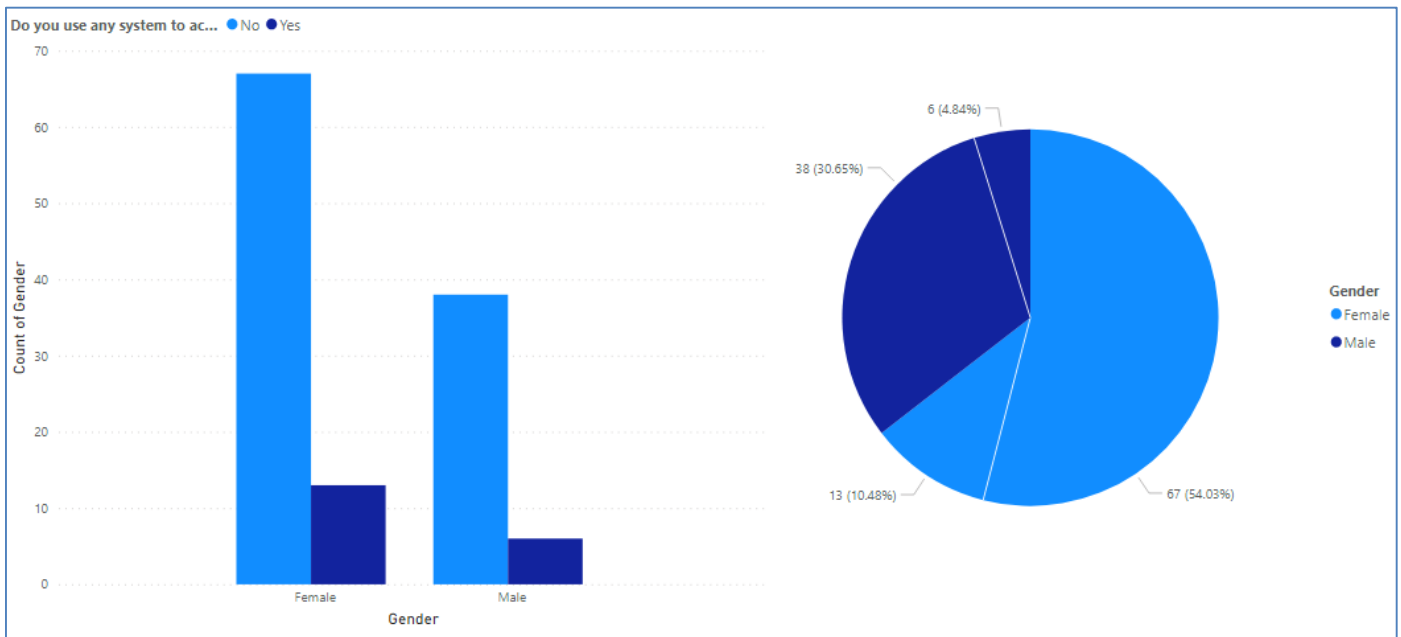
The researcher established that women at 10.48 percent of the respondents used ICT tools against 54.03 percent who do not while men at 4.84 percent use ICT tools against 30.65 percent who do not. These findings implies non-significant association between gender and the use of AMIS in accessing market information.

Figure 4.9: Relationship between Age and Use of AMIS
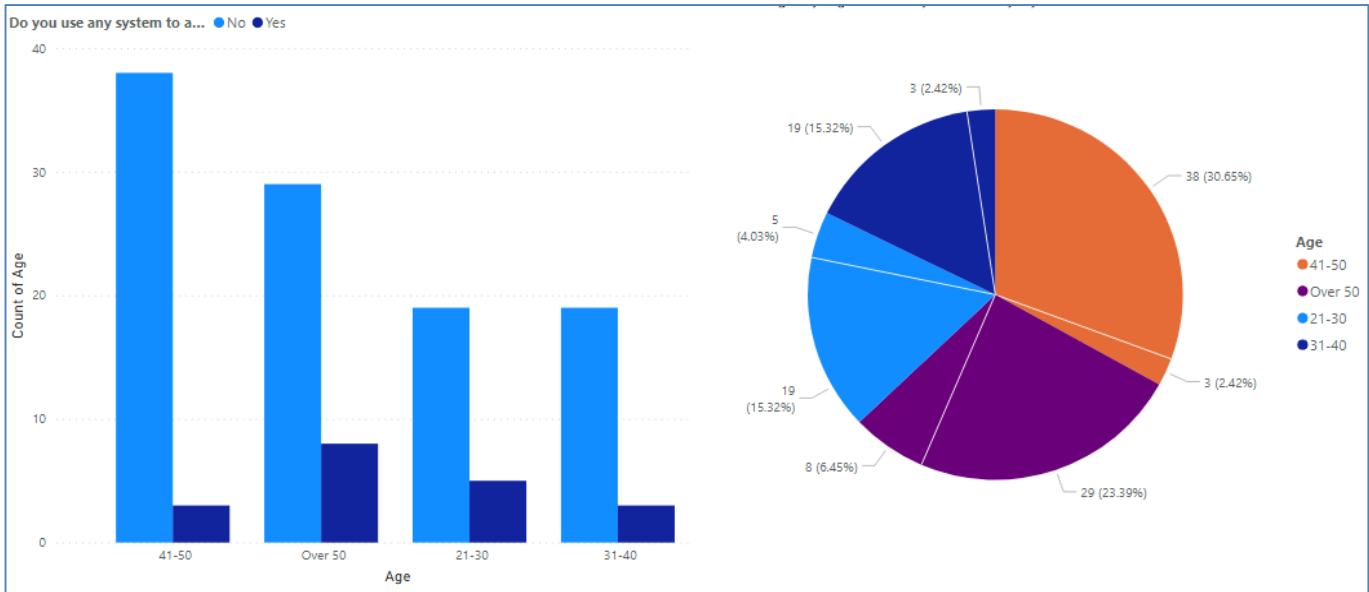
The study identified that the age between 21 – 30 had 15.32 percent for not using ICT tools and 4.03 percent for not using, age between 31 – 40 had15.32 percent for not using and 2.42 percent for use, age 41 – 50 had 30.65 percent for not using and 2.42 percent for use while age over 50 had 23.39 percent and 6.45 percent for using ICT tools. The results therefore indicate non-significant relationship between age and the use of AMIS in accessing market information.

Figure 4.10: Relationship between Occupation and Use of AMIS
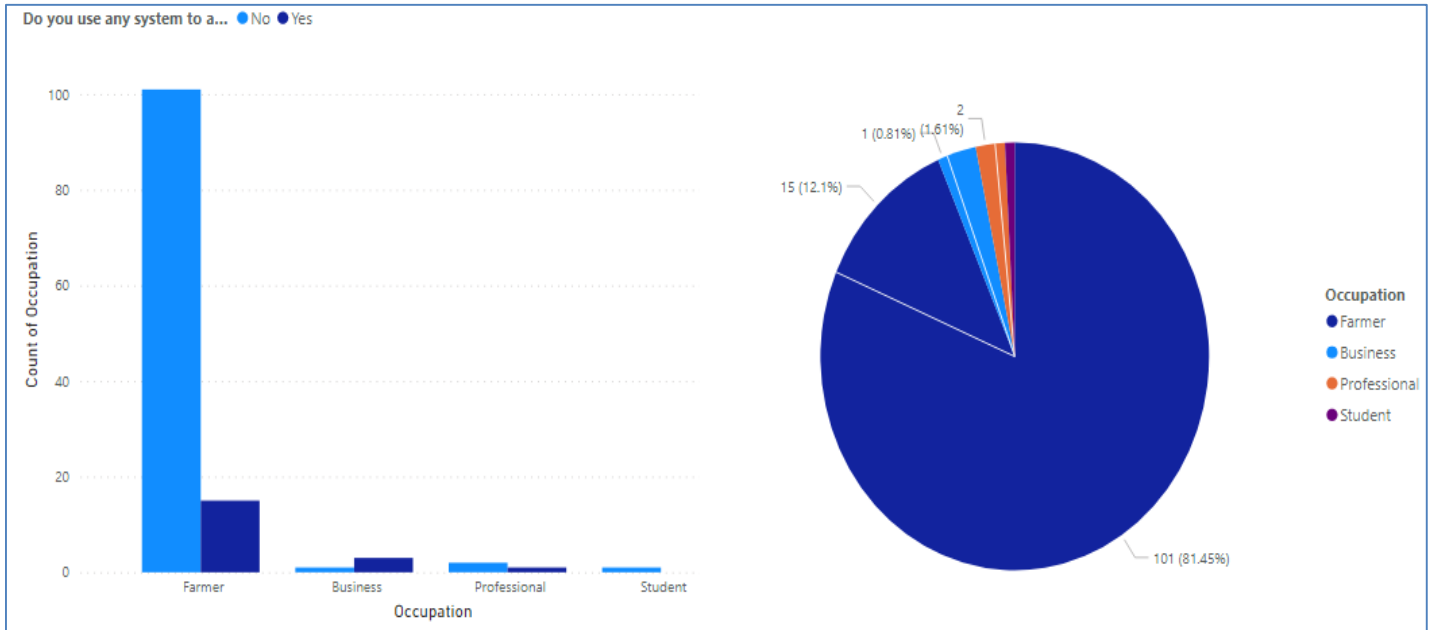
The researcher established that farming as an occupation had a percentage of 81.45 not using ICT tools and 12.1 percent using, Business had 2.42 percent for not using and 0.81 percent for using, professional occupation had 1.61 percent for not using ICT tools and 0.81 percent for using while student had 0.81 percent for not using. The results therefore indicate significant relationship between Occupation and the use of AMIS where respondents with main occupation as farming are less likely to use the systems.

Figure 4.11: Relationship between Source of Income and Use of AMIS
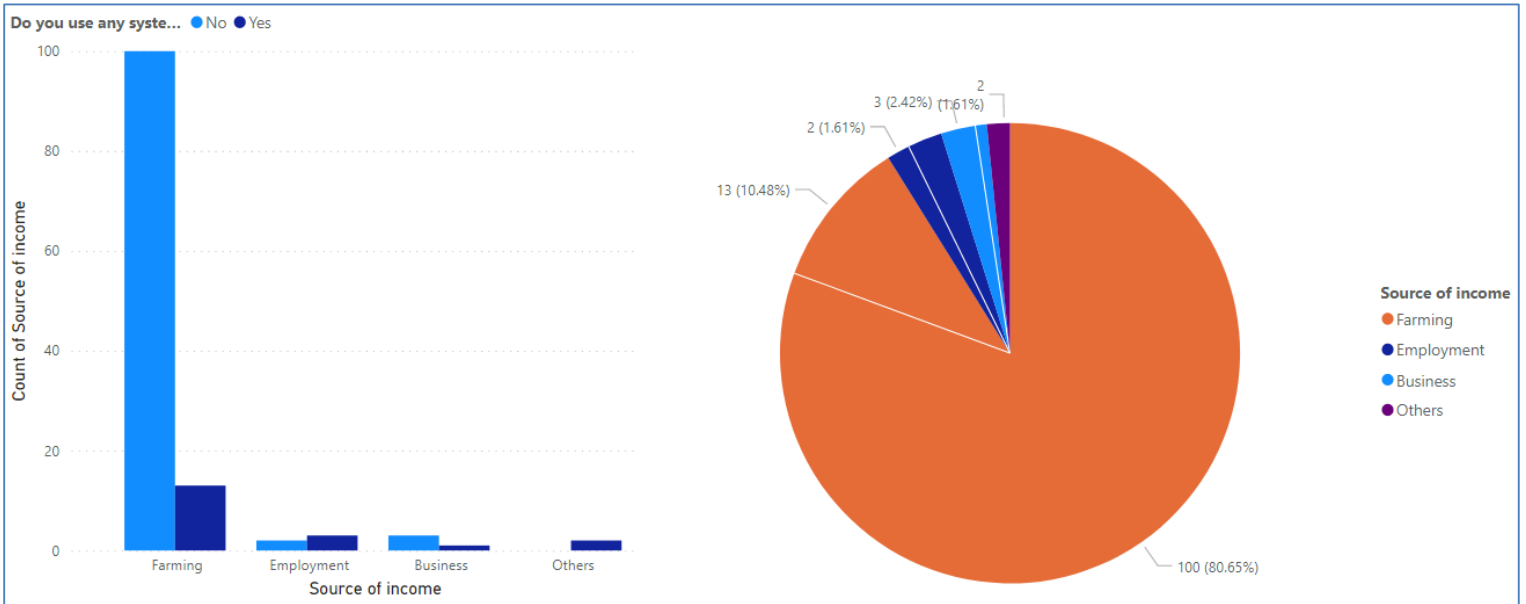
The study identified that farming as a source of income had 80.65 percent for not using ICT tools and 10.48 percent for using, employment had 2.42 percent for not using and 1.61 percent for using, business had 2.42 not using and 0.81 percent while other sources of income recorded 1.61 percent for using ICT tools. The results imply significant association between source of income and the use of AMIS in accessing market information.

