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A.C. Meyers Vænge 15

2450 København SV

Title: *Electronic Market System for Agriculture in Tanzania*

"Information flow based system"

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Supervisor(s):

Henning Olesen

Student

Kennedy Michael Ngowi

Abstract:

This study investigated the challenges facing key stakeholders on agricultural sector in rural area, Tanzania. Through collaboration with industrial partner, BlueTown the feasibility study was conducted to identify relevant findings in order to develop an application to improve the current situation. The study has revealed the main challenges faced by farmers are lack of market information, lack of platform to share agriculture knowledge and absence of reliable market to sell crops. To accomplish this, the study delivers electronic market system which consist of mobile application and web base as prototype to improve current business model. The system assists key stakeholders such farmer, agriculture officer and buyer to have better way information flow. In conclusion, due to the sharing of sensitive data, the study carefully analyzed the management of identity as essential part to ensure the system is operating in a trustworthy environment.

ACKNOWLEDGMENTS

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Finally, my deepest gratitude goes to my family and friends for unconditional support during my two years study.

LIST OF ABBREVIATIONS

FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
TCRA	Tanzania Communication Regulatory Authority
ICTs	Information and communication technologies
ICTE	Innovative-communication-technology-entrepreneurship
ODK	Open Data Kit
SMS	Short Message Service
GSM	Global System for Mobile
SQL	Structured Query Language
XML	EXtensible Markup Language
JSON	JavaScript Object Notation
REST	Representational State Transfer
PPP	Public-private partnerships
MoSCoW	Must Should Could Wont
XP	eXtreme program
UML	Unified Markup language
GUI	Graphical user Interface

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1. INTRODUCTION

The first part of this introduction chapter illustrates the background and motivation of the study to describe the overview of the challenges of agriculture sector in sub-Saharan countries. Next, the specific challenges facing Tanzania rural farmers are pointed out as the focus point.

As the main objective of this project is to deliver a prototype aimed to support key stakeholder to have a better flow of information, the research question will be presented. Based on that, the sub – questions will be illustrated as expected outcome that will provide answers to the identified agriculture challenges.

In order to avoid the divergence of the study, the delimitation will be identified as appropriate path to be focused based on the resources and time allocated for this study.

1.1 MOTIVATION AND BACKGROUND

Agricultural production in sub-Sahara Africa has been facing several challenges which held back both producers and buyers from profitability due to the lack of sustainable investment and the presence of unreliable markets. Despite the population growth and urbanization, the agricultural sector has not met the huge demands of the farmers in business perspective, regardless of being the backbone of economy in many Sub-Sahara countries [1].

The 2008 world development report, points out that many sub-Saharan countries have failed to explore the significance of the role of agriculture for the purpose of reducing poverty in rural areas. This indicates that there is little effort deployed on the agricultural sector which leads to many farmers living in poverty. The report also points out that African governments have failed to establish a flexible system which will integrate with other systems such as mobile technology to improve the life of farmers [2].

Table 2: Transaction cost advantages of small and large farms

	Small farms	Large farms
Unskilled labour supervision, motivation, etc	X	
Local knowledge	X	
Food purchases and risk (subsistence)	X	
Skilled labour		X
Market knowledge		X
Technical knowledge		X
Inputs purchase		X
Finance & capital		X
Land		X
Output markets		X
Product traceability and quality assurance		X
Risk management		X

Source: Poulton et al. 2005

Figure 1:Transaction cost advantages of small and large farms [3].

The table above reflects the results which indicate insufficient investment in small scale agriculture in Africa. It provides the description about the issue that is being addressed by this study. For instance, market knowledge in the table above shows that only large farms have awareness about it compared to smaller farms.

In additional, it can be argued that the existing agriculture sector experiences many challenges such as market, distribution channel, vital information and technology. These challenges are well summarized in the following sub-chapters.

1.2 AGRICULTURE MARKET

The government of Tanzania has the objective of having a well-to-do society that could depend on agriculture. To accomplish that, there have been some initiatives by the Tanzanian government to create several development campaigns as well as strategies. According to the Food and Agriculture Organization (FAO), the agricultural sector in Tanzania managed to contribute 28% to its annual GDP and it employs 75% of total labor force. These achievements have been successful due to the several initiative campaigns like "Green Revolution" with the motivating slogan "Kilimo Kwanza" (Agriculture First) [4].

Despite the fact that agriculture is one of Tanzania's economic pillars, the biggest challenge for small scale farmer is the lack of sustainable market. According to a survey conducted in rural areas of the Dar es Salaam region by the Department of the Tanzania Bureau of Statistics and Ministry of Agriculture in Tanzania, the *number of agricultural households in the Dar es Salaam region was 35,160 out of which 21,786 (62%) were involved in growing crops only and 4.2 percent of the total number of crops growing by households were only sold. The rest of the harvests were damaged due to the lack of reliable markets and absence of vital information between farmers and local buyers* [5].

With all efforts that have been taken since agriculture was introduced as economic backbone, the government of Tanzania failed to maintain that success and today poverty is coming up again.

Figure 2: Farmers selling crops along the highway-Tanzania

This situation has been a challenge since then to date. The figure 2, has been taken at one of the Tanzanian highways which shows the challenge small farmers are facing on finding reliable markets to sell their crops. During the harvest season, farmers have difficulties to get their crops to the market due to the fact that the government does not put adequate efforts in coordinating the whole process of enabling farmers to deliver those crops in the market.

The major challenge is the lack of a better agricultural market infrastructure which is crucial for connecting those farmers along the highway and the buyers who live in the city center [5].

1.3 DISTRIBUTION CHANNEL OF MARKET INFORMATION

Many village offices in Tanzania are using notice boards for posting public messages to inform villagers about different activities taking place or to be taken place in the villages. By taking into consideration the challenges facing the farmers to obtain market information, this study conducted field study at Kerenge village. The community is located in rural area in Bagamoyo District whereby the farmers live in remote environment from the village office.

The notice board placed in KERENGE villages, becomes the main tool to improve and enhance their services such as health information, education and agriculture. The boards which are located just outside an office, have been used by the village leader to inform people about different activities on health, education and agriculture. The main target to put the board outside is to enable many people to see what has been posted when they pass. To ensure the information is posted on time, someone has been put in charge of updating the content as well as to ensure the posted information is up to date at least once a week.

However, there have been some challenges, especially for the farmers who spend many hours at their farms. This makes them not able to catch up with the important news posted on the village notice board.

The notice board has not been a significant tool for the farmers as they are finding difficulties in accessing the information posted. The fact that, geographically, the farms in Kerenge Village are located far from the village office makes it difficult for the village leader to reach the farmers as well.

The figure 3, shows different information posted on the wall in Kerenge Village. Such posters navigate through different important details about health, education and agriculture. To get those details, farmers must travel to the Kerenge village office.

Figure 3:Kerenge notice board

1.4 STAKEHOLDER PARTNERSHIP

In the economic perspective, partnerships are observed as a management approach intended to reduce the cost of doing business by allowing key actors to engage in the same business with equal interest [6].

Agriculture officer

According to a study conducted by Elifadhili Daniel [7], the major challenges faced by an agricultural officer in not reaching farmers on time are being caused by

- *Low budget allocated to the agricultural sector and equipment like a vehicle or motor bike that will enhance accessibility into rural areas.*
- *The geography of Tanzania, many areas for farming are located on high altitude whereby it's difficult for the agricultural officer to reach there on time.*

Farmer

The absence of the important tools at district level, contributes to poor business environments which affect local farmers to achieve their goal.

- *Lack of innovative business ideas failed to give farmers access to relevant information about the market as well as checking the market price.*
- *Lack of reliable means to coordinate the farmers with the buyer to buy the crops in reasonable price.*

Private sector

In recent years, there has been an increasing interest in Partnership as a new way to achieve successful agriculture and business opportunities. According to an investigation by Ibrahim Assane, a partnership between the government and the private sector could be a root for new ways to minimize costs of supporting famers and the agricultural sector by transforming the traditional market system to be an innovative sector and to be competitive [8].

Despite such positive arguments, there are little efforts from the government to stimulate the private sector to engage in the domestic agriculture sector in order to add value. This introduce primary discussion here about,

How to reform the partnership policies to improve the way of doing business as well as to inspire the private sector to engage the agricultural sector?

There have been several concerns from the private sector perspective that many issues must be resolved in the public sector such as *bad leadership accountability* and *poor commitment.*

Likewise, from the government perspective issues that need to be resolved are that private investors are *not introducing genuine plans to involve the community and put their own interest as first priority during the investment*.