Figure 4.12: Relationship between Level of Education and Use of AMIS
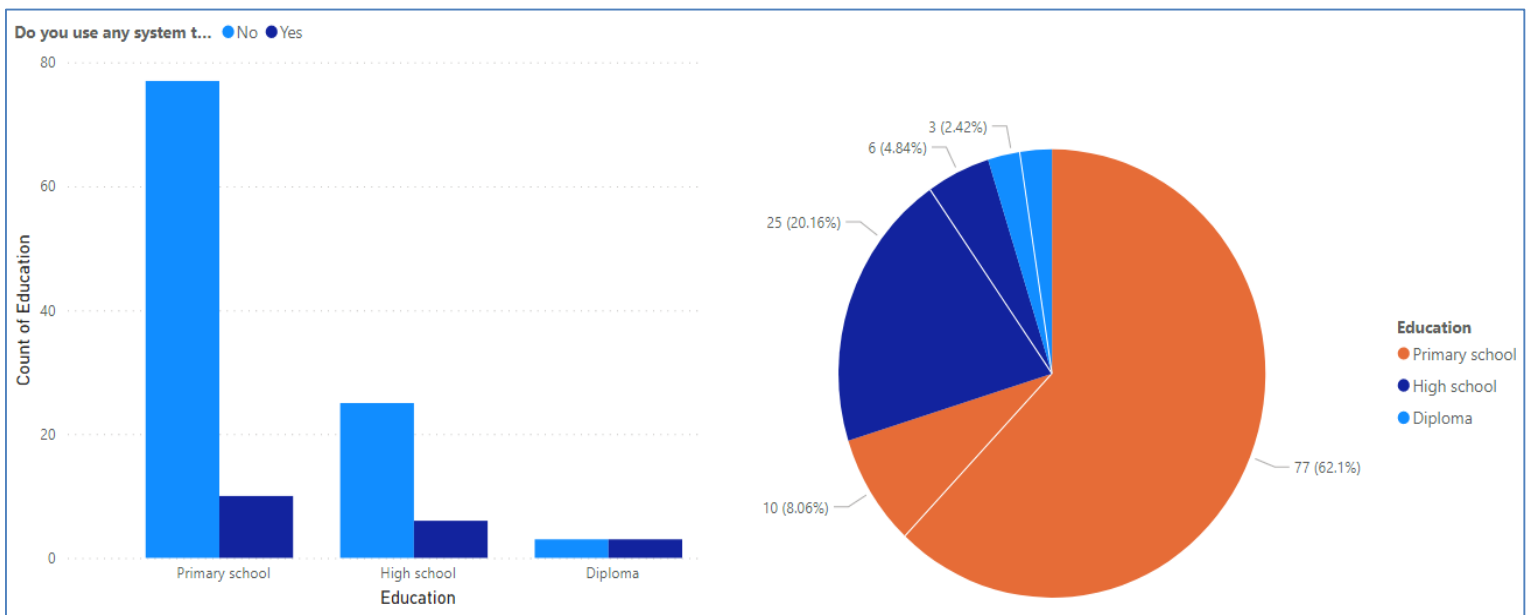
The researcher identified primary school level of education had 62.1 percent for not using and 8.06 percent for using ICT tools, high school level had 20.16 percent for not using and 4.84 percent for using while diploma level had 2.42 percent for both using and not using ICT tools. Further findings showed that degree and masters level of education recorded zero (0) percentage. The results imply significant relationship between level of education and the use of AMIS in accessing market information especially for those with higher level of education.

4.4 To Investigate the influence of language on the adoption of Agricultural Market Information System (AMIS)

The second Objective of the study was to Investigate the influence of language on the adoption of Agricultural Market Information System (AMIS) by smallholder farmers in Machakos County, Kenya. The influence of language on the adoption of AMIS was evaluated by analyzing the responses of the 124 respondents. The figures below show the relationship.

Table 4.2: Language used by Current Systems

Language	Frequency	Percentage
English	75	60.48
Swahili	35	28.23
Others	14	11.29
Total	**124**	**100**

The study established that English based systems recorded 60.48 percent, Swahili based systems had 28.23 percent and 11.29 percent of language used by current systems. The findings further show that English based tools were mostly deployed. The results imply significant relationship between language used by current systems and the low use of AMIS in accessing market information. Lonyangapuo (2016) noted that many African farmers are illiterate and unable to read or write in English and thus content written in English is not useful to them.

Figure 4.13: Preference on Swahili based AMIS
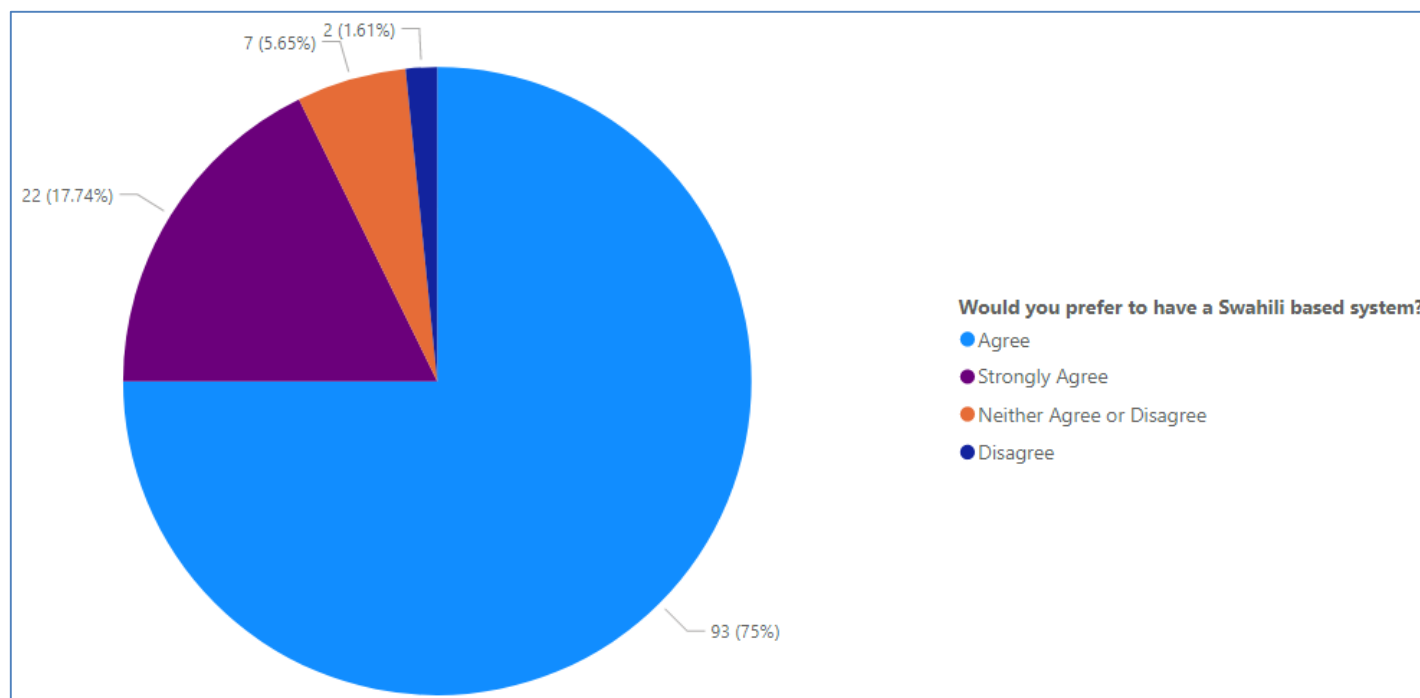
The finding in figure 4.13 identified that 75 percent of the respondents agree and 17.74 percent strongly agree towards use of Swahili based AMIS while neither agreed or disagreed had 5.65 percent and 1.61 percent for disagree. The results imply significant relationship between Swahili based AMIS and the use of AMIS in accessing market information. Kavita, Kavita & Nester, Muthoni (2018) noted that, rural farmers were becoming more literate making it possible for information systems to presented in one of the national language (Swahili) for easier use and understanding by majority of farmers.

Table 4.3: Swahili based system impact on usage of AMIS

Response	Frequency	Percentage
Agree	95	76.61
Strongly Agree	19	15.32
Neither Agree or Disagree	8	6.45
Disagree	1	0.81
Strongly Disagree	1	0.81
Total	**124**	**100**

The researcher identified that 76.61 percent of the respondents agreed that Swahili based system improves their usage of AMIS, 15.32 strongly agree, 6.45 neither agreed or disagreed while disagree and strongly disagree had 0.81 percentage each. The results imply significant relationship between Swahili based AMIS influencing the use of AMIS for accessing markets.

4.5 To design and develop an Integrated Agricultural Market Information System (AMIS) for use by smallholder farmers

The Third Objective of the study was to design and develop an Integrated Agricultural Market Information System (AMIS) for use by smallholder farmers and other stakeholders in Machakos County. The development was guided by response received from the 124 respondents in terms of the access methods, features and services presented on the platform in relation to current adopted systems.

Figure 4.14: Use of systems to access market information
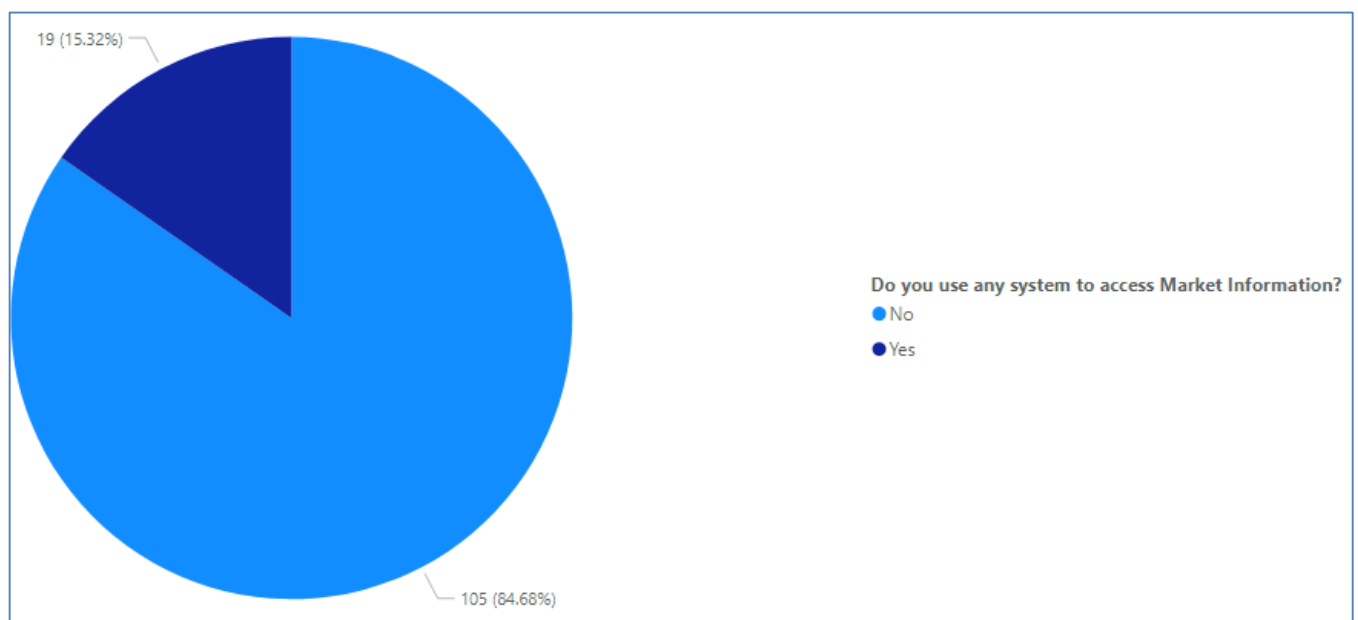
The finding in figure 4.14 indicated that 84.68 percent of all the respondents did not use any systems to access market information and 15.32 percent used market information systems. The findings imply low usage or access to market information systems by smallholder farmers in Yatta sub-county in Machakos county, Kenya.

4.5.1 Proposed System Modules/ services

Figure 4.15: Farmer preferred System Modules/ services
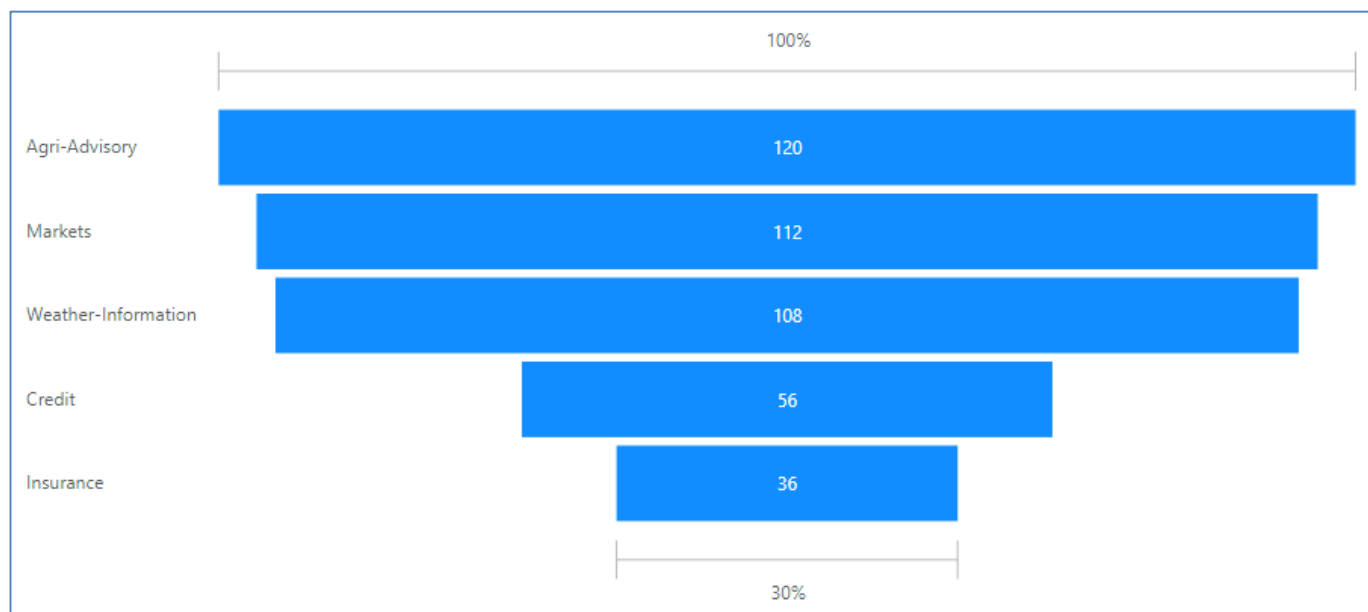
Table 4.4: Farmer preferred System Modules/ services

Response	Frequency	Percentage
Agri-Advisory	120	96.77
Markets	112	90.32
Weather-Information	108	87.10
Credit	56	45.16
Insurance	36	29.03

The finding in figure 4.15 and table 4.4 indicate preferred AMIS services by respondents where 96.77 percent of all respondents prefer agri-advisory, markets at 90.32 percent, weather information at 87.10 percent, credit at 45.16 percent and insurance services at 29.03 percent. This results imply a need to develop integrated market information system offerings these services.

Figure 4.16: Preferred Subscription type for the AMIS.
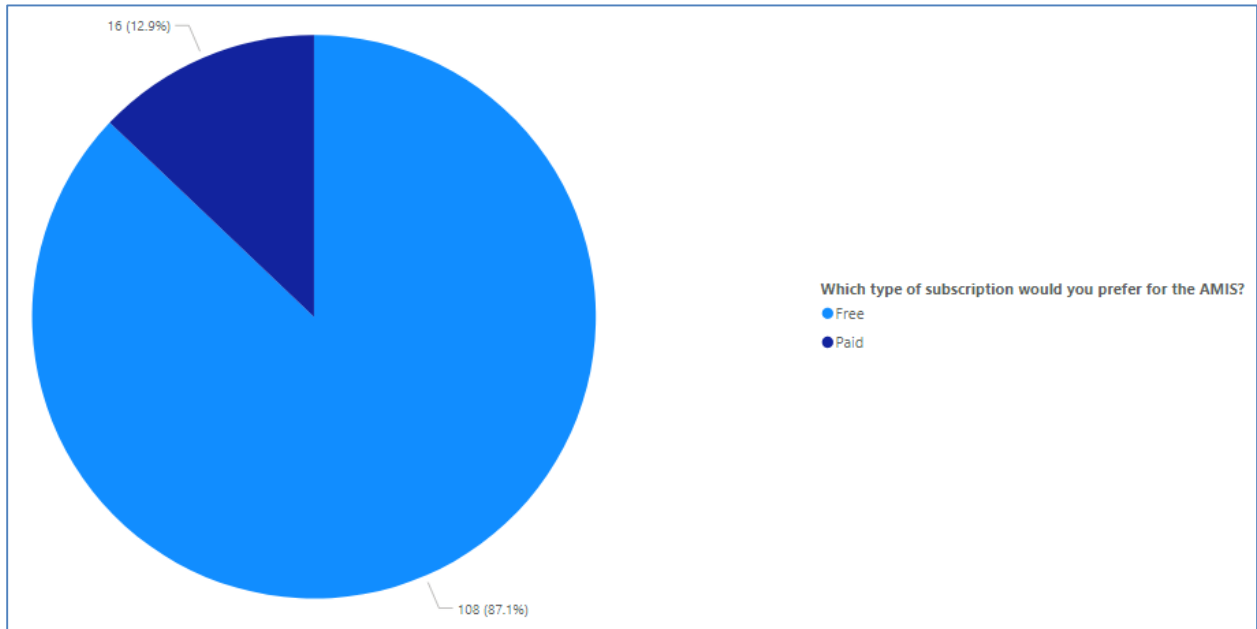
The study identified that 87.1 percent of all 124 respondents preferred an AMIS system that if available for free subscription while 12.9 percent indicated a paid subscription.
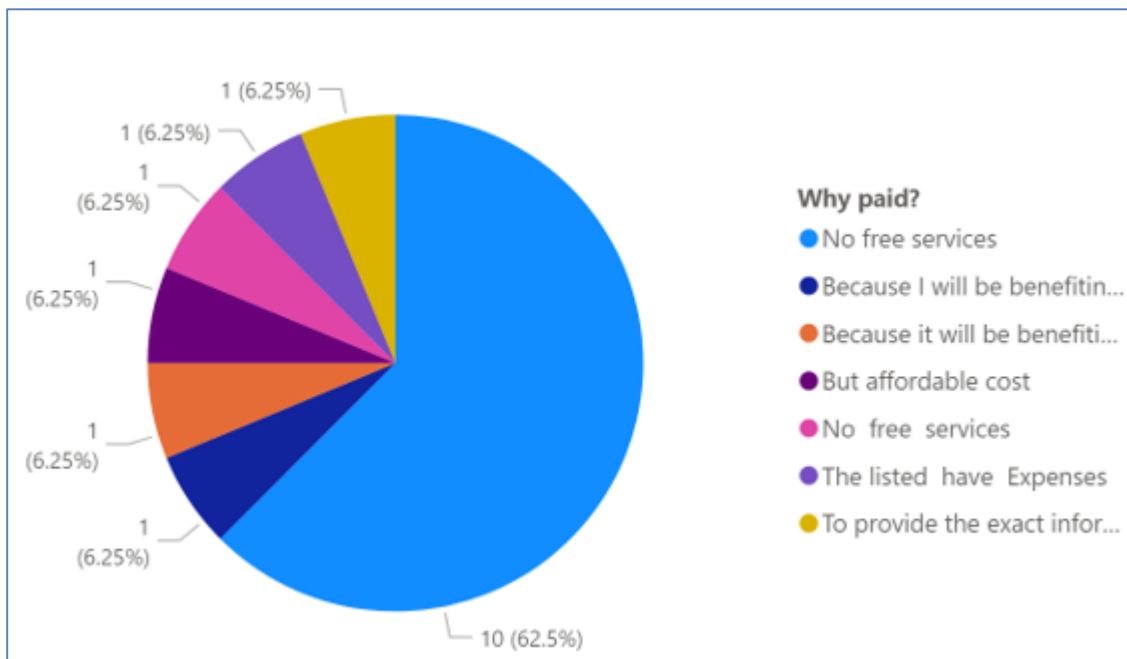
Figure 4.17: Why Paid Subscription.

The findings in figure 4.17 identified that 12.9 percent of all 124 respondents preferred paid service. The results in figure 26 captured the various reasons given by each of the 16 respondent for their preferred subscription type. The respondents indicated that paid services guarantees better services at affordable costs.

Figure 4.18: Why Free Subscription.
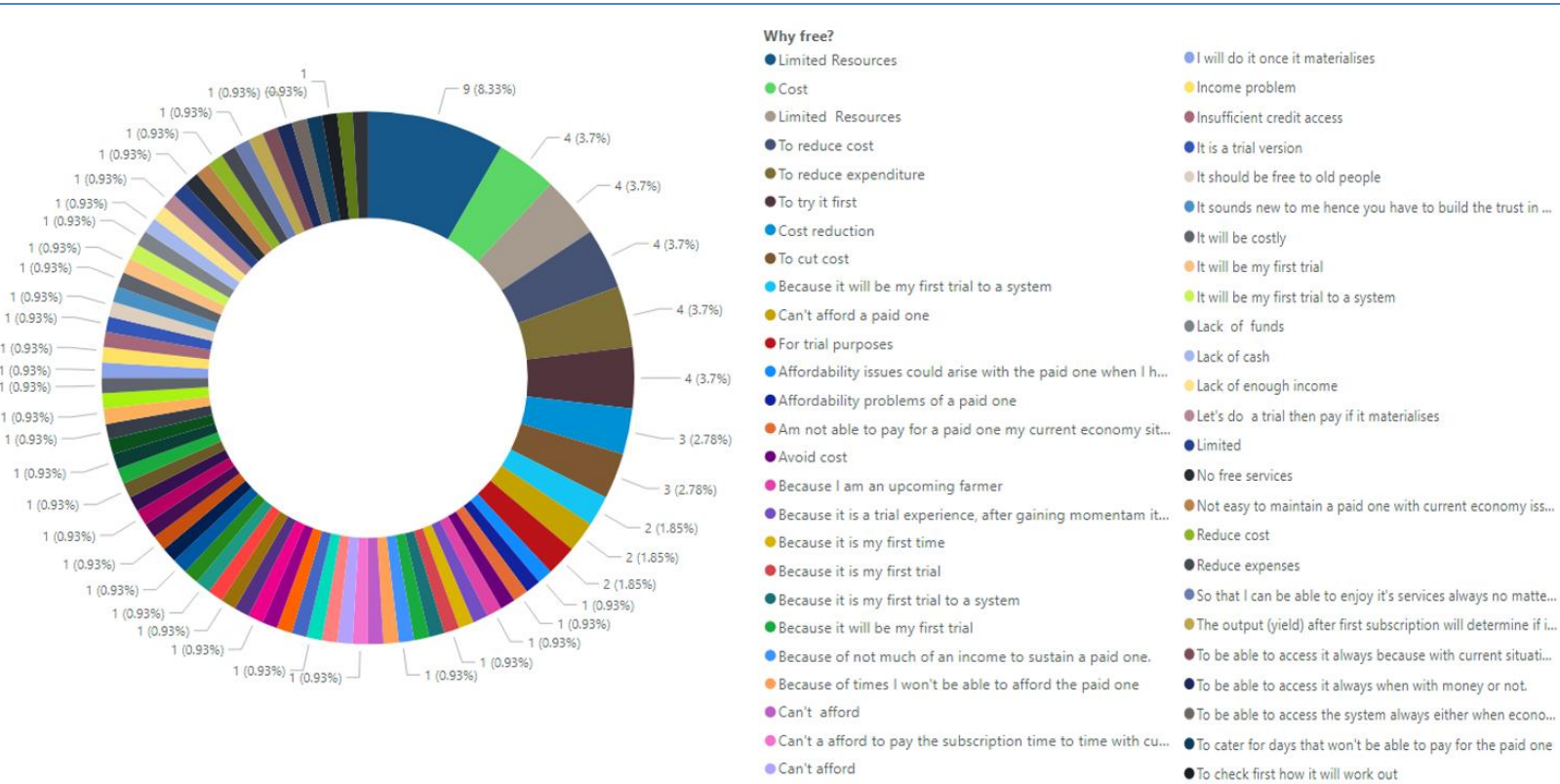
The findings in figure 4.18 identified that 87.1 percent of all 124 respondents preferred free subscription. The results in figure 27 captured the various reasons given by each of the 108 respondent. Some of the responses are: -

- Limited resources for sustaining paid subscription due to current economic status
- Subscription costs too high
- Free subscription reduces my expenditure
- Not enough revenue/ income from farming to sustain paid subscription

41

4.5.2   System Design and Implementation

4.5.2.1 Introduction

To ensure proper design and implementation of the system, the researcher undertook a needs assessment to understand user needs. The summarized data guided the overall design of the various MAMIS modules.

4.5.2.2 Design Requirements

The design and development of the system was done as per the gathered requirements acknowledging major research aspects like: -

  i.   Relevance

   Any application that has observed relevance enhances acceptance and therefore leads to adoption. MAMIS was developed to address the very basic and essential needs for smallholder farmers.

  ii.   Usability

Usability of the web and mobile system in terms of interface is essential in ensuring acceptance and use of the application. MAMIS system design is simple and adopted a step by step use form that guarantees ease in application usability.

  iii. Adaptability

The ease of adapting to any new application is mostly affected by the confidence users have in using the system. Provisioning simple menus for easier navigation improves adaptability and essentially confidence in use of applications.

  iv.   Implementation

MAMIS has been developed with a view of bringing out technology as a benefit towards access to market information and not a confounding factor.

  v.   Testing

The applications main concept of usability was tested and validated to ensure conformity to the needs assessment.

4.5.2.3 Application Implementation

The application implementation adopted a three (3) tier architecture design; database, user interface and functionality (Web Application, Mobile Application and database).

a) Use Case Model

A use case model was adopted to capture user interactions within the system and graphically represent these activities. Figure 4.19 shows these scenarios for different users when interacting with the system

Figure 4.19: Application use Case Model
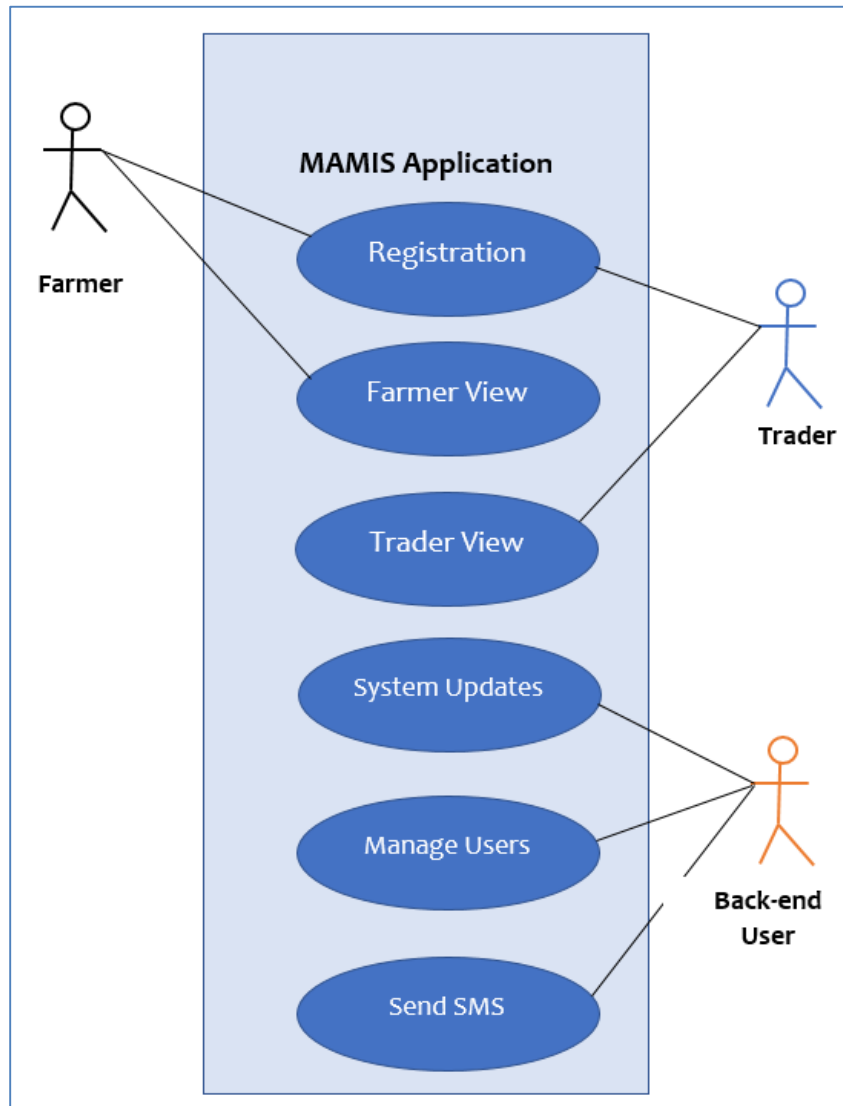
Figure 4.20: Showing Entity Relationship Diagram
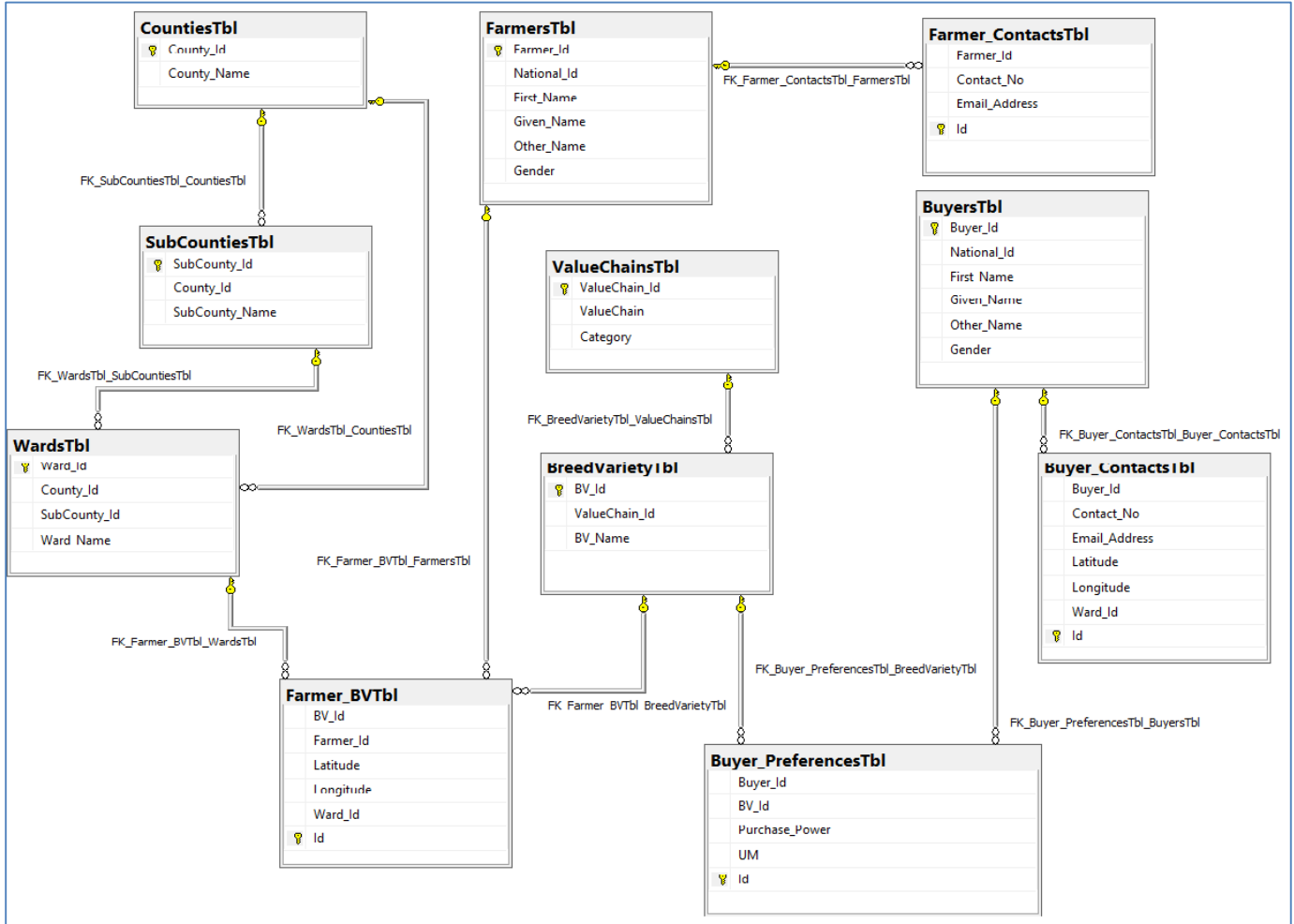
Figure 4.21: Showing MAMIS Sign-up process (English)