1.4.1 STAKEHOLDERS INTERACTION PROBLEM

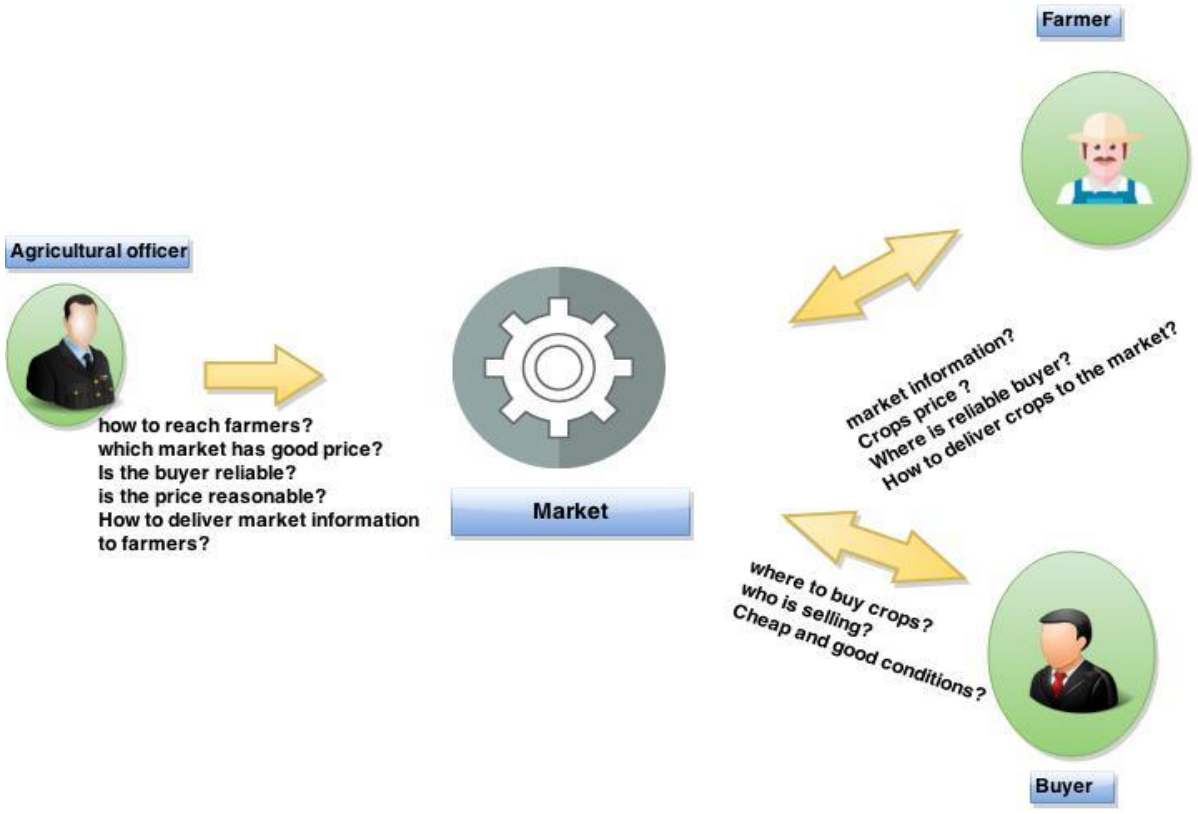


Figure 4: Stakeholder interaction problem

The figure 4 shows the description of the problem which this study will investigate in detail, so to find out the possibility of improving the traditional market to small scale farmers. The drawing above describes the situation whereby the agricultural officer is struggling to reach farmers on time and respond to their queries. Moreover, the officer has to identify the best market for buyers as well as share that information with farmers.

At the center, the traditional market which failed to connect various key stakeholders to obtain information such as, price of crops, location of the crops and general market information, is displayed.

The farmers who are living in rural areas experience difficulties for doing business due to the diversity of the market, crops prices and the complexity of identifying reliable buyers.

As most of the farmers stay in remote areas, the buyer has difficulties to drive from the city to their farms without being sure the crops are in good condition or in large enough quantities to satisfy the huge demand in the city.

1.5 THE IMPACT OF THE MOBILE PHONE IN TANZANIA

There are many ways in which mobile phone services can support agricultural development and improve the livelihoods of the agriculture-dependent community in Tanzania and other developing regions. This is significant because mobile penetration can provide affordable ways for millions of people living in rural areas to access information such as markets, finance, crops status and governance systems. Currently, unavailability of mobile phone applications for agriculture causes farmers to miss unique opportunities to reach buyers through a mobile phone [9].

Recently, agricultural activities in Tanzania have been mostly handled based on the instinct and knowledge of experienced farmers. There is no systematic approach to optimize available technologies such as smartphones and apps, aimed to manage and analyze agricultural work.

For instance, to know exactly the crop's price in the market and what type of crops is needed in the market could be vital. Such vital information could be optimized by farmers to control production costs as well as to avoid crops being damaged by staying longer in storage facilities.

Although farmers have been keeping records on paper in order to manage business transactions, the role of mobile based applications could reduce the burden of the managing and enable implementation of better access to information between buyers and rural farmers about market status [10][11].

Over the past decade, mobile phone usage has been growing very fast in Tanzania, according to the Tanzania Communication Regulatory Authority (TCRA)

"The number of subscriptions in terms of the figure shows that, from 3 million subscribers in 2000 to 15 million in 2009 [12]. *Moreover, the study conducted by Mtega.M* [13] *projected that 28 million users will be registered in 2012. In the mid of 2013 the number of subscribers already reached 26 million"* [12].

Another study conducted by A United Kingdom-based independent analyst, Business Monitor International (BMI), indicated that Tanzania is among the fastest growing mobile technology markets in sub-Saharan Africa countries due to the fact that the number of mobile users is expected to rise over 36 million by 2015 [14].

Despite all these good figures of mobile users, unfortunately not much has been reached yet to eliminate the challenges facing small scale agriculture sector

While other stakeholders such as policymakers, researchers and agricultural officers available in each constituency, there is no framework which could implement suitable environment to integrate them with farmers and buyers.

The affordability and availability of cheap smartphones in Tanzania could open numerous potential business opportunities that will link relevant information from an agricultural officer to local farmers as well as buyers who mostly come from city centers. Such vital information will reduce costs of crop production to farmers and enhance convenient business environments between buyers and farmers.

The major obstacle delaying the farmers to have such access to better information about the market, is a lack of services which will bring value by connecting with key stakeholders in Agricultural Fields [15].

1.6 ICT ADOPTION BURRIERS IN RURAL AREA

Information and communication technologies (ICTs) adoption in agriculture has the potential to empower the rural community to archive sustainability agriculture. However, there are many barriers hinder the ICT to be a significant approach to support agricultural because of the following reasons [16].

- Lack of the awareness of farmers about the contribution of ICT.
- High cost of ICT infrastructure in rural area due to low availability of essential services such as stable electricity and educated experts

1.7 PROBLEM FORMULATION

This study will explore the role of a mobile application on the electronic market as an enabler to enhance better access of information for buyers and rural farmers. The output of the investigation will be a working prototype of a mobile app integrated within a web-based application addressing the following sub questions:

How ICT could be applied to improve the information flow between key stakeholders on agriculture market in Tanzania rural areas?

1.8 EXPECTED OUTCOMES OF THE PROJECT

The expected outcome of this study would address the information flow outlines on the fig 4, such as:-

- Trusted electronic market system that will secure resources for small scale farmers
- Supporting of data integrity and security awareness in an electronic market system
- To enhance farmers to upload photos of their crops by integrating a camera and a developed app
- To implement a solution which could create a system bridging farmers and vendors
- To enable Agricultural officers to transfer available knowledge and information to the farmers in a timely and efficient manner

1.9 DELIMITATION

As mentioned in the previous chapter, the main concept of this study is to establish a prototype which will provide a basis for a trusted electronic market that will facilitate a more efficient and sustainable way of conducting agricultural business for small farmers in Tanzania.

- This small scale platform will focus on integrating the exiting feature available on phone, camera and applied to help farmers to send pictures of their crops. Since the web pages will also be developed, the mobile app which is Android native will integrate with it as well.

- Due to limited time and resources, the prototype will not contain a payment system and the mobile app will not work on other operating systems such as MacOS, Linux and Mozilla.

- Furthermore, the prototype will not collect user activities to build the profile because the prototype will not provide any experience preference to the user. However, the study will acknowledge this aspect and propose in future perspective

The motivation and background identify the key stakeholders, information flow and technologies as the main target to improve agriculture sector in Tanzania rural area. The challenges were summarized to provide the insight of obstacles hinder the information flow between key stakeholders.

The expected outcome of this research chooses to develop a prototype as result to answer problem formulation.

In order to have well describe study work, the scientific approach will be required to provide clear focus of the study. The following sub-chapter explains the methodology of this study.

1.10 METHODOLOGY,

This chapter starts with a figure 5 that explains the flow of the theoretical approach to be used in this project. After that, the descriptions of qualitative and quantities techniques will be covered as well. The main objective is to build good justification on how data collection was conducted in this study and how they have been optimized to identify the relevant findings. Since the project will deliver the prototype, the methodology will be mainly focusing on the coverage of a development framework which will support the designing and implementation spectrum.

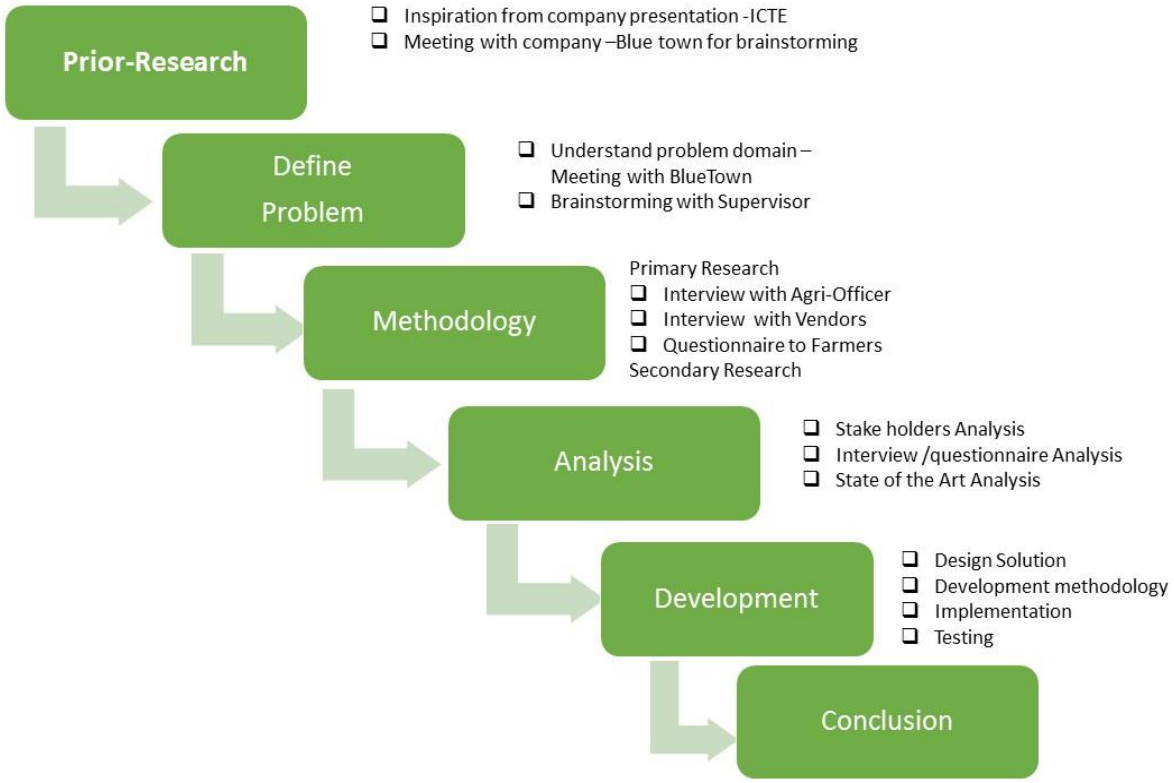


Figure 5: Methodology

1.10.1 PRIOR-RESEARCH

The inspiration of this study started during the meeting with companies at ICTE. The meeting aimed to connect students with companies in order to identify potential ideas for the final project. A short presentation from representatives of companies created a great opportunity to initiate the collaboration with Blue Town Company. This Danish Company engages on wide coverage of hotspot 2G, 3G in Tanzania rural areas. The company was looking for developing solutions that will bring value to the most inaccessible areas in Tanzania.