Figure 4.22: Showing MAMIS Sign-up process – Part 1 (Swahili)

Figure 4.23: Showing MAMIS Sign-up Process Part 2 (Swahili)

Figure 4.24: Showing MAMIS Sign-up Process Part 3 (Swahili)

Figure 4.25: MAMIS Web Application (English)

Figure 4.26: MAMIS Web Application (Swahili)

Figure 4.27: MAMIS Mobile Application
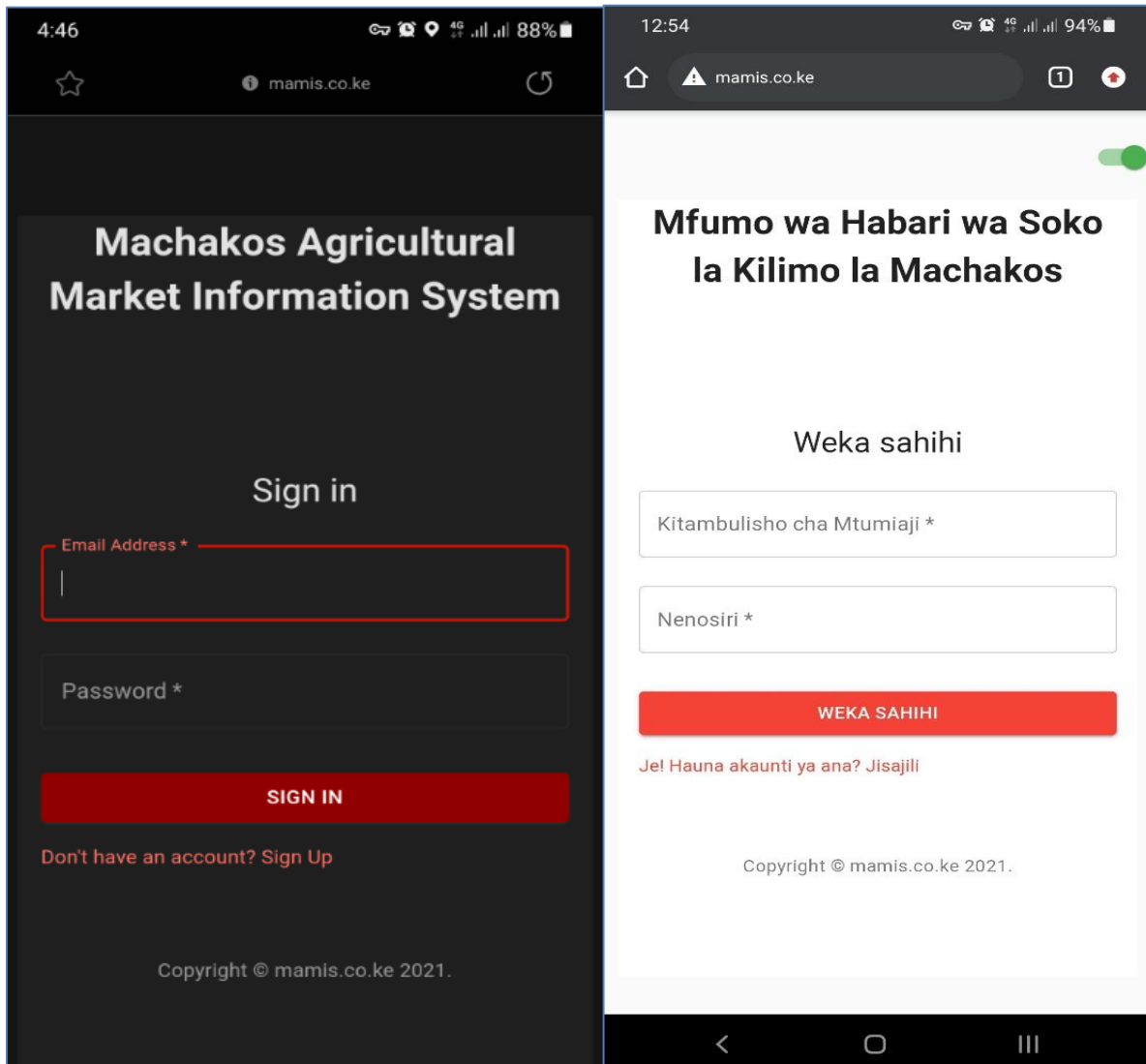
Figure 4.28: Farmer Homepage View

Figure 4.29: Trader Homepage View
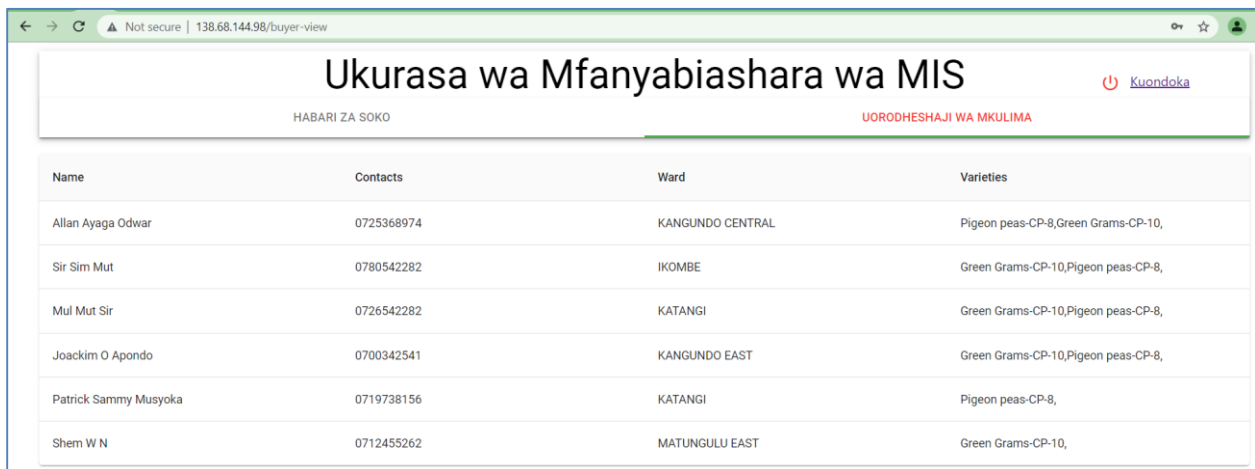
Figure 4.30: Admin Center
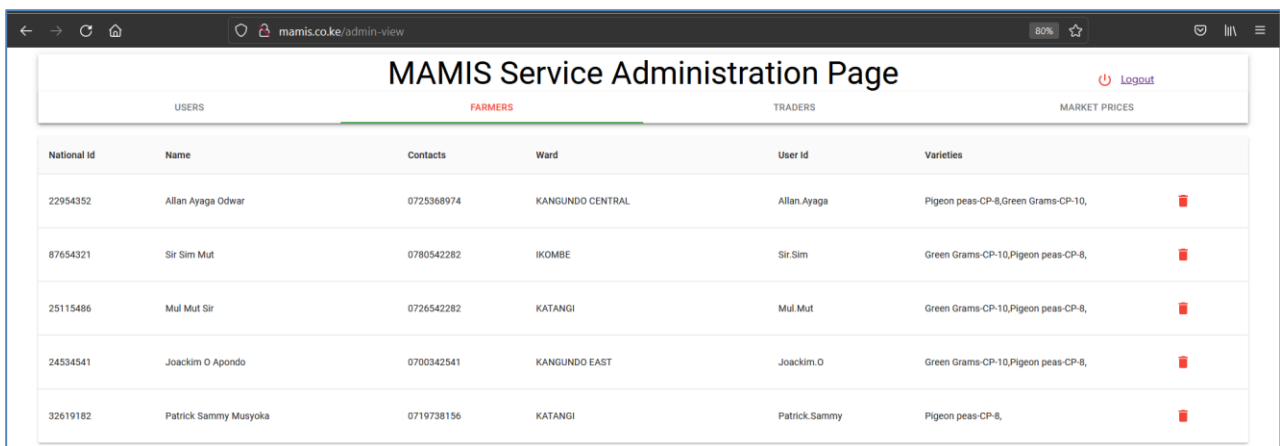
Figure 4.31: Error Handling

Figure 4.32: MAMIS SMS Module
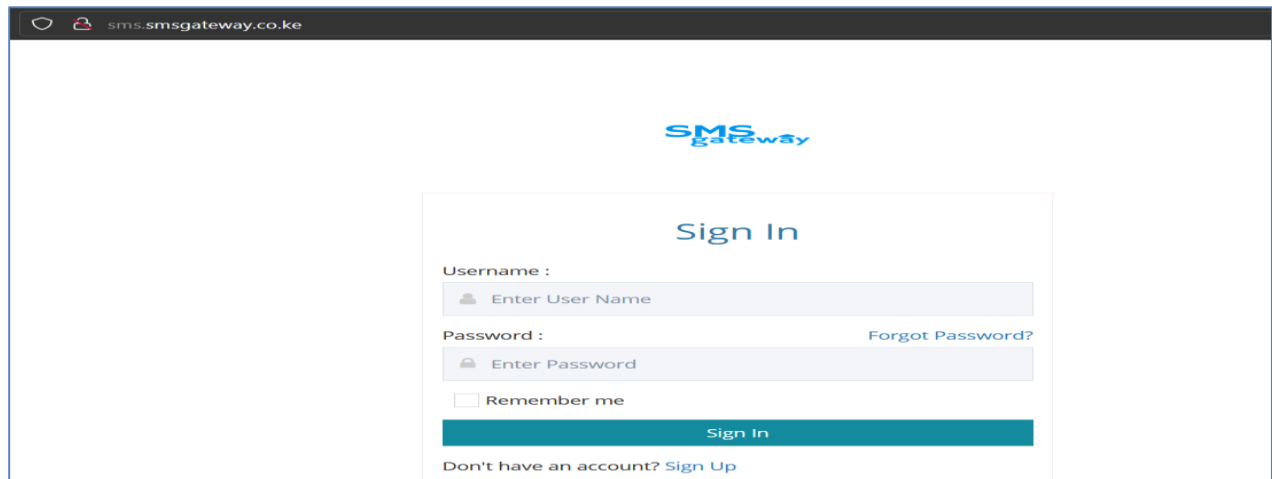
4.5   To test and validate the usability of the MAMIS Application

The Fourth Objective of the study was to test and validate the usability of the MAMIS Application. The results from user testing and evaluation were analyzed and formed basis for evaluating the usability of the system.

4.5.1   Evaluation of results from testing and validation

A total of 18 questionnaires were shared to a select target of smallholder farmers from Yatta sub-county. The questionnaire had questions that tested and evaluated content, design, personalization, communication and collaboration of the application.

The application underwent the following tests: -

1)   User Acceptance testing to measure usability and satisfaction

2)   Functional Testing to ensure the application meets the user needs

3)   Specific Module testing

Application testing involved ratting different aspects of the system like the user interface, system functionality, usability and how easily users understood the concept. Responses received from these farmers shaped the evaluation criteria for the application. Testing approach entailed a description of the application functionalities, users performing tasks on the system and a qualitative questionnaire centered on the tasks performed on and by the application.

4.5.2   Accessibility & Ease of Use

A detailed representation of the feedback received from the respondents on accessibility, usefulness and usability of the application based on the various metrics used during system testing was analyzed and represented below.

i. Successful Sign-in to the AMIS Application

Figure 4.33: Shows the statistics of Successful logins into MAMIS

Were you able to successfully sign-in to the AMIS
● Yes

18 (100%)
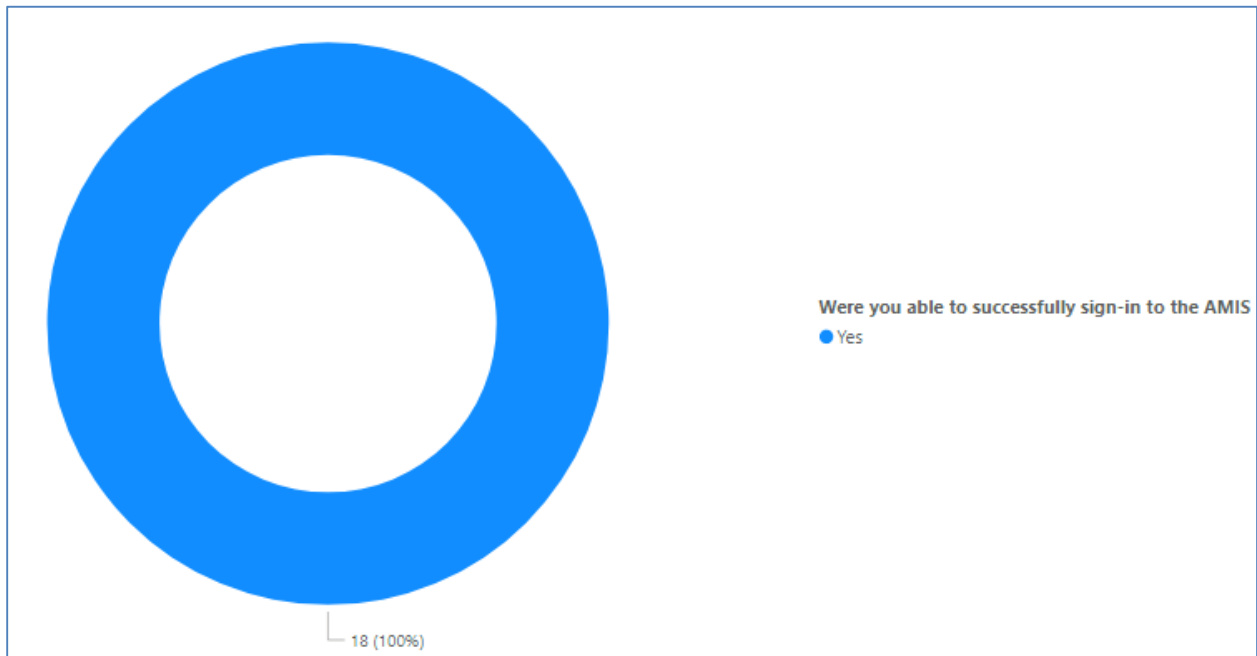
The results from testing and validation indicated that all the eighteen (18) users involved in the exercise were able to successfully register and login into the application as per figure 4.33.

ii. **Content**: Organization and Usefulness

Figure 4.34: Response on the organization of the content within the application

2 (11.11%)

Content is well organized in the application
● Strongy Agree(5)
● Agree(4)

16 (88.89%)
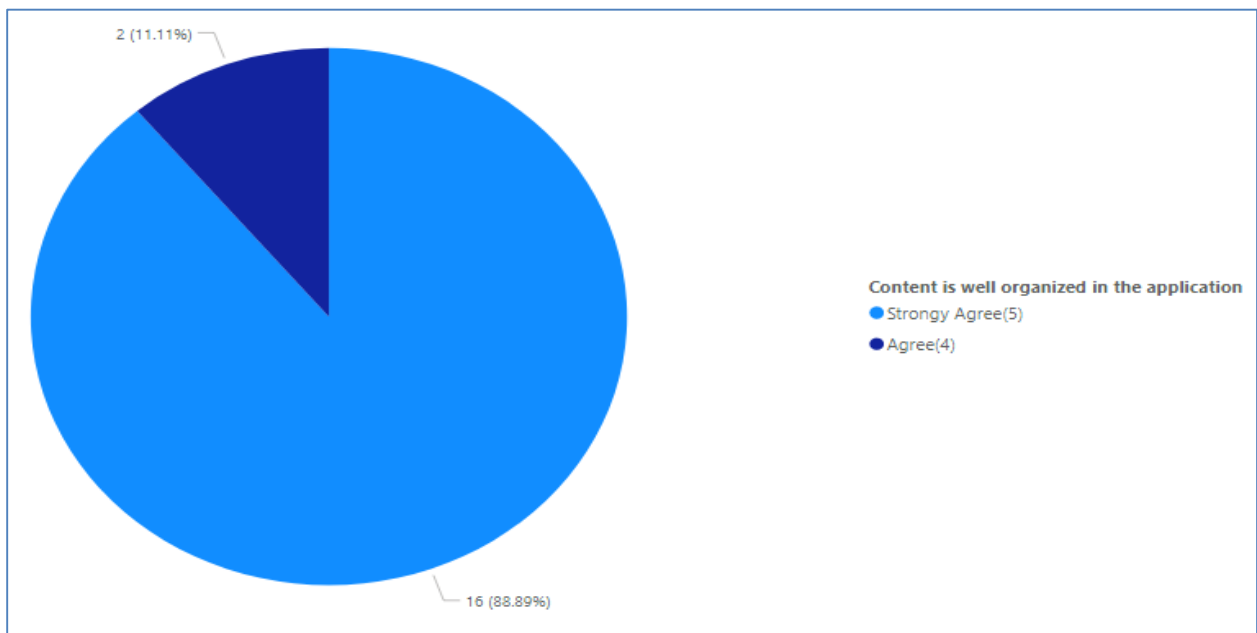
The results in figure 4.34 disclosed that 88.89 percent of the respondents strongly agreed that the content within the application was well organized while only 11.11 percent. These results imply that the developed application meets the user needs in terms of content.

Figure 4.35: Response on Clarity, Focus and Language application testing
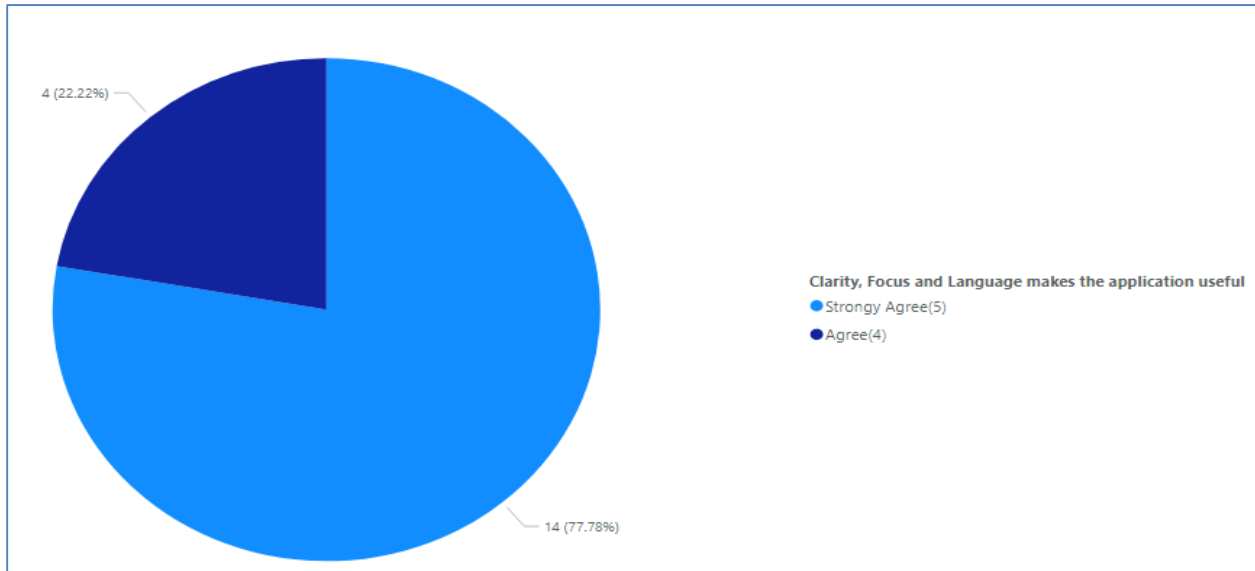
The findings in figure 4.35 illustrates that 77.78 percent of the respondents strongly agreed that clarity, focus and language made the application useful.

  iii.   **Design**: Usability, Graphical design and Use

Figure 4.36: Response on testing simplicity and accessibility.
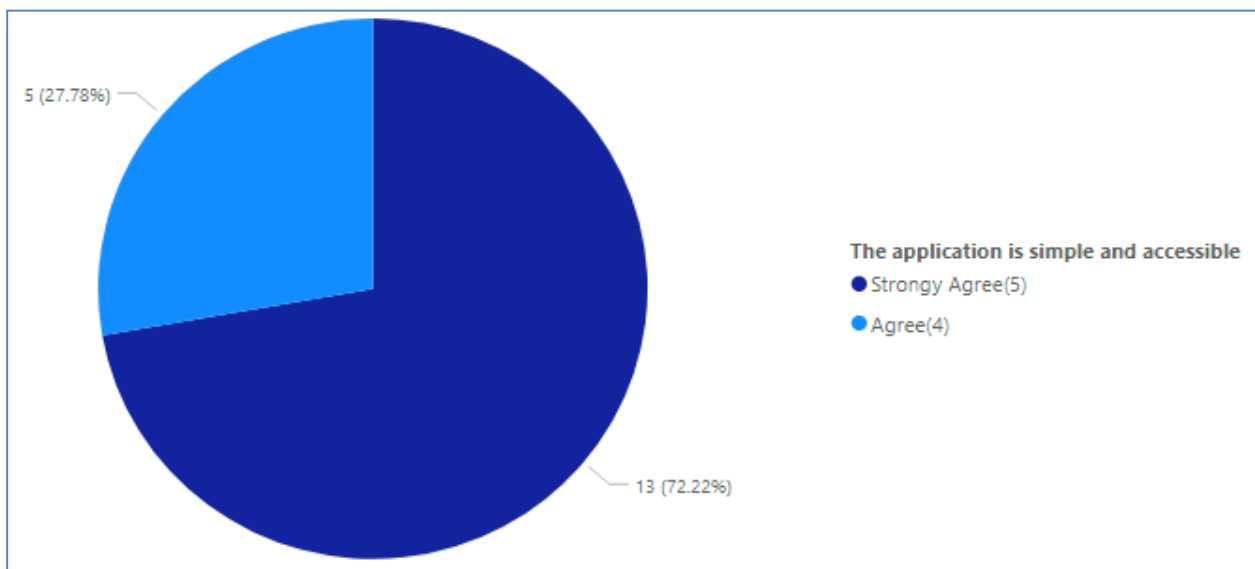
Figure 4.36 indicates that 72.22 percent of all respondents strongly agreed while 27.78 agreed that the application was simple and accessible. These findings imply that the applications simplicity and accessibility enhances usability.

Figure 4.37: Response on Application Graphical Interface Tests
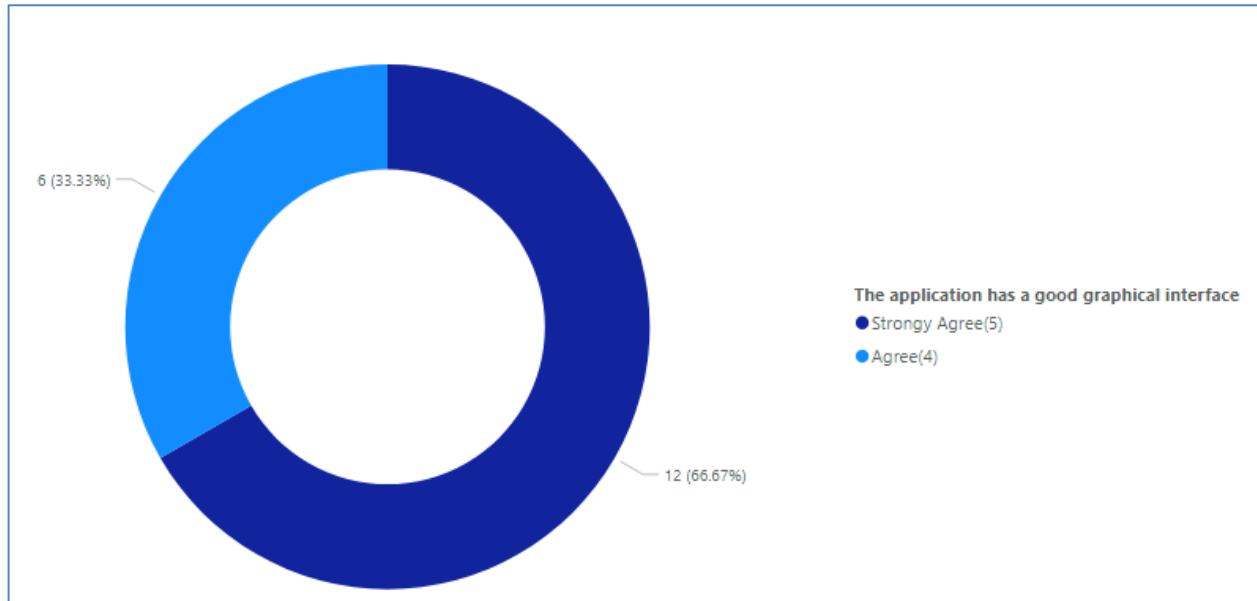
The findings in figure 4.37 identified that 66.67 percent of all respondents strongly agreed and 33.33 percent agree that the application had a good graphical interface that was simple.