1.10.2 DEFINE THE PROBLEM

As the problem appeared to be a new phenomenon considering to the nature of the place, Tanzania, much exploration was needed to meet the criteria of being the thesis problem. Therefore, different meetings were conducted to reshape the scope and define clearly the formulation of the problem. Here, the inputs from the company and supervisor played a big role to define the problem and we came up with the title *Electronic market for small scale farmers in Tanzania.*

1.10.3 METHODOLOGY

After being motivated, this study looks in-depth at human behavior of the farmers about "How and Why" they are facing problems of lacking market for their crops. Therefore, to understand this, a feasibility study was conducted in a rural area of Tanzania for one month.

1.10.4 PRIMARY RESEARCH

In this study, collecting primary data from the site was a key priority. Participants such as farmers, buyers and agricultural officers were selected as major stakeholders in the agricultural sector in Tanzania. The main purpose was to gain knowledge on their experience by replying the research questions which were designed. Within a period of one month, all the relevant information was obtained through the interview

1.10.4.1 HOW INTERVIEW HAS BEEN CONDUCTED

The interview was conducted with farmers, agriculture officer and buyer. Its aim was to get more ideas from expert's point of view.

As indicated in methodology, interviews were conducted using simple questions shown in appendix.1. In order to encourage subjects to feel free to speak and tell their stories, the local language "Swahili" was used.

The appointment has to be made through the assistance of BlueTown local office in Tanzania. Since they had several activities before with Kerenge community, it was easy to get relevant people for interview.

The interview took place at Kerenge office where BlueTown antenna installed. The interview was in form of dialogue with the agricultural officer and it has been described in this report as **scenario one.**

The interview with ***buyer*** was not much official because most of buyers own small kiosks at market area in the city center. The questions (appendix 1) were presented to the buyer to get his view about the challenges experience daily on agriculture business.

Farmers selected were those with a farm size of more than 0.5 hectares and priority was given to those who live in Kerenge village. As mentioned before, the questions were structured and administered using an application, called Open Data Kit (ODK) tool. ODK is a free and open source set of tools that allows data collection using mobile devices and data submission to an online server, even without an Internet connection or mobile carrier service at the time of data collection [17]. The discussion of the interviews is shown in the analysis chapter.

1.10.5 SECONDARY RESEARCH

For better understanding of relevant candidate technologies and existing research done by different scholars, secondary research was conducted by going through desktop researches. The method provided some facts based on mobile phone usage in Africa and how they can adapted to add value in the agricultural field. For example some facts are:-

- Key information about other mobile applications developed by different organizations such as M-Farm, Safe Farming, SMS Market place and pride of Africa (*reference to state of the art*).
- The government of Tanzania census data about the number of people depending on agriculture as a source of income.
- The projection of the mobile phone usage in Tanzania including other sub-Sahara countries
- The role of public and private partnerships in agricultural sector

1.10.6 ANALYSIS

The fourth stage in the methodology is the analysis part. This stage focuses on elaborating insight of the state-of-the-art, interviews, and problem domain research. The findings of this stage will be presented in-depth in the analysis chapter

1.10.7 DEVELOPMENT

For the software implementation stage, the agile method will be used. This approach is suitable for small and middle size project due to the fact that user will be involved from the begin to the end of development stage. The requirement implementation will be based on the iterative and incremental approach whereby after completion of one stage then move to the next.

2 STATE OF THE ART

A review of the key concepts is presented in this chapter to describe the related works on this field of electronic markets in various parts of Africa. The main purpose is to determine to what extent those applications have managed to achieve better access market information and linking buyers with customers for conducting business. The output of the review will be compared and give information on what has been missed from those existing projects. The results will provide new features to be built in this project.

2.1 EXISTING PROJECT

Blue Town is a Danish Company working with the Mobile Company in Tanzania engaging in wide coverage of hotspot 2G, 3G in Tanzanian rural areas. Through, that they create affordability for local residence to have access of cheap internet services through their mobile devices. In collaboration with Telecommunication service providers, Blue Town manages to create a platform of services based on existing infrastructure.

The platform supports other experts to build various services on top of it to create value to the local user specific in agricultural sector [18].

Figure 6: BlueTown- Tanzania project[18]

The designed platform targets populated rural areas in Tanzania to enable them to have access of the cheap internet. This study will elaborate on the successful pilot project that I visited during data collection for this project. The project includes installation of a local Wi-Fi hotspot run on solar energy and reachable battery located at a Kerenge village in Tanzania (*reference figure 6*).

Using solar energy makes the system to work independent of the local electricity supply and keeps the costs down for local users to get their phone online. The pilot project has managed to cover approximate 18,000 local residents within 1-2km who have cheap smartphones. Such coverage enables people to be linked to the global network and through other local mobile companies available in Tanzania.

This aspect of connecting rural areas is crucial as Brian Bisgaard, the CEO of blue town explains, because services such as education, health, agriculture and business will be significantly improved.

The CEO also added, *now it is the turn of developing countries. Just think of what it would mean if the local population in West Africa could find information on the Internet right now about Ebola and how to prevent the spread of the disease*

As the objective of this project is to contribute to this effort initiated by BlueTown by exploring other options, this project will reuse the platform and deliver solutions that will bring value to the most inaccessible areas in Tanzania. The platform opened new opportunities to those local residents by fulfilling their demands for having a very cheap mobile application for selling their crops outside Kerenge Village.

As the figure 7 shows the project architecture, whereby, Wi-Fi hotspots are installed on the roof of local residents. This feature will enhance farmers to be connected globally to cheap internet and make them able to have access information about market status around the country through the mobile application

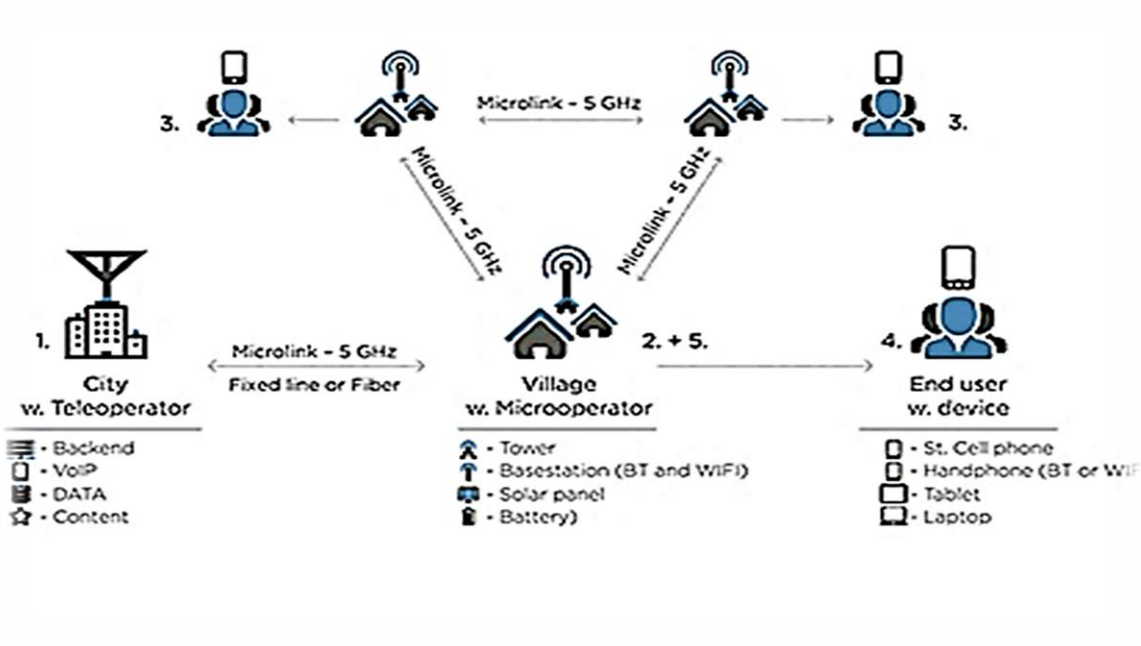


Figure 7: BlueTown Wi-Fi hotspot communication solution[54]

2.2 EXISTING SOLUTION

M-Farm

The M - farm is an application that mainly supports day-to-day market information on different commodity prices. This application provides offers and bids to match farm products with demand from vendors, and facilitates links between farmers and agricultural officers. M-Farm hires 18 agents in different locations around Kenya, who identify and link farmers with buyers and charge a commission of 10-15% for each conducted service. The main task of the agent, is to find the best price for the farmers in a market, then assist them to post their crops on M-Farm system during sales.

Since the system was implemented, farmers' sales have been doubled compared to before. So far, about 5,000 farmers are using M-Farm as a platform to sell their crops and projects show the number will increase in coming years. The picture below, shows the market platform contains information on crops such as prices of crops, quantity and other descriptions like the locations of the crops.[19]

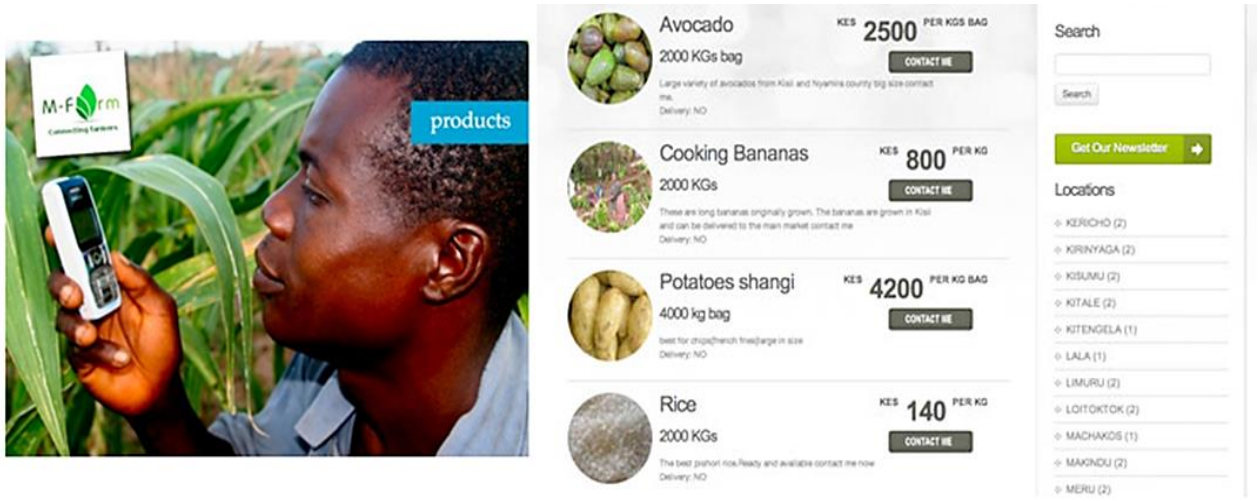


Figure 8:M-farm crops display[20]

SMS Sokoni

SMS sokoni means "SMS Marketplace" is another popular mobile application service that supports farmers to get market prices in various market centers around Kenya and Tanzania through SMS. The SMS links rural farmers to markets as well as general information about agricultural status. The figure 9 shows the stages on which the user will enter a certain code to select the service. The first screen indicates three main categories such as the Market place for vendors and commodities for Farmers to sell the crops.[21]

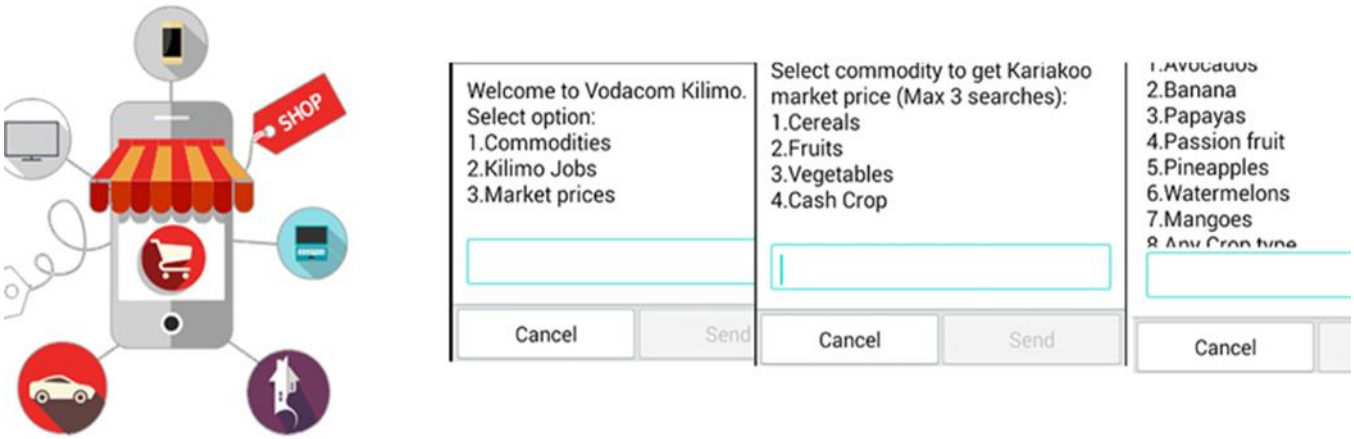


Figure 9: Market place menu selection[21]

Kilimo Salama

The program, called ***"Kilimo Salama,"*** which in Kiswahili means "safe farming," is a partnership between the Insurance companies and telecom operator Safaricom in Kenya for enabling sustainable agriculture sector. The project has been established to offer farmers important information about the seasonal weather status to avoid them from significant financial losses during the drought or excess rain.

The main purpose of the application is to assist farmers to minimize the risk of losing crops due to bad weather. Previously, the farmers were locked in a way that, it was difficult for them to identify what types of the crops should be planted based on the seasonal rains.

The information obtained from weather stations across different locations in the country, "Kilimo Salama" has managed to provide reliable information that farmers have to use before the farming season has started. Such inputs help the farmers to improve their life since they have the confidence to invest more on agriculture.[22][23]

Figure 10:Kilimo Salama application[23]

Pride of Africa

Another existing application innovated to assist farmers to do business called ***PRIDE OF AFRICA*** by DrumNet in Kenya. The main idea of the application is to replace a dishonest middleman who sells crops on behalf and enables the farmers to have direct contact to Vendors. The application links those two stakeholders by providing significant information about market status through the normal GSM mobile phone.

The farmer types a message with crop name and sends it to special code 411 (*reference figure 11*). Then the farmer will receive a menu which contains a list of the market centers to be selected. The farmer sends a code of the market place display on the screen to retrieve the current price in the market [24][25].

Figure 11:Pride of Africa

2.1 COMPARISON OF THE STATE OF THE ART

Table 12:Comparison Table

Project Features	M_farm App	SMS Marketplace	Safe Farming	Pride of Africa	Village Notice board
Price negotiations	Not implemented	Not implemented	Not implemented	Not implemented	Not implemented
Picture of crops	Implemented	Not implemented	Not implemented	Not implemented	Not implemented
Share market information and knowledge	Few details uploaded by the Agri - officer	Only the price of one type of crop in the market	Provides seasonal weather and type of crops to be planted	Only links farmers and buyers through GMS phone SMS	Posts information at village office
Trust Reputation	No technology implemented to enhance trust	Telecom company-Vodacom controls everything			Only the village office controls the information
Data Integrity	No information about control of user sensitive data	No trusted part controlling the data. Vodacom registers and keeps user sensitive data		The user information is controlled by the project owner	The information display opens on the posters
The mobile application integrates with web pages	No Mobile application. Web pages only	A GSM phone application using user mobile number	No mobile application and web pages	No mobile application and webpage implemented	Not Implemented

2.1.1 COMPARISON SUMMARY

The table 12 represents the comparative techniques used in this study to determine to what extent the different existing systems are able to solve the issue of an unstable agricultural market for rural farmers. For instance the application M-Farm, which has been used in Kenya, has managed to eliminate a dishonest middle man who used to take advantage of 5000 farmers. Also, it's noted that, since the M-farm system was implemented, those farmers' sales went to double compared to before. So, these are positive achievements for the farmers who did not see profitability of their crops before.

However, the comparison indicates that not all the important features have been implemented to improve farmer's business. For instance, the M-Farm application has not implemented the mobile app which could also add significant value to those farmers considering many farmers have a mobile phone. Also, among other applications, it shows that none of them have implemented the mobile application while Africa is the fastest in expansion of mobile users.

Another key issue which is missing from the compared applications is lack of a simple design of the system which could boost interaction when users want to engage in business. Referring to the application SMS marketplace and safe farming, both are using GSM SMS exchange to enable business between farmers and buyers. Such an approach does not provide enough details for the buyer who does not have the opportunity to see the physical product.

2.2 CANDIDATE TECHNOLOGIES

After presenting various relevant initiatives established to enable a better way for farmers to sell their crops, here the focus will be on examining the objectives of technologies which can be tailored to fit with the development of the prototype of this study.

2.2.1 CLOUD TECHNOLOGY

Despite agriculture being one of the economic pillars in Tanzania, the production of crops has experienced major challenges that failed to meet Tanzanian farmers' expectations. Lack of sustainable investment and an unreliable market are among the obstacles that slow down the progress of reducing poverty for those rural farmers. This leads to discussion about introducing a platform to create new business opportunities between farmers and buyers. Such a service will involve cloud computing, which will provide support on migrating the traditional farming system to the new

paradigm of a service oriented architecture. The establishment of cloud services as a model will empower users to have better access to vital information about market status as well as sharing of giving resources regarding application and storage. Given the fact that Tanzania is among the fastest growing mobile technology markets in sub-Saharan Africa, this study will explore the significant role of mobile phones and cloud services on establishment of an electronic market for farmers. [26][27][28]

Unlike other traditional computing facilities whereby, the system locates at an IT office, the aspect of cloud computing as service is completely different from those systems. This is due to the fact that its framework has been modeled to support many users sharing the resources among them. This implies that, migrating from desktop computing to a virtual network infrastructure will minimize the costs associated with having physical facilities at enterprises IT office. But, there are serious concerns about putting the working situation to more vulnerable conditions for security matters. That leads into another discussion on,

How the cloud service can enable the consumer to get the interest of participating in a system without fearing about their sensitive data?

As the purpose of this study is to deliver a working prototype of a mobile app integrated within a web-based application based on cloud services, concerns of user sensitive data should be first priority.

According to the report, recently, the consumer wanted to be involved in building an open infrastructure whereby the service provider has to disclose the physical location of the data as well as getting authorization from user for releasing sensitive data to a third party.

So, this indicates that the development of an electronic marketing system has to recognize the trust issue as one of the major processes to create a positive reputation into the society.[29]

2.2.2 SQL

SQL is a Structured programming language designed for querying data from a database such as MySQL, SQL Server, Access, Oracle, Sybase, DB2, and other database systems. It sets a basis for the user to manipulate relational database management by adding, deleting or updating a set of records.[30]

Advantages of the SQL

- Modification of the tables in the database can be done easily without compromising the whole system
- Very powerful and flexible because of the relational joint mechanism whereby each table has a unique attribute for identification
- It supports clustering of aspects to enable fast processing of information in distributed environments
- It retains the consistence of the records in the database by reducing data redundancy •
- It creates a useable system which increases the performance and scalability

2.2.3 JSON AND XML

XML stands for extensible Markup Language designed to describe data and not to display them. XML tags are not predefined; however, the user can define its own tags. The XML was designed to transport and store data. The XML is very essential for the bigger websites which have been deployed in distributions environment. In such environments, XML is more secure because the data structure can easily be modified without compromising the whole system. However, for the lightweight stuff, JSON is playing a key role for data exchange considering smartphone users are limited in power consumption and bandwidth usage. [31]

As the main focus of this study is to minimize time latency as well as to improve exchange of data volume, therefore JSON could play a key role to support end to end services between mobile app and system.