Figure 4.38: Response on SMS Module Testing
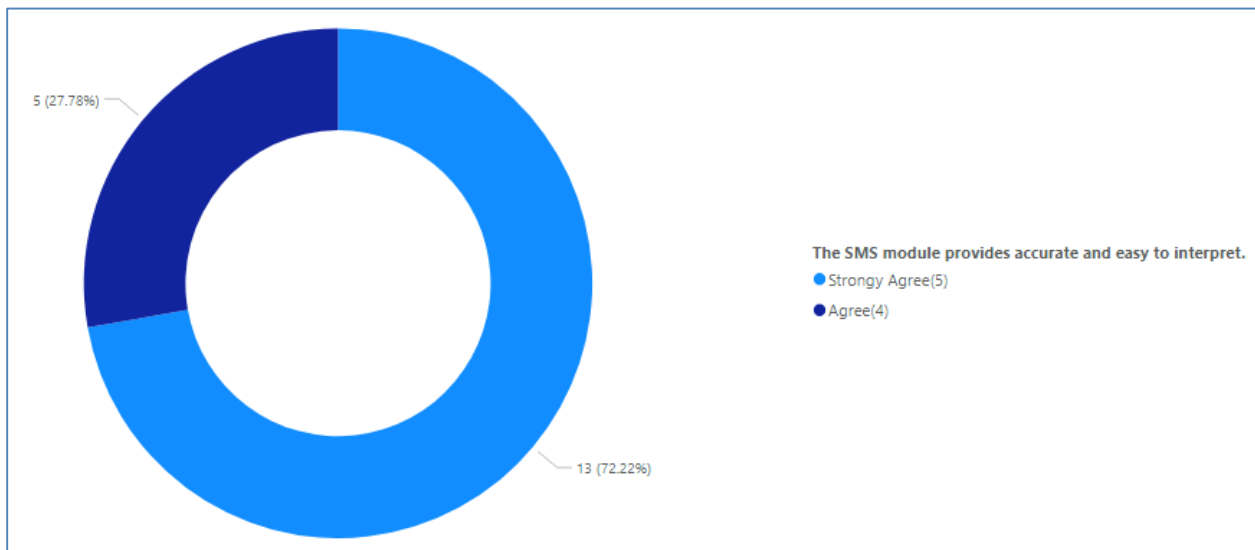
The results in figure 4.38 indicated that 72.22 and 27.78 percent of all respondents strongly agreed and agreed respectively that the SMS module provided accurate and easy to interpret advisories. The results implied that 100 percent of all respondents found the information provided through SMS service to be very accurate.

MAMIS Agro-Advisory SMS Service – Mung bean

Table 4.5: Sample SMS sent to farmers for - Green-grams/ Mung bean

Action	160-character message	Translation (Kiswahili)
Marketing of Green-grams/ Mung bean	Establish where possible market outlets will be available at the time of harvest or use warehouse store until demand rises. For more information call 0111010100	Baini mahala soko litapatikana wakati wa mavuno au hifadhi ghalani hadi mahitaji ya Maharagwe ya Mung yatakapoongezeka. Kwa habari zaidi piga simu 0111010100

Table 4.6: Sample SMS sent to farmers for - Pigeon Peas

Action	160-character message	Translation (Kiswahili)
Marketing of pigeon peas.	Establish market for pigeon peas at the time of harvest, depending on where price and gross margin are better. For more information call 0111010100	Tafuta soko la mbaazi wakati wa mavuno, kulingana ubora wa bei. Kwa habari zaidi piga simu 0111010100

iv.   **Personalization**: Navigation, Content/ Services

Figure 4.39: Response on navigation with the application
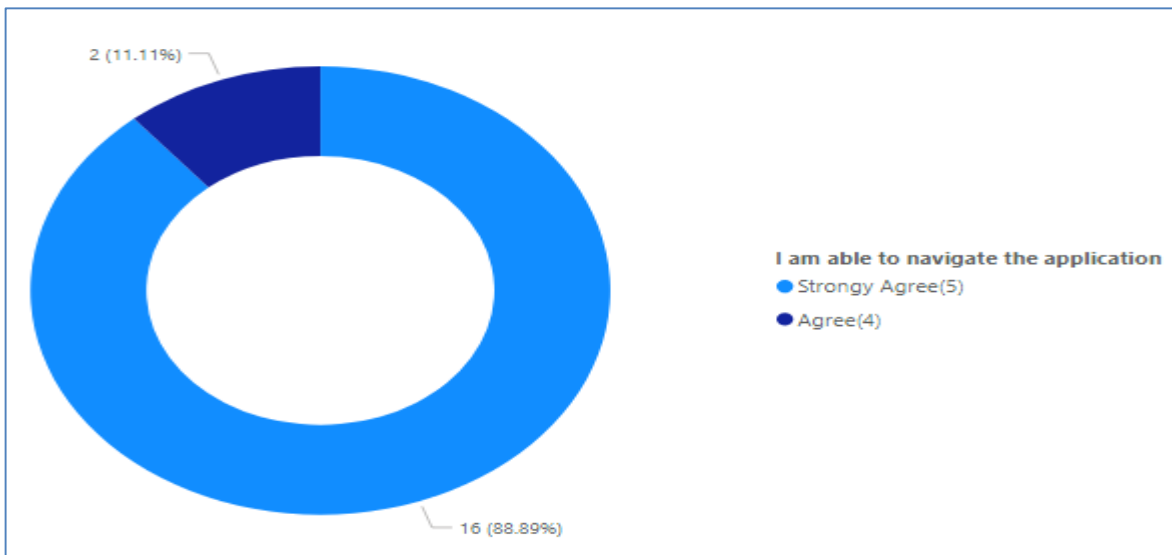
The researcher established that 88.89 percent and 11.11 percent of the respondents strongly agreed and agreed respectively that they were able to navigate within the MAMIS application with ease. These statistics implied that 100 percent were able to easily navigate the application.

Table 4.7: The information and services available in the system

The study revealed that all the respondents agreed that the information and services available in the system was suitable to their needs.

Response	Frequency	Percentage
Agree	17	94.44
Strongly Agree	1	5.56
Total	**18**	**100**

v. **Community**: Communication and Collaboration

Figure 4.40: Influence of MAMIS on access to Integrated market information

This application can influence access to integrated Market
● Strongy Agree(5)

18 (100%)
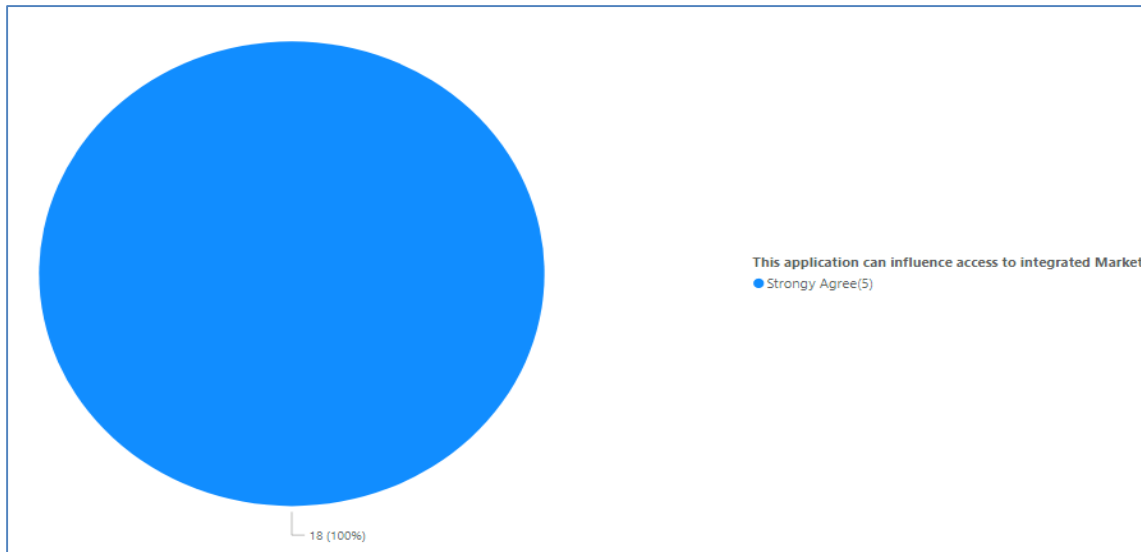
The study identified that 100 percent of the respondents noted that the application had Influence on access to Integrated market information within smallholders in Machakos county. The results imply a need for farmers to access valuable market information for decision making.

Figure 4.41: Influence of MAMIS on stakeholder collaboration
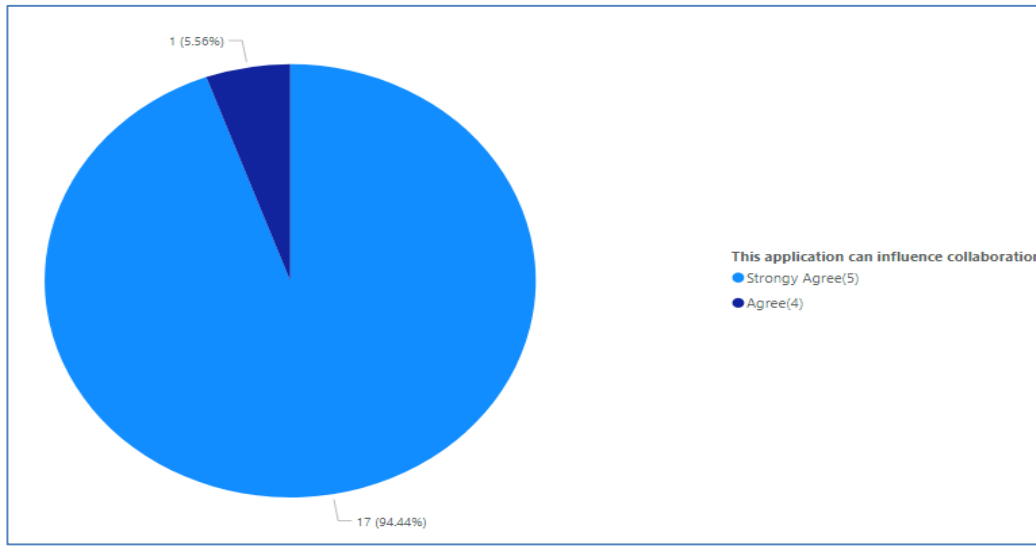
The study identified that 94.44 percent of the respondents strongly agreed and 5.56 percent agreed that the application had Influence collaboration within various stakeholders. The results imply a need for farmers to access vital market information for decision making.

vi.   **Language and Adoption**

Figure 4.42: Influence of Swahili language on usability
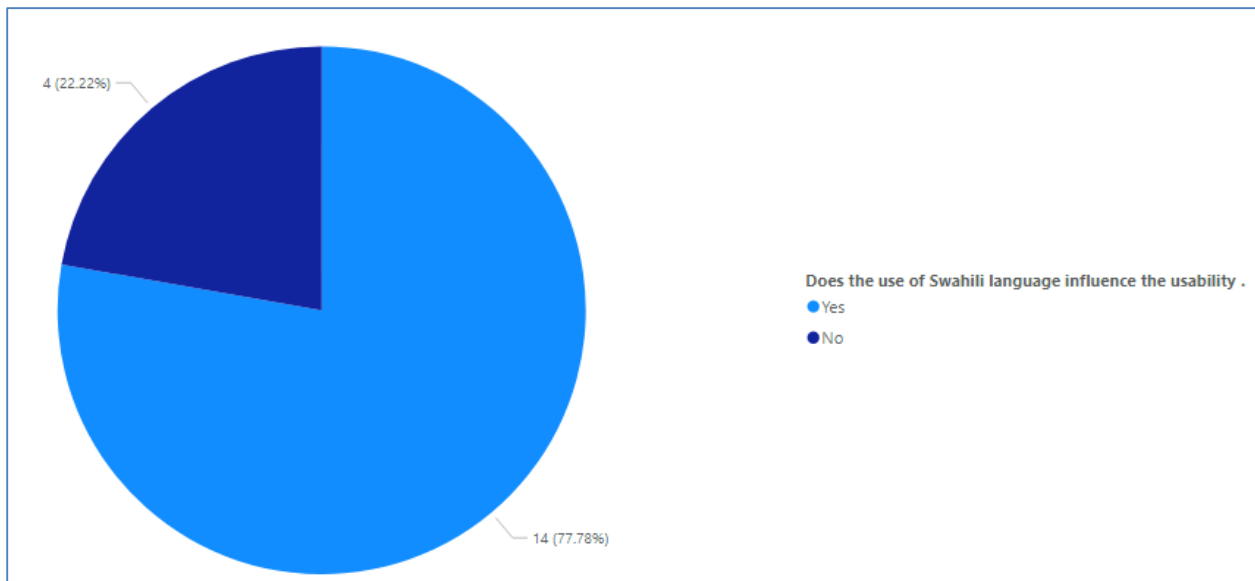
The study established that 77.78 percent of all respondents agreed that the use of Swahili language was a major influence on usability of MAMIS while 22.22 percent disagreed. These results show the importance that choice of language plays in usability of AMIS systems.

Table 4.8: Willingness to use the Application

Response	Frequency	Percentage
Yes	18	100
No	0	0
Total	**18**	**100**

Table 4.8 indicated that 100 percent of all respondents were willing to use the MAMIS application to access integrated market information.

4.5.2 Results Summary

The results from application testing and validation from the eighteen respondents proved that the application was designed and developed in line with the data collected during needs assessment and results indicated;

i.   That 100 percent of the respondents were able to successfully register and sign-in and were willing to use the application.

ii.   That 88.89 percent of all respondents strongly agreed that application content was well articulated and organized.

iii.   That 77.78% of all respondents strongly agreed that the system clarify, focus and language made the application useful.

iv.   That 72.22% of all respondents agreed that the system was simple and easy accessible.

v.   That 66.67% of all respondents agreed that the application had a good graphical user interface.

vi.   That 72.22 percent of all respondents strongly agreed that an SMS module provided accurate and easily interpretable information especially to users without smartphones.

vii.   Majority of the users agreed that the application was easy to navigate, had better information and service offerings which influenced access to integrated market information and stakeholder collaboration.

viii.   Over 77 percent of all respondents indicated that use of Swahili language influenced the usability of the application.

ix.   The study also established that adoption and use of AMIS was influenced by gender, age, language, level of education and services offered to smallholder farmers.

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

This chapter displays a summary of the findings, conclusions and recommendations of the study. The findings were derived from the interviews conducted in-line with the overall study objective as administered by the researcher. The data collected was analyzed and presented in tables and figures to draw conclusions on these findings.

5.1 Conclusions

Lately, Kenya has seen an increased penetration in ownership of smartphones and internet access which presents an opportunity for development and deployment of web and mobile based agricultural market information systems with SMS support. The challenge of usability and adoption of AMIS was reviewed and despite the fact that there are newer and advanced Agricultural Market Information Systems (AMIS), smallholder farmers still lacked simple and usable systems to access market and market information. The existing gaps in current systems were examined by reviewing their design architectures and services offered.

The proposed solution to address these gaps was to design, develop and test a web and mobile based integrated multi-stakeholder AMIS for acquisition and dissemination of Market Information to smallholder farmers within Machakos county, Kenya. The application allowed farmers and traders to register into the application and access the various services within the application for markets and market information, weather and agronomic advisories. The study showed that the adoption and use of AMIS can be promoted by considering the following factors in designing these applications; simplicity, service offered, accessibility and affordability of market information systems. This was evident from user testing and evaluation which established that the MAMIS application fulfils its ease, usability requirements and quality of the service was above average. Adoption of these factors would promote usability, adoption and use of AMIS. The findings of the study indicated that all respondents agreed that the SMS module provided the much needed means of information dissemination to majority of farmers who do not have smartphones. The study also established that adoption and use of AMIS was influenced by gender, age, language, level of education and services offered to smallholder farmers.

5.2   Recommendations

Derived from the findings and conclusions this study therefore recommends;

i.   Adoption of the proposed architecture design for AMIS as shown in figure 3.2 above.

ii.   Introduction of Swahili based AMIS for enhanced usability.

iii.   AMIS applications should be offered at affordable rates if not free.

iv.   Donors, developers, county governments and the Ministry of Agriculture should unanimously work together to sensitive and educate farmers on existing market information systems.

v.   Smallholder farmers should be facilitated with affordable internet access.

vi.   Market information systems should be integrated with other services like weather advisory, agronomic advisories, credit and insurance.

5.3   Recommendations for further research

The study recommends that further research be undertaken to;

i.   Improve the applications functionalities and roll-out as a universal application that can be implemented from the Ministry of agriculture to cover all crops as a way promoting adoption and use on AMIS across th county.

REFERENCES

Abrar, Mukhlash & Sidik, ezis japar. (2019). Analyzing ethical considerations and research methods in children research. 13. 184-193. 10.11591/edulearn.v13i2.6516.

Adi, Putu. (2015). Scrum Method Implementation in a Software Development Project Management. International Journal of Advanced Computer Science and Applications. 6. 10.14569/IJACSA.2015.060927.

Adom, Dickson & Hussein, Emad & Adu-Agyem, Joe. (2018). THEORETICAL AND CONCEPTUAL FRAMEWORK: MANDATORY INGREDIENTS OF A QUALITY RESEARCH. International Journal of Scientific Research. 7. 438-441.

Ahmed, S. Ahmad, Dr. N. Ehsan, E. Mirza, S.Z. Sarwar, "Agile Software Development: Impact on Productivity and Quality" , pp. 287-290, IEEE 2010.

Alomeer, Saleh. (2015). INTEGRATION OF CLINICAL INFORMATION SYSTEMS IN SAUDI ARABIAN HEALTH CARE CONTEXTS: A GROUNDED THEORY EXPLORATION. 10.13140/RG.2.2.23061.63203.

Apleni, Anele & Smuts, Hanlie. (2020). An e-Government Implementation Framework: A Developing Country Case Study. 10.1007/978-3-030-45002-1_2.

Avison, D. E., & Fitzgerald. G. (1995). Information systems development: methodologies, techniques, and tools. London: McGraw-Hill.

Babbie E (1990) Survey Research Methods, Wadsworth, ISBN 0-524-12672-3

Bachhav, N. B. (2012). Information Needs of the Rural Farmers: A Study from Maharashtra, India: A Survey. Nebrasca: University of Nebraska, Lincoln, Digital Commons. *library philosophy and practice-(e-journal) 1540*, Retrieved from http://www.scihub.org/AJSMS

Bernard, R., Dulle, F. and Ngalapa, H. (2014). Assessment of information needs of rice farmers in Tanzania; A case study of Kilombero District, Morogoro.

Binti Mohd Arifin, Siti Roshaidai. (2018). Ethical Considerations in Qualitative Study.

Biørn-Hansen, Andreas & Majchrzak, Tim A. & Grønli, Tor-Morten. (2018). Progressive Web Apps for the Unified Development of Mobile Applications. 10.1007/978-3-319-93527-0_4.

Chiatoh M, Gyau A. 2016. Review of agricultural market information systems in sub-Saharan Africa. ICRAF Working Paper no. 235. Nairobi, World Agroforestry Centre. DOI: http://dx.doi.org/10.5716/WP16110.PDF

Cohn, Mike. Succeeding with agile : software development using Scrum. Upper Saddle River, NJ: Addison-Wesley, 2010.

Delone, William & McLean, Ephraim. (2003). The DeLone and McLean Model of Information Systems Success: A Ten-Year Update. J. of Management Information Systems. 19. 9-30. 10.1080/07421222.2003.11045748.

Eidt, & Pant, Laxmi & Hickey, Gordon. (2020). Platform, Participation, and Power: How Dominant and Minority Stakeholders Shape Agricultural Innovation. Sustainability. 12. 461. 10.3390/su12020461.

FAO. (2017). *The state of Food and Agriculture: Leveraging Food Systems for Inclusive Rural Transformation.* Rome: FAO. Retrieved from http://www.fao.org/3/a-i7658e.pdf.ISBN 978-92-5-109873-8.

FAO, IFAD, UNICEF, WFP & WHO. (2017). The State of Food Security and Nutrition in the World 2017: Building resilience for peace and food security. Rome, FAO. Retrieved from http://www.fao.org/3/a-i7695e.pdf ISBN 978-92-5-109888-2

Fuglie, Keith & Gautam, Madhur & Goyal, Aparajita & Maloney, William. (2019). Harvesting Prosperity: Technology and Productivity Growth in Agriculture. 10.1596/978-1-4648-1393-1.

Galtier, Franck & David-Benz, Hélène & Subervie, Julie & Egg, Johny. (2014). Agricultural market information systems in developing countries: New models, new impacts. Cahiers Agricultures. 23. 232-244. 10.1684/agr.2014.0716.

Gwademba, G.K., Muthee, D.W. & Masinde, J.M. (2019). Application of ICTs in Transforming Agricultural Extension. *Regional Journal of Information and Knowledge Management*, 4 (2),12-21.

Ihenacho, Tc. (2014). Agile SCRUM Methodology - A Project Management Framework. Agile SCRUM Methodology - A Project Management Framework.

Islam, M Sirajul & Grönlund, Åke. (2010). Agriculture Market Information Services (AMIS) in the Least Developed Countries (LDCs): Nature, Scopes, and Challenges. 109-120. 10.1007/978-3-642-14799-9_10.

Joyous S. Tata & Paul E. McNamara (2018) Impact of ICT on agricultural extension services delivery: evidence from the Catholic Relief Services SMART skills and Farmbook project in Kenya, The Journal of Agricultural Education and Extension, 24:1, 89-110, DOI: 10.1080/1389224X.2017.1387160

Kahenya, D. W., Sakwa, M., and Iravo, M. 2014. Assessing Use of Information Communication Technologies among Agricultural Extension Workers in Kenya Using Modified UTAUT Model, 4531, 11–22.

Karoney, B. K. (2016). A mobile based marketing information system for farmers and buyers in Kenya (Thesis). Strathmore University. Retrieved from http://su-plus.strathmore.edu/handle/11071/4901

Kenya Vision 2030 Newsletter No. 001(Undated). The Kenya Vision 2030 Newsletter Issue No. 001 (2008 –2012) http://vision2030.go.ke/inc/uploads/2018/05/Kenya-Vision-2030-Newsletter..pdf

Kavita, Kavita & Muthoni, Nester. (2018). Enhancement of Agricultural Extension Services in Kenya: A Case of Embu County. JOURNAL OF AGRICULTURE AND ENVIRONMENTAL SCIENCES. 7. 10.15640/jaes.v7n2a4.

Kigatiira, K. K., Mberia, H. K., &Wangula, K. (2018). The Effect of the nature of messages conveyed between the Extension Officers and farmers on the adoption of Irish potato farming in Meru County. International

Journal of Academic Research in Business and Social Sciences, 8(4), 392–407.

Kitchenham B, Pickard L, Pfleeger SL (1995) Case Studies for Method and Tool Evaluation. J IEEE Software, July, 52-62

Karanja, J.W., Lagat J.K, Mutai B.K (2019). Market Participation of Smallholder Pigeon Pea Farmers in Makueni County, Kenya. Journal of Economics and Sustainable Development. ISSN 2222-1700 (Paper) ISSN 2222-2855 (Online) DOI: 10.7176/JESD Vol.10, No.16, 2019

Kumar, Gaurav & Bhatia, Pradeep. (2012). Impact of Agile Methodology on Software Development Process. International Journal of Computer Technology and Electronics Engineering (IJCTEE). 2. 2249-6343.

Kpenavoun Chogou, Sylvain. (2012). Public market information system and farmers food marketing decisions: Econometric evidence from Benin. Journal of Development and Agricultural Economics. 4. 10.5897/JDAE11.100.

Lutabingwa, J & Auriacombe, Christelle. (2007). DATA ANALYSIS IN QUANTITATIVE RESEARCH.

Lonyangapuo, KM. (2016). Language and the development of Kenya. AFRREV LALIGENS: An International Journal of Language, Literature and Gender Studies. 5. 1. 10.4314/laligens.v5i2.1.

Macire Kante, Robert Oboko, Christopher Chepken (2018) An ICT model for increased adoption of farm input information in developing countries: A case in Sikasso, Mali, Information Processing in Agriculture, https://doi.org/10.1016/j.inpa.2018.09.002.

Magesa, Mawazo & Michael, Kisangiri & Ko, Jesuk. (2015). Towards a Framework for Accessing Agricultural Market Information. Electronic Journal of Information Systems in Developing Countries. 66. 10.1002/j.1681-4835.2015.tb00473.x.

Matilda A. Ouma, Christopher A. Onyango, Justus M. Ombati & Nelson Mango | (2020) Innovation platform for improving rice marketing decisions among smallholder farmers in Homa-Bay County, Kenya, Cogent Food & Agriculture, 6:1, 1832399, DOI:10.1080/23311932.2020.1832399

Muyanga, Milu & Jayne, Thomas. (2006). Agricultural Extension in Kenya: Practice and Policy Lessons.

National Agricultural Sector Extension Policy (NASEP) Report Kenya, (2012)

Otieno Onyalo, Paul. (2019). WOMEN AND AGRICULTURE IN RURAL KENYA: ROLE IN AGRICULTURAL PRODUCTION. International Journal of Humanities and Social Science. Vol.. 1.

Parmar, Ishwar Singh & Soni, Peeyush & K R, Salin & Kuwornu, John. (2018). Assessing farmers access to ICT and non-ICT sources for agricultural development in Semi-Arid Region in India. Journal of Agricultural Informatics. 9. 10.17700/jai.2018.9.2.459.

Peshin, Rajinder & Vasanthakumar, Jeyarajan & Kalra, J.. (2009). Diffusion of Innovation Theory and Integrated Pest Management. 10.1007/978-1-4020-8990-9_1.

Pham, A., et al., "Scrum in action Agile software project management and development". Boston, Mass., Course Technology PTR, 2011.

Rao N.H. (2007). A framework for implementing information and communication technologies in agricultural development in India. *Technological Forecasting and Social Change, 74*(4), 491-518. doi: 10.1016/j.techfore.2006.02.002

Rogers, E.M. 2003. Diffusion of Innovation 5th ed., Free Press, New York.

Saleh, Malik. (2011). An Agile Software Development Framework. International Journal of Software Engineering (IJSE). 2. 97 - 106.

Shepherd, A.W.: Farm Radio as a Medium for Market Information Dissemination. Marketing and Rural Finance Service. FAO, Rome (2001)

Taherdoost H (2016) Sampling Methods in Research Methodology; How to Choose a Sampling Technique for Research.International Journal of Academic Research in Management. 10.2139/ssrn.3205035

Trogo, Rhia & Ebardaloza, Jed & Sabido, Delfin & Bagtasa, Gerry & Tongson, Edgardo & Balderama, Orlando. (2015). SMS-based Smarter Agriculture decision support system for yellow corn farmers in Isabela. 1-4. 10.1109/IHTC.2015.7238049.

Torero, M. (2011) A Framework for Linking Small Farmers to Markets. In: Conference on New Directions for Smallholder Agriculture. 24-25 January, Rome, IFAD HQ.

Umair M (2018) Research Fundamentals: Study Design, Population, and Sample Size: Undergraduate Research in Natural and Clinical Science and Technology (URNCST) Journal

United Nations Development Report (UNDP). (2015). Retrieved on 05-09-2015 from www.UNDPannualreport2011.ac.in

USAID (2013). An Assessment of Market Information Systems in East Africa Briefing Paper.

Verma, Saumya & Gautam, Rajneesh & Pandey, Spriha & Mishra, Aman & Shukla, Shubham. (2017). Sampling Typology and Techniques. International Journal of Scientific Research. 2321-0613.

Venkatesh, V. 2012. Consumer Acceptance and Use of Information Technology, 36(1), 157–178.

Wausi, A. N. (2009). Organizational Implementation of Information Systems Innovations: Case University in Kenya (Doctoral dissertation, Doctoral Dissertation. University of Nairobi, Kenya).

Wildt, M.d.R.d., Elliott, D. and Hitchins, R. (2006) Making Markets Work for the Poor: Comparative Approaches to Private Sector Development, The Springfield Centre.

Wohlin, C. et al. "13 Empirical Research Methods in Web and Software Engineering." (2011).

Wyche, S., & Olson, J. (2018). Gender, mobile, and mobile internet – Kenyan women's rural realities, mobile internet access, and "Africa rising". Information Technologies & International Development, 14, 15.

Zarmai, J. U., Okwu, O. J., Dawang, C. N., & Nankat, J. D. (2014). A Review of Information Needs of Rice Farmers : A Panacea for Food Security and Poverty Alleviation. Journal of Economics and Sustainable Development, 5(12),9–16

Zhou, Munyaradzi & Herselman, Marlien & Coleman, Alfred. (2015). USSD Technology a Low Cost Asset in Complementing Public Health Workers' Work Processes. 10.1007/978-3-319-16480-9_6.

Zoltner, J. and Steffen, M. (2013) An Assessment of Market Information Systems in East Africa.

1) **Needs assessment Report**

Introduction

My name is Simon Mulwa. I am a Masters student at the University of Nairobi: School of Computing and Informatics. I am

carrying out a study research on: APPLICATION OF AMIS FOR IMPROVED ACCESS TO AGRICULTURAL MARKET INFORMATION:

CASE STUDY MACHAKOS COUNTY, KENYA

DISCLAIMER: The information collected in this questionnaire will be used for research purposes only. The information

collected will be treated with the HIGHEST DEGREE OF CONFIDENTIALITY.