This chapter will not go into detail about comparison between XML and JSON, however other important aspects to be investigated in this research are:-

- *REST*

REST is an approach that uses a standard URI (Uniform Resource Identifier) that makes a call to a web service .The approach is very simple to implement due to the fact that representation of resources will be encoded in JSON to scale up operation of data exchange between client and server through mobile phone.[32]

3 ANALYSIS

This chapter presents an exhaustive review of the motivated studies and suggests a direction for better development of the prototype. It starts with an investigation of the findings form the various existing applications and projects. Then, the roles of various actors will be presented afterwards. The discussion of the interviews will be presented to point out the findings from the site visit as well as to support the design and implementation of the prototype. At the end of the chapter is the illustration of the designs to show how the users will interact with the system in order to achieve the particular requirement.

3.1 DATA INTEGRITY IN ELECTRONIC MARKET

After comparing state-of-the-art, one of the key challenges seen is integrity of the data. The integrity of data is the promise from the project owner that data collected from the system users are kept safe within their original context [33]. This means, the legibility of data must be maintained by preventing any kind of modification. As shown in the comparison table, M-Farm and Vodacom are not specifying what mechanism or regulation is used to handle user sensitive data.

It was noted that the systems concentrating on connecting farmers with different markets are guaranteeing that what is seen on the system is exactly the same information uploaded by the other party. The absence of certified aspects from those applications caused the user to misjudge the integrity information and have the negative perception that the information was set to attract customers

According to the Survey of the Trust and Reputation Systems for Online Service Provision by Audun Jøsang [34], the electronic market is the unique platform which allows two parties who have never been engaged in any kind of traditional transaction before to meet and exchange sensitive data. Such critical conditions, whereby neither buyer nor seller have enough information about each party, create the vulnerable environment for ensuring the integrity of the data.

In this study, the proposed system will accommodate the third party who will act as ***verifier*** to validate the goods and services offered by system. Below is the work flow to be implemented.

- Each user will be forced to register to the system before posting or order goods. During the registration, the user will be required to enter a specific pre-defined input pattern on the registration form such as email address, full username and password
- The third entity who will be an agricultural officer will check for validity of the data entered by the farmer or vendor. For instance, the officer will verify the classification of various crops based on the current price in the market.
- To avoid double standard, the verifier will ensure that the time stamp is implemented to avoid double input of the same product also to alert the vendor about the input date of the crops.

3.2 TRUST MODEL FOR ELECTRONIC MARKER ENVIRONMENT

Another finding from the state-of-the-art is the issue of ***trust reputation***. It was noted that the primary objective of the applications have been focused only to link farmers with the different markets. Due to lack of relevant information, it was hard for the participants to make a trusted decision during transaction because there is no sign of guarantee of what is seen on the system is exactly the same product as the one intended to order. For instance, the SMS marketplace application shows that only one side, the authorities, is acting as a main coordinator of the system. In this scenario, there is no indication from the applications of having independent party who will ensure farmers and buyers engaging into the transaction within the trusted cycle.

With the online transaction systems and sharing of resources in the same platforms, the broker based trust model is a very important vital aspect to assess the trustworthiness between the consumer and service provider [35].

In addition, the journal written by Chaitali Uikey and Dr. D. S. Bhilare, indicates that when two actors want to participate in e-services, there should be a scheme to evaluate to what extent the system achieved trust aspect.

Audun Jøsanga [34] added that users can still have confidence about that product shown on the system regarding that the seller has good reputation from other customers who bought the same product before. This indicates that despite the system containing insufficiencies in information about the product or seller, still, trust plays a key role to facilitate the buyer to put believe on the information

3.2.1 IDENTITY ECOSYSTEM

Another interesting argument from the National strategy for trusted identities in cyberspace paper [36], trust structure is the big field that needs to be established within a community whose fellows have identical objectives. The community will identify the regulations and standards that will enable each member to play a significance role to achieve identity ecosystem. The paper also added that such an ecosystem framework can be tailored by users to meet their preferences.

In this study, trusted relationships will be established among farmers, agricultural officers and buyers as they will all be members of the identify ecosystem. For instance, when the buyer wants to make an order of the crops available on the system, he/she has confidence on the information available because farmers who posted pictures of crops have been validated by agricultural officers. In addition, the pre-defined metadata which is attached to the picture of crops will have a trust mark to verify that the information came from a verified party.

However, the context of trust purposively will be designed to provide a solid trust environment for participants. *According to the presentation made by Henning Olesen* [37], *in a trustworthy relationship, entities are inspired to share their sensitive personal information freely with no fear of exploitation because the user is a member of the identity ecosystem and retains the right of his sensitive data when exchanging them with another party during transaction*. This awareness will ensure that if the data will be shared outside the ecosystem then the accountability will take place.

3.3 PRICE NEGOTIATION

Due to the high competition at the online market, *price negotiation* is the key factor to be considered for attracting more customers to use the system. According to the Jinkai W. et al who urges that price negotiation can be observed into two perspectives. One is the buyer's point of view whereby the negation opens a wide range to debate on the price. Another perspective is from the seller's point of view that the negotiation creates flexibility when setting a price of product [38].

EBay founder Pierre Omidyar in February 1996, said that when you establish a free and open platform to allow people urging about a price, the platform will encourage many people to engage into business and build a trustworthy relationship. He also added that the negations will encourage even strangers to exchange information over the network [39].

In this project, there will be room for the buyers and farmers to bargain in order for the buyers to obtain their favorite crops with a reasonable price as well as the farmers to increase their income in short time. This aspect of negotiation in the electronic market has been put forward in this research as one of the main objectives to assist participants to make satisfactory deals. The paper written by Youlin C, points out that price negotiation is a very important approach to draw a client's interest and encourage him to do business again in the next time after a successful deal [38].

3.4 STAKEHOLDER ANALYSIS

To encourage a sustainable agriculture sector to grow, this study has to address a number of frameworks, policies and technical solutions in collaboration with key stakeholders such as farmers, buyers and agriculture officers. Based on the findings from desktop reviewing and the site visit to Kerenge village, spotlights in rural areas where farmers suffering of poverty. The only solution to overcome this is to collaborate with key stakeholders, to work together and enable technology as a tool to facilitate knowledge exchange.

In India, despite good policies implemented by the government on agriculture business, the efficiency of those policies has been questionable because of the unfair interaction of stakeholders in the market which lead to discomfort to the farmers. Lack of a standard platform which could enable fair prices to the farmers and buyers causes the Indian market to suffer and it failed to provide better life to the farmers living in rural areas [40].

The implementation of policies is not the only solution to reform the agricultural sectors. A number of partnerships has to be established by bringing some expertise from private sector as well. For example, BlueTown as private company who achieved to improve communication in remotely areas in Tanzania. Such efforts play a key role in enabling farmers, buyers and agricultural officers to have better means for communication and exchanging knowledge and performing transactions [18].

3.4.1 PUBLIC PRIVATE PARTNERSHIP

According to the World Bank, the public-private sector collaboration has grown tremendously in developing countries since 2007. The report also added that the participation of private sectors in the economic sector increases the effort to address and solve the challenges in a places where public sector failed to do so [41].

The emphasis of partnerships has also been addressed by Whitehouse paper, if the private sector will also be involved in all levels of government by working together. Such partnerships will boost the economy and prevent the security issues by creating a trustworthy ecosystem [36].

Essentially, the requirements of the farmers are possibly the main factor that draws attention to investigating better means of doing business and ensuring sustainable agriculture. The most vital need is their demand to be involved in the trustworthy ecosystem which will ensure them that the person who engages in business will not make them feel uncomfortable during transactions. Moreover, the platforms need to be established in order to provide a more reliable way of doing business not only just to sell the crops but also to keep on attracting more buyers in the system [41].

Interview with AAU PhD students about PPP

According to **Williams, PhD student AAU**, before public-private partnerships (PPP) commenced into the African continent, *private sectors were contracted to take over the public assents. Such processes were observed as a negative approach towards society because the public interests were put under private ownership.* Since societies were not involved during the deployment of the privatized services, there was a bad relationship between private investors and the targeted community. However, he added that the replacement of privatization with PPP resulted in a gain of community trust towards the deployment service and system and it contributed to economic reformations.

The governments should play a big role by putting community interests forward considering that many farmers are illiterate.

In an interview with **Albert Gyamfi, PhD student at AAU** who is investigating the challenges associated with collaboration between cocoa farmers and the private sector in Ghana, urges that Ghana's agricultural sector has succeeded to overcome PPP challenges because the collaboration must be *publicly driven and not private*. The government formed an administration board which oversees the whole process of investment when the private sector requests to engage in business with local farmers. Such a process has to go through regulations established by the board to see if the investment has enough capacity to provide services to those farmers. Afterwards, the private sector will get licenses to cooperate with local farmers under the umbrella of the government.

The criteria to be investigated before accepting the partnership are:-

- Risk factors associated with the cooperation
- Affordability of the service to be offered within the partnership
- The deployment of the services and procedure to maintain
- The role of each stakeholder who will be involved must be clearly identified

Hence, the proposed solution of this study will cooperate with both public and private sectors. Therefore, the system needs to facilitate good partnerships to harmonize the participation of the private sector in agriculture services.

Below, the figure that shows the interaction between stakeholders to enable better tools on decision marking during partnership. The designed model below has been tailored to ensure that all the stakeholders are favored. It is important that the PPP scenario to be driven with the perspective that the local community such as farmers, buyer and agriculture officers are considered and their interests will be improved.

The model should act widely and contribute to lift the life of the rural community especially farmers, otherwise the application which will be developed for the farmers to sell their crops can lead in failure.