GUIDANCE: Kindly provide accurate information as possible. For any questions, contact Simon Mulwa on 0726542282 Email:

Simon.Mulwa@students.uonbi.ac.ke

Yes

No

Consent: Do you agree to be interviewed?

Enter a date

yyyy-mm-dd

Section A: Enumerator Details

Name of Enumerator

Section B: Farmer Details

Name of farmer

National ID

Mobile number

6/30/2021 AMIS

Male

Female

Other

Gender

Under 20

21-30

31-40

41-50

Over 50

Age

Farmer

Student

Business

Professional

Occupation

Farming

Business

Employment

Others

Source of income

Primary school

High school

Diploma

Bachelor's degree

Post-graduate

Education

Pigeon Pea

Green Gram

Both

Crops

6/30/2021 AMIS

County

Machakos

Sub-County

Yatta

Ikombe

Katangi

Ward

GPS Latitude & Longitude

latitude (x.y °)

longitude (x.y °)

altitude (m)

accuracy (m)

Section C: Access to Mobile Phone, Smart phone and internet

Yes

No

Do you have a mobile Phone?

Yes

No

If yes yes ………… Is it a Smart Phone?

Yes

No

Do you have access to internet?

6/30/2021 AMIS

If No…. Give Reason

i.e. lack of data bundles

Section D: Currently Adopted Systems for Market Access

Local market

Urban market

Other counties

Others
Where do you sell your farm produce?
Others, please specify.
Traditional market
Electronic
Word of mouth
How did you find-out where to sell your farm produce?
Phone
Call
Email
Whatsapp
If electronic,
Agricultural officer
Trader
Other farmers
IIf word of mouth: From Who or from Where?
Yes
No
Do you use any system to access Market Information?
If Yes..List them
If No..Give explanation
6/30/2021 AMIS
Strongly Disagree
Disagree
Neither Agree or Disagree
Agree
Strongly Agree
Do they address all your Market information needs?
i.e . Where/ When to sell or buy and at what Price to sell, agronomic advisories.
Section E: Language influence on usability
English
Swahili
Others
Which Language is used by the current adopted systems?
If others, specify
Strongly Disagree
Disagree
Neither Agree or Disagree
Agree
Strongly Agree
Would you prefer to have a Swahili based system?
Strongly Disagree
Disagree

Neither Agree or Disagree
Agree
Strongly Agree
A Swahili based system will improve my usage of market information system?
Section F: Services offered on AMIS
6/30/2021 AMIS
Markets (Masoko)
Agri-Advisory
Crop Insurance
Weather-Information
Credit Facilities (Mikopo)
From the list below, select which other services would you like offered on AMIS?
Paid
Free
Which type of subscription would you prefer for the AMIS?
Why paid?
Explain
Why free?
Explain
Section G: AMIS Improve market reach
1-2
3-4
More than 5
How Many Markets do you sell your produce to?
Strongly Disagree
Disagree
Neither Agree or Disagree
Agree
Strongly Agree
Would you like to access more markets?
Strongly Disagree
Disagree
Neither Agree or Disagree
Agree
Strongly Agree
Access to additional markets across the country improve your decision on when and where to sell your produce?
6/30/2021 AMIS
Section H: AMIS Improve Extension Service
Phone
Radio
Internet
Extension Officers

How do you get access to extension services?
Strongly Disagree
Disagree
Neither Agree or Disagree
Agree
Strongly Agree
Would you like to access extension services via Mobile/Web?
Strongly Disagree
Disagree
Neither Agree or Disagree
Agree
Strongly Agree
Use of AMIS enables in reaching wider markets.
2) Testing and Validation
Agricultural Market Information System Final
MAMIS APPLICATION TESTING AND VALIDATION QUESTIONNAIRE
My name is Simon Mulwa. I am a Masters student at the University of Nairobi: School of Computing and Informatics. I am
carrying out a study research on: APPLICATION OF AMIS FOR IMPROVED ACCESS TO AGRICULTURAL MARKET INFORMATION:
CASE STUDY MACHAKOS COUNTY, KENYA
DISCLAIMER: The information collected in this questionnaire will be used for research purposes only. The information
collected will be treated with the HIGHEST DEGREE OF CONFIDENTIALITY.
*GUIDANCE: Kindly provide accurate information as possible. For any questions, contact Simon Mulwa on 0726542282 Email:
Simon.Mulwa@students.uonbi.ac.ke
Yes
No
Consent: Do you agree to be interviewed?
Section A: FARMER DETAILS
a) Respondent Name:
b) Respondent Phone:
Yatta
c) Sub-County:
Ikombe
Katangi
d) Ward:
SECTION B: Accessibility & Ease of Use
Yes
No
Were you able to successfully sign-in to the AMIS Application?
Less than one minute

1-2 minutes

2-5 minutes

Above 5 minutes

If Yes, how much time did it take you to successfully sign-in to the AMIS Application?

Long response time

Application is non-responsive

Application responsive but slow

If No, what challenge(s) did you experience in accessing the AMIS Application?

CONTENT

In a scale of 1-5, where 5=Strongly Agree and 1=Strongly Disagree, please rate the following statements after interacting with

the MAMIS system?

Strongy

Agree (5)

Agree (4)

Neither Agree Nor Disagree (3)

Disagree (2)

Strongy Disagree (1)

Content

Content is well organized in the

application

Clarity, Focus and Language makes the

application useful

DESIGN

In a scale of 1-5, where 5=Strongly Agree and 1=Strongly Disagree, please rate the following statements after interacting with

the MAMIS system?

Strongy

Agree (5)

Agree (4)

Neither Agree Nor Disagree (3)

Disagree (2)

Strongy Disagree (1)

Design

The application is simple and accessible

The application has a good graphical interface

The SMS module provides accurate and easy to interpret agronomic advisories

PERSONALIZATION

In a scale of 1-5, where 5=Strongly Agree and 1=Strongly Disagree, please rate the following statements after interacting with

the MAMIS system?

Strongy

Agree(5)

Agree(4) Neither
Agree Nor
Disagree(3)
Disagree(2) Strongy
Disagree(1)
Personalization
I am able to navigate the application
The information and services available in the system suits my needs
COMMUNITY
In a scale of 1-5, where 5=Strongly Agree and 1=Strongly Disagree, please rate the following statements after interacting with
the MAMIS system?
Strongy
Agree (5)
Agree (4)
Neither Agree nor Disagree (3)
Disagree (2)
Strongy Disagree (1)
Community
This application can influence access to integrated Market information by the various multi-stakeholders? i.e. Farmers, Traders, extension officers
This application can influence collaboration among various stakeholders? i.e. Farmers, Traders, extension officers
LANGUAGE and ADOPTION
Yes
No
Does the use of Swahili language influence the usability of the application?
Yes
No
Would you be willing to use the application?
List down any recommendations to improve the application?

APPENDIX 2: Sample Source Code

```
import React, { Component } from "react";
import { useHistory, useLocation } from "react-router-dom";

import Stepper from "@material-ui/core/Stepper";
import Step from "@material-ui/core/Step";
import StepLabel from "@material-ui/core/StepLabel";
import Typography from "@material-ui/core/Typography";
import { FormControl, FormHelperText, Button } from "@material-ui/core";

import Switch from "@material-ui/core/Switch";
import FormGroup from "@material-ui/core/FormGroup";
import FormControlLabel from "@material-ui/core/FormControlLabel";

import PersonalDetailsForm from "../PersonalDetailsForm/PersonalDetailsForm";
import ContactDetailsForm from "../ContactDetailsForm/ContactDetailsForm";
import BuyerDetails from "../BusinessDetails/BuyerDetails";
import FarmerDetails from "../BusinessDetails/FarmerDetails";
import CredentialsForm from "../CredentialsForm/CredentialsForm";
import RegistrationResult from "../RegistrationResult/RegistrationResult";
import { googleTranslate } from "../../utils/googleTranslate";

import { getAdmins } from "../../store/epic/adminsEpic";
import { getValueChains } from "../../store/epic/valueChainsEpic";

import "../../../styles/FormStyles.css";

const styles = {
 button: {
  margin: 15,
 },
};

let administrationList = "";
let valueChainsList = "";
const resetLabels = {
 nationalId: "National ID",
 firstName: "First Name",
 givenName: "Given Name",
 otherName: "Other Name",
```

```
gender: "Gender",
female: "Female",
male: "Male",
transGender: "Trans-gender",
userType: "User Type",
farmer: "Farmer",
trader: "Trader",
valueChain: "Value Chain",
variety: "Variety",
purchasePower: "Purchase Power",
productPreference: "Product preference",
preferenceInstruction:
  " Please select the produce and the variety you prefer",
varietyPreferenceInstruction:
  "Please select the produce and the variety you have on your farm(s).",
unitofMeasure: "Unit of Measure",
close: "Close",
addProduct: "Add Product",
selectMapInstructions: "Please select your location from the map.",
selectFarmInstruction:
  "Please select from the map where your farms are located. Then you will be prompted to select
what farming you practice in that location.",
phoneNumber: "Phone Number",
emailAddress: "Email Address",
county: "County",
subCounty: "Sub-county",
ward: "Ward",
passwordError: "Please ensure the passwords are the same",
newPassword: "New Password",
confirmPassword: "Confirm Password",
failureResult: `The registration was not successfull. Please check the
details you entered. There could be duplicate entries in
national ID. The error is:`,
successResult: `You have been successfully registered in the MIS service.
Please login with username and password you entered. Your
user name is:`,
stepPersonalDetails: "Personal Details",
stepContactDetails: "Contact Details",
stepBusinessDetails: "Business Details",
stepLoginDetails: "Login Details",
```

```
  stepConfirmation: "Confirmation",
  stepSignin: "Sign in",
  stepContentPersonalDetails: "Enter your personal details",
  stepContentContactDetails: "Enter your contact details",
  stepContentBusinessDetails1: "Your Farm(s) Details",
  stepContentBusinessDetails2: "Business details",
  stepContentPassword: "Please enter a password for your new account",
  stepContentConfirmation: "Confirmation",
  errorCheckMessage:
    "Please ensure that you have entered all the required fields",
  mainFormTitle: "MAMIS Service Registration Form",
  mainBackButton: "Back",
  mainSaveButton: "Save and continue",
};

export class RegistrationForm extends Component {
  constructor(props) {
    super(props);
    this.state = {
      step: 1,
      nationalId: null,
      firstName: "",
      givenName: "",
      otherName: "",
      gender: "",
      contactNo: "",
      emailAddress: "",
      userType: null,
      latitude: null,
      longitude: null,
      countyId: null,
      subCountyId: null,
      wardId: null,
      wardName: "",
      buyerBV: [],
      farmerBV: [],
      userName: "",
      password: "",
      submitted: false,
      hasError: false,
```

```
    errorText: "",
    checked: false,
    labels: {
      nationalId: "National ID",
      firstName: "First Name",
      givenName: "Given Name",
      otherName: "Other Name",
      gender: "Gender",
      female: "Female",
      male: "Male",
      transGender: "Trans-gender",
      userType: "User Type",
      farmer: "Farmer",
      trader: "Trader",
      valueChain: "Value Chain",
      variety: "Variety",
      purchasePower: "Purchase Power",
      productPreference: "Product preference",
      preferenceInstruction:
        " Please select the produce and the variety you prefer",
      varietyPreferenceInstruction:
        "Please select the produce and the variety you have on your farm(s).",
      unitofMeasure: "Unit of Measure",
      close: "Close",
      addProduct: "Add Product",
      selectMapInstructions: "Please select your location from the map.",
      selectFarmInstruction:
        "Please select from the map where your farms are located. Then you will be prompted to
select what farming you practice in that location.",
      phoneNumber: "Phone Number",
      emailAddress: "Email Address",
      county: "County",
      subCounty: "Sub-county",
      ward: "Ward",
      passwordError: "Please ensure the passwords are the same",
      newPassword: "New Password",
      confirmPassword: "Confirm Password",
      failureResult: `The registration was not successfull. Please check the
      details you entered. There could be duplicate entries in
      national ID. The error is:`,
```

```
    successResult: `You have been successfully registered in the MIS service.
    Please login with username and password you entered. Your
    user name is:`,
    stepPersonalDetails: "Personal Details",
    stepContactDetails: "Contact Details",
    stepBusinessDetails: "Business Details",
    stepLoginDetails: "Login Details",
    stepConfirmation: "Confirmation",
    stepSignin: "Sign in",
    stepContentPersonalDetails: "Enter your personal details",
    stepContentContactDetails: "Enter your contact details",
    stepContentBusinessDetails1: "Your Farm(s) Details",
    stepContentBusinessDetails2: "Business details",
    stepContentPassword: "Please enter a password for your new account",
    stepContentConfirmation: "Confirmation",
    errorCheckMessage:
      "Please ensure that you have entered all the required fields",
    mainFormTitle: "MAMIS Service Registration Form",
    mainBackButton: "Back",
    mainSaveButton: "Save and continue",
    },
  };
}

toggleChecked = () => {
  const { labels, checked } = this.state;
  let changeLabels = labels;
  let tempLabels = labels;
  if (checked && window.language === "en") {
    window.language = "sw";
    for (let key in changeLabels) {
      let translation = this.getTranslation(
        changeLabels[key],
        "en",
        window.language,
        key,
        changeLabels
      );
    }
    this.setState({
```

```
      checked: true,
      labels: changeLabels,
     });
    this.setState({
      checked: true,
      labels: changeLabels,
     });

    } else if (checked && window.language === "sw") {

     window.language = "en";
    this.setState({
      labels: tempLabels,
      checked: false,
     });
    this.setState({
      labels: tempLabels,
      checked: false,
     });
    } else if (!checked && window.language === "en") {
     window.language = "sw";

     for (let key in changeLabels) {
      let translation = this.getTranslation(
        changeLabels[key],
        "en",
        window.language,
        key,
        changeLabels
      );
     }
    this.setState({
      checked: true,
      labels: changeLabels,
     });
    this.setState({
      checked: true,
      labels: changeLabels,
     });
    } else if (checked && window.language !== "sw") {
```

```
    window.language = "en";
    this.setState({
      labels: tempLabels,
      checked: false,
    });
    this.setState({
      labels: tempLabels,
      checked: false,
    });
  }
};
```