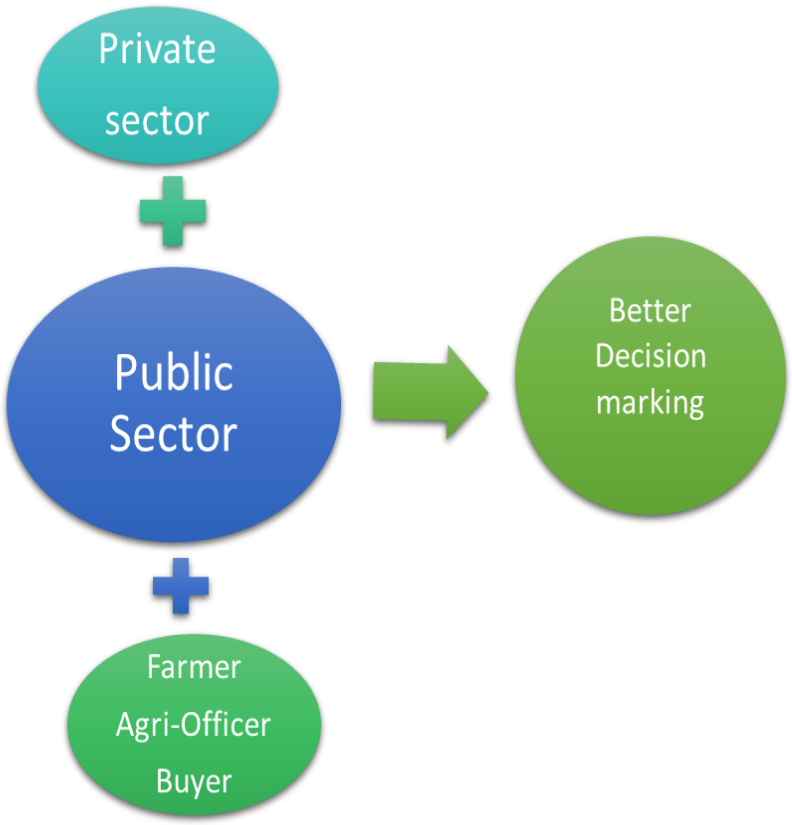


Figure 13:proposed pupblic private patnership

4 FIELD FINDINGS

This chapter describes the scenarios that contain realistic discussions with farmer, agricultural officer and buyer to get their practical experience on how they have been engaged in agricultural business aspects. The main objective to have these scenarios is to integrate them with the use case during the requirement engineering. The behaviors of the actors like farmers, buyer and agricultural officer will be used to detect the problems faced by the agricultural sector as well as model the solution that will be used to solve the identified problems.

4.1 SCENARIO –AGRICULTURAL OFFICER

In Tanzania, an agricultural officer plays a key role in distributing information, skills and agricultural material to the rural farmers. There are less than five agricultural officers in the Kerenge Village to support more than hundreds of farmers. This is the critical working situation considering the ratio of each farmer required to be visited by us.

"An agricultural officer is dealing with uncountable numbers of challenges as a consequence of the effectiveness of agriculture still being debated in Tanzania. This is due to the fact that the officers have failed to work closely with farmers to improve their income and reduce poverty."

Those are the words from **Kazoka**, an agricultural officer in Bagamoyo region.

Also he added that the only option to distribute information to the farmers though radio stations, mobile vehicles and in worship places. It is difficult to widen the scope and reach many farmers because of the limited resources get from the main government.

The pictures below show the equipment used by officers to educate and to visit the farmers. On the left is the mobile vehicle with posters to educate and share information with farmers. At the center are examples of papers used by officers to record information and track farmer's activities. Kazoka, shown on the right with a motor bike, faces obstacles such as lack of reliable means of transport to reach the farmers and limited financial support from the main government to support his day to day activities.

Figure 14: Public announcement car, recording paper and agriculture officer

The interview also reveal agriculture officer are well aware about revolution of mobile phone technology in Africa. The officer also urges the technology can play critical role in delivering cost-effective

It was noted that it's important to implement a common platform that provides a direct link with farmers especially those who cannot travel every day to the village office.

4.2 SCENARIO TWO –FARMER

Moringe grew up on a farm and since then agriculture has become the main source of his income and his family. Moringe has a large harvest almost each year, but often struggles to sell his crops, even in small quantities. Therefore, his life in general, has never become sustainable from the agribusiness perspective in comparison to survival farmers who do not have any expectations of farming. Moringe mentioned that there are many farmers like him in the same village who are suffering the same challenges such as lack of good roads as well as lack of reliable information about the market status. As a consequence of these factors, their lives remain trapped in a circle of poverty. Less investment in rural infrastructure to support means of selling the crops to reliable vendors contributes to both challenges.

Moringe claims that those challenges faced by the agricultural sector affects many Tanzanian farmers in rural areas. Lack of means of communication between farmers and buyers causes farmers to fail to deliver their crops to the markets in time.

Moringe added also that there is no consideration from the government to change the current situation soon to create a sustainable market. Even though there are tools like mobile phones which can be utilized as key techniques to improve farmer's life.

In the future, says Moringe, "*the smartphone will become cheaper and camera-phones will be widespread. So I think it's time now to plan strategies through expanding ideas of integrating the camera and app as tools to enhance farmers to upload photos of their crops directly to the market platform. The pictures of their crops will allow vendors to get better information on how to buy such crops."*

Figure 15: Farmer at Kerenge village

4.3 SCENARIO THREE-BUYER

Lema George owns a small shop selling agricultural goods in Dar es Salaam in the coastal region of Tanzania. The business is not doing so well due to the fact that his customers found it difficult to get what they need from his shop. As a consequence, many of his clients simply complain and do not return. During the interview with Lena George, he says

"*I sell a few products nowadays because of the limited supplies from the farmers. This creates problems with my customers because when they come and find the shelves are empty, they just end up telling me they will come back next time but in reality most of them disappear.*"

The other challenge mentioned by Lema is lack of a wide range of innovative ideas that could help to improve business and facilitate farmers to access vital information about the market situation here in the City Centre. Lema believes that such information could boost the business in a sense that there are huge demands of agricultural products.

Figure 16: Buyer in the Dar es Salaam

Many shop owners in the city have mobile phones which are often used for calling and sending SMS As explained by buyer during the interview that, currently there is no promising solution which could create a system by bridging farmers and vendors.

It was found that one possibility solution to link the buyer and the farmer is to optimize the technology in efficient way so that buyer and farmers can engage in the following activities:-

- Issuing order direct through mobile technology
- Negotiating the best price with farmers
- Exchanging important details such as farmer location and quality of crops

4.4 QUESTIONAIRE FINDINGS

Twelve (19) rural farmers from different locations around Dar es Salaam and Bagamoyo were interviewed (reference to appendix). The geographical locations of the interviewed farmers plotted on Google maps as shown fig 17.

Figure 17: Farmers Location

The main objective of interviewing these farmers was to gain insight on how they practice daily farming management and on business aspect. The sampling technique was based on judgmental sampling because it was anticipated that the particular residents will signify all the other farmers in the different regions. In addition, it was based on the inspiration from BlueTown Company as Wifi hotspot installation in those places. The interview was divided in three main aspects as shown in the table.1

Table 1:Questionnaire information

	Questionnaire	details to be Identified
1	Farmer's general information	• Gender • Education level • Other Occupation • Business experience
2	Information flow	• Market status • Exchanging of business knowledge • Mobile phone usage
3	Online transaction behavior	• Securing Sensitive Data • Trust reputation • Market negotiations

4.4.1 RESULTS

At least more than half of the farmers have basic education and the rest have secondary school education as is shown in figure16. This level of education indicates that the farmers have the ability needed to maintain the application and being able to perform business online.

It was also observed that the agricultural market has been dominated by middlemen. Most of them are dishonest and take advantage by convincing farmers to amount their crops at lower prices. This leads to exposure of farmers to more risks like getting little income considering what they harvested.

So when they have been asked about the vital information to be put in the system, the result was turn as shown on fig 18 right side.

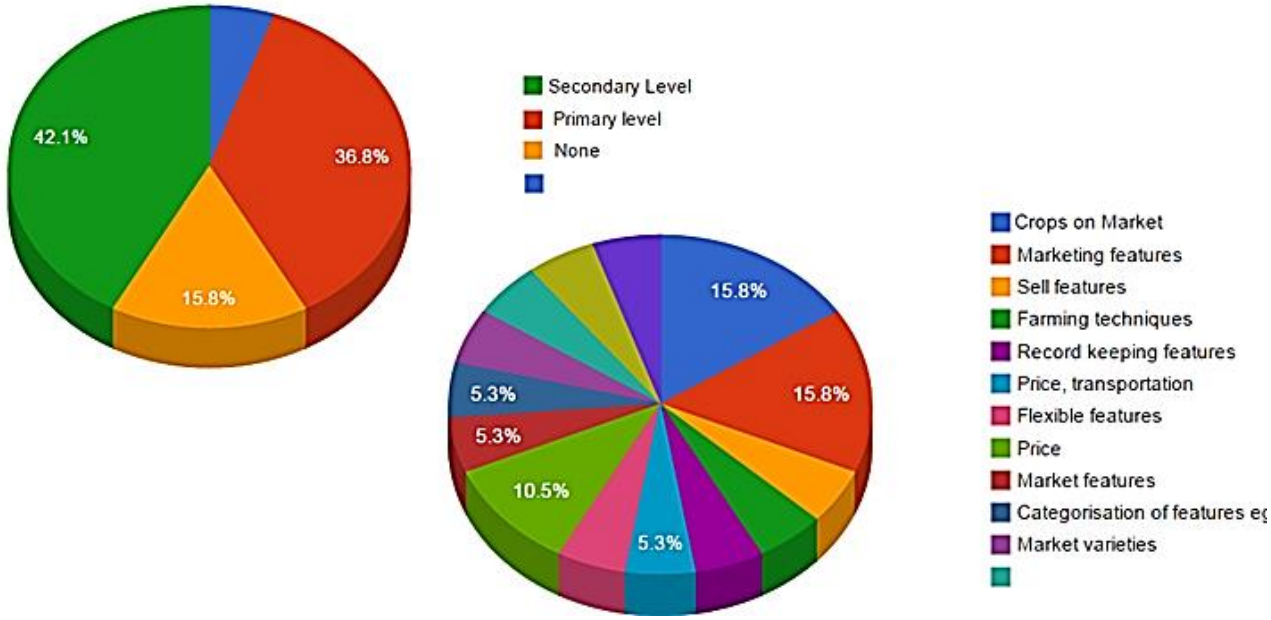


Figure 18: Education status and Market information

As shown from the farmer's scenario, most of the farmers questioned have been handling the agriculture sector based on knowledge heritage from the previous generation. This brings some concerns from farmers that the application will change their traditional habit of working. However, they were positive about having an application which will connect them with buyers direct.

As projected figure 19, all the farmers interviewed owned a mobile phone and they are quite well used to the functionalities available on the phones. For instance, many farmers are familiar to calling and receiving calls, sending and receiving SMS through their mobile phones. On the issue of the smartphone, it was observed that there is still a demand for education to help farmers to get familiar with smartphones. Although BlueTown is doing a good job to provide cheap smartphones with few functionalities to enable many farmers to have a smartphone, education should be provided in future.

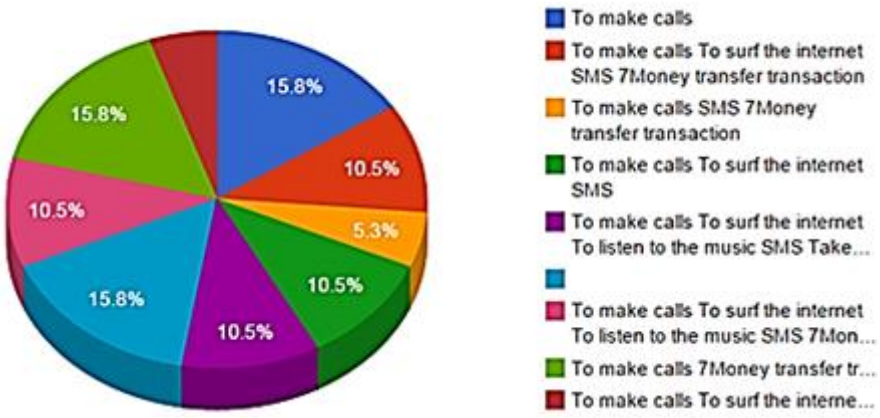


Figure 19: Phone usage

Although many of the farmers have a password on their phone for security issues, it was unexpected that almost all the farmers were not aware of trust issues. The context of trust was something new to them despite the fact that they have been doing online money transactions (M-Pesa). Nevertheless there was a positive expression of interest in knowing the trust issues and safety of their sensitive data. *It was turn out that 52 % where having password on theirs smartphone, 26.3 % no passwords, 21.1% did not say anything (figure 20).*

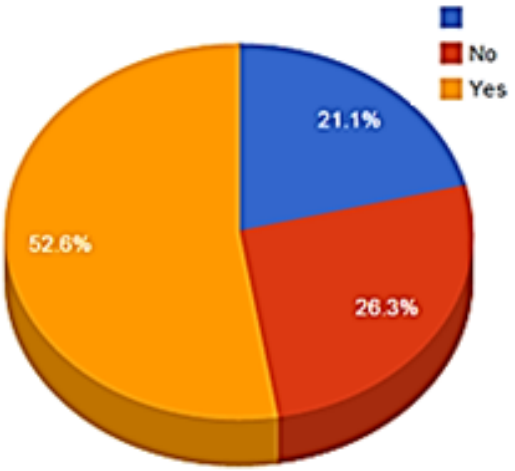


Figure 20: Security features

It was found that agriculture officer has enough knowledge to attend farmers' problems nevertheless there is no successor tool to support them to transfer such key information they know to the farmers. As shown

Due to the geographical challenge whereby many farmers are located into remotely areas, *it was noted that 57.9% are visited by agriculture officer when necessary, 31.6% never visited while 10% only once a week*

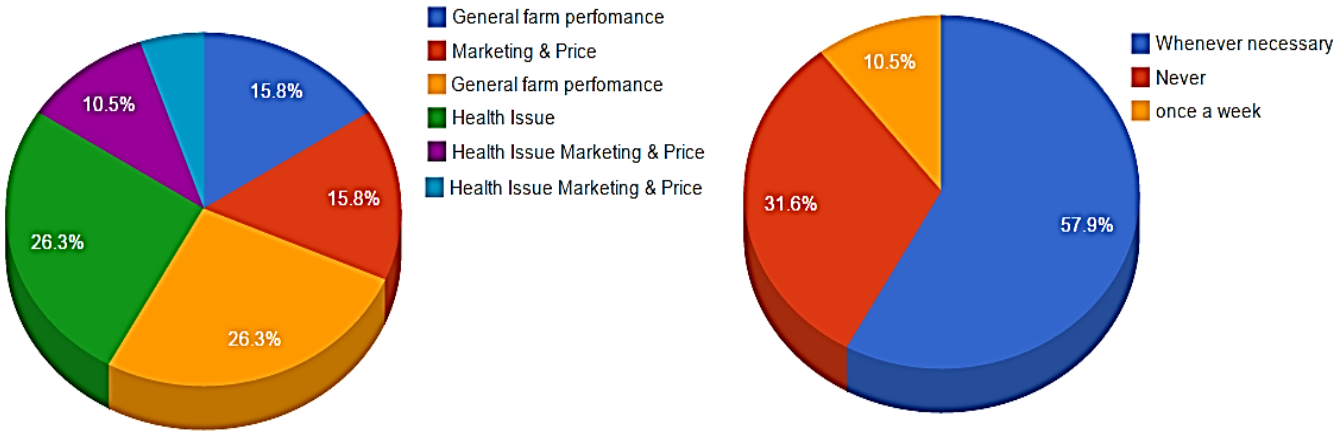


Figure 21: Agriculture officer visit

After identifying the key stakeholders and analyzed the challenges in depth, the following chapter illustrates the management of the questionnaire results into system architecture as engineer approach towards development of the system. System architectures will simplify the complexity of the challenges noted during the collection of data and help the designing process to deliver quality product.

4.5 SYSTEM ANALYSIS

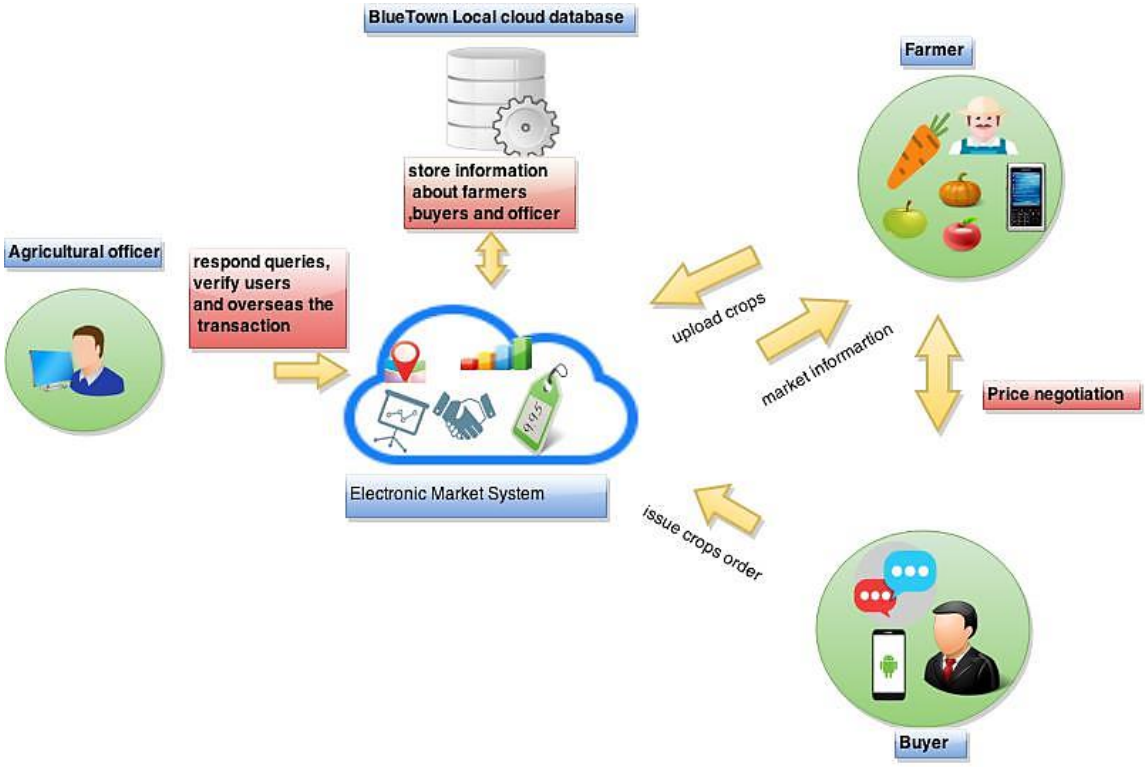


Figure 22: Information Flow Architecture

The figure 22 shows the prototype application to be developed as an electronic market for small scale farmers. The key stakeholder such as the Agricultural officer will be responsible for responding the queries from farmers and buyers. Also the officer will verify the authenticity of the information uploaded by each party. Furthermore, the officer will share the information about the status of various markets, including the trending price of the crops by uploading them to the system.

At the center, the electronic market system is displayed which will act as a platform to support both stakeholders to obtain information such as price of crops, location of the crops and general market information. The system will register both users and store their information into the local cloud storage provided by state-of-the-art BlueTown Company. The information will be accessed locally through the Wi-Fi hotspot installed by Blue Town.

At the right upper corner, the farmers will upload the picture of the crops into the system through the developed prototype mobile application. The picture will contain pre-defined metadata such as the

location of the crops, name of the crop and quantity of the crop. Also, the farmer will be able to access market information from the system through the phone to assist him/her in knowing the trending price as well as the type of crop which is highly demanded in the market.

At the right bottom is the buyer who will issue the crop order from the system. The buyer will use the developed mobile prototype to select the type of crop uploaded by farmers, then the system will direct the buyer to the location where he/she can negotiate the price with the farmer.

4.6 CONTEXT DIAGRAM

After illustrating the findings in the analysis chapter, the next stage is to implement those inputs at the architectural level which will describe the overview on how stakeholders will be interacting with the system. This architecture consists of three main designs. The central part is the electronic market system which consists of the mobile Application running on android mobile operating systems and the web base application.

The second party of the system is the mobile application that will be used by farmers to send pictures of the crops using a smartphone camera and by buyers who will use it to order and negotiate prices. Also, through this application farmers will be able to view different reports regarding the market status.

The third part of the system enables system administrators and other users to get access to the collected data and different reports generated by the system. The central database server will be deployed in local cloud storage from BlueTown and supervised by the district agricultural office.

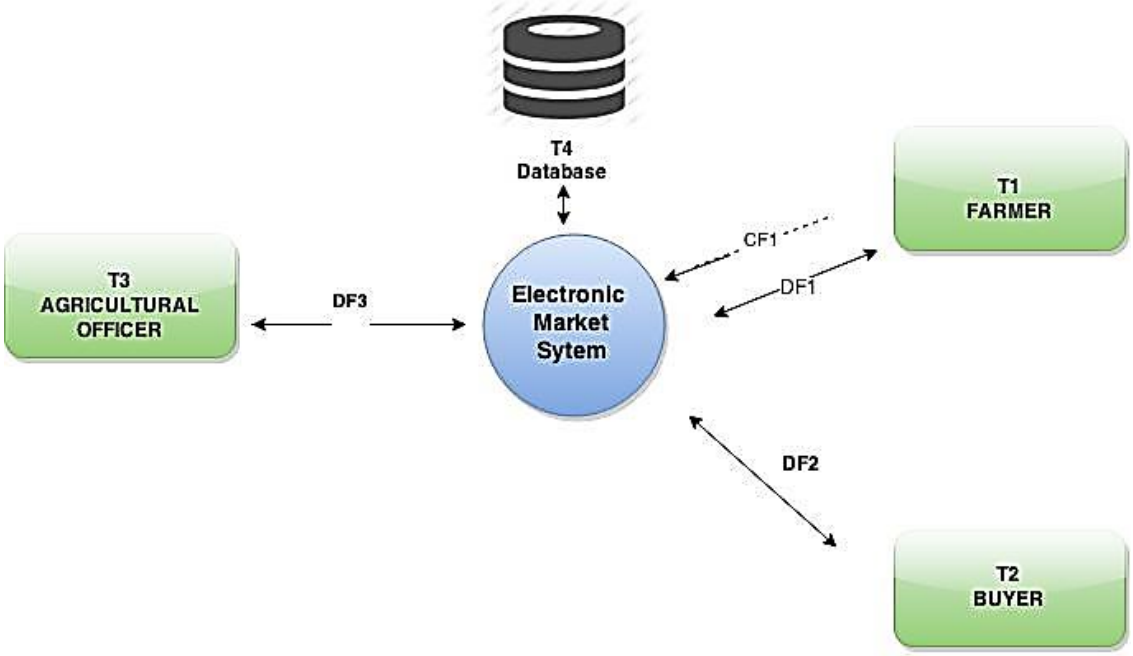


Figure 23: Context Diagram

The designed context diagram above illustrates the full suggested Electronic Market solution for small farmers in Tanzania.

- The labels T1, T2, T3 and T4 represent terminators which represent external system interfaces to processes and functions
- The data flows show the interaction between the system and the external terminators communications labeled as DF (data flow)
- Control flows marked as CF, represent the steps and conditions such as that phones should have a camera, farmers should take photo

As mentioned above, the designed diagram represents the full solution. However, based on the time allocated and availability of resources, this study will optimize a few functions and processes to develop a prototype solution as proof of concept.

Table.1 explains in details about the terminators who have been mentioned in fig 23. The purpose of the table is to describe the interaction between terminators and the system as well as the role of the system.in responding the requests.

Table 2:Terminator

Terminators	
T1	• Terminator represents the Farmer • Terminator should have a mobile phone with camera to take pictures of crops • Terminator should have an interface to enter requests for operations such as the market status, posting photos of crops and negotiate prices with buyer
T2	• This terminator represents a Buyer • This terminator requests and receives crop's order information • This terminator submits orders • This terminator could use the information from system to negotiate prices with farmer • This terminator will have access to the webpage
T3	• Terminator shall represent a person in charge to oversee the whole aspect of the electronic market • That person is agriculture officer • Terminator will verify system users and information posted • Terminator will receive and respond queries form farmer and buyer • Terminator collects information about the market status and post them in the webpage of the system
T4	• Terminator represents a local cloud database, which contains market information, business knowledge and system user's information. • Terminator stores daily market reports submitted by the agriculture officer • Terminator responses to the system when such information is requested.

Table 3 shows the control flow as series of activities required to be performed by terminators in order to fulfil mandatory conditions to interact with the system.

Table 3:Control Flow

CF1	• A smart phone takes photos of crops and posts them in the system • A phone detects the geographic location

Table 4 describes what kind of inputs needed to be requested terminator and responded by the system in different scenarios.

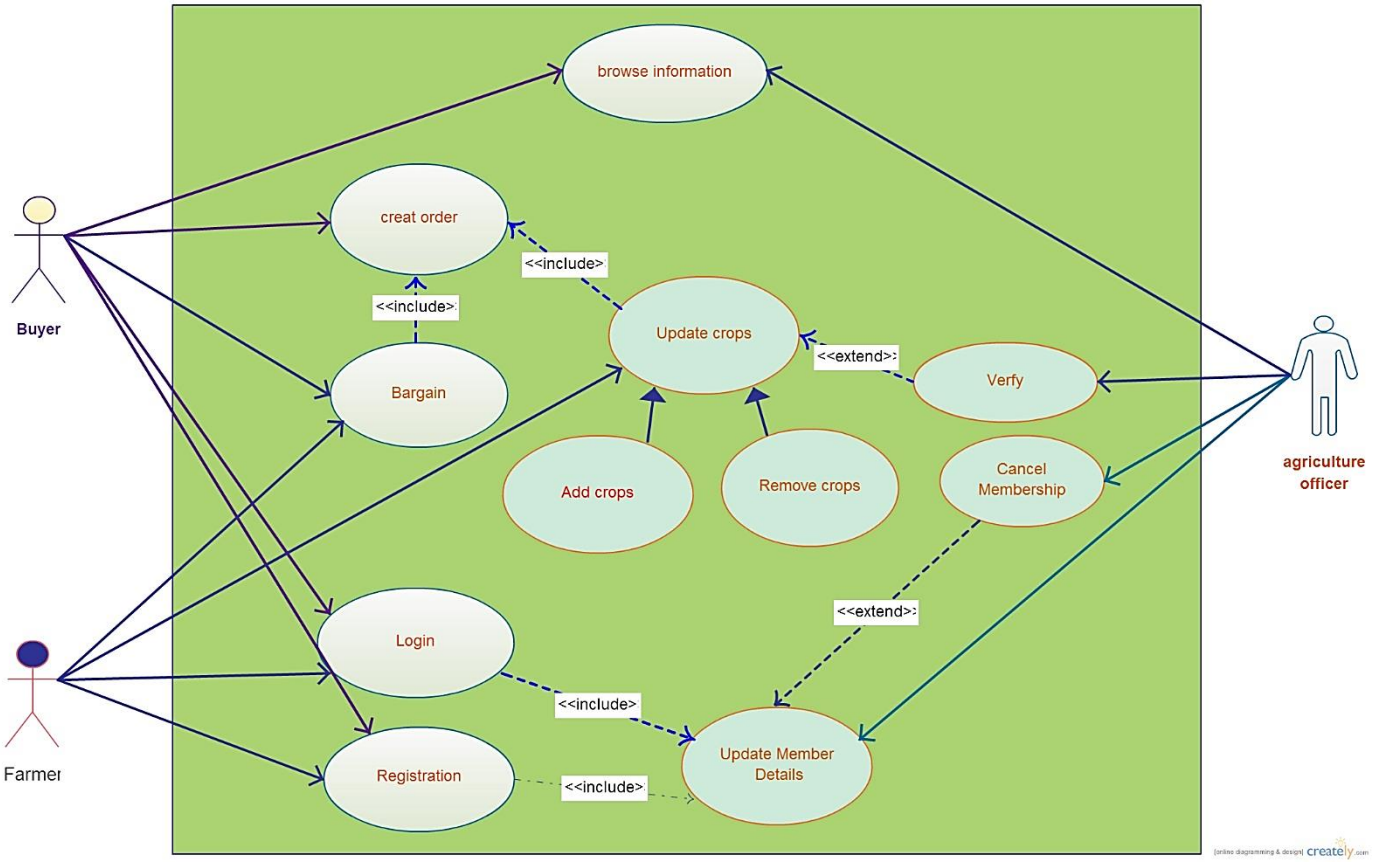
Table 4:Data Flow

Data flows	
DF1	A farmer uses a smartphone • Posts pictures of crops to the system • Retrieve information about daily market condition from the system • Receive order from buyer and engage into negotiable era
DF2	A buyer uses a smartphone and webpage • Requests crop's price information • Negotiates prices with farmer • Browses to check different types of crops • Sends query to agriculture office when necessary information needed, for instance clarification of price posted by farmer
DF3	Agriculture officer • Uses web page to post market information and verifies users • Shares knowledge and information from the main government • Replies to queries

4.6.1 USE CASE

Use of a case diagram is one of the key milestones during software development process. It describes the series of interactions that involve the actor and system. The actor is a role played by a user while the use cases are the set scenarios which interpret the requirement from project analysis. The use cases diagram put those requirements into engineering view to assist the developer to simplify the complexity of the project.

Table 5:Use Case diagram



The diagram above represents an outcome of the system requirements from different stakeholders of this project initiating dialogue with the system.

Inside the green box is the model of the system requirements to be developed as full blown solution as well as prototype solution. The modeling indicates two types of associations such as *extends* and *include*. The extend function describes how one scenario of the use case involves a second use case by either inheriting some conditions or may not to complete a certain task. While the include aspect indicates the inheritance of the conditions from another use case that must be complete to allow the original use case to finish the requested task.

Outside the box are actors who initiate the series of conversations with the use cases. The actors are representing the context of stakeholders mentioned in the analysis chapters. The main objective of the use case diagram is to ensure there is no direct interaction between actors and actors.

4.6.1.1 USE CASES DESCRIPTION

Use cases descriptions present in depth the best ways to capture whole activities done by actors and the way the system behaves towards them. The illustration points out the potential aspect that can go wrong during the interaction between actor and system. The main objective is to enable the developer to have a clear structure of system design during programming.

Table 6: Use case Description -Register

Use Case	Register
Brief description	The web page shows the interface for account registration
Primary Actors	User
Secondary Actors	Database
Preconditions	1. User connected to network 2. Registration fields are visible
Main Flow	1. The registration opens 2. User filling the registration fields and complete the registration
Post conditions	1. User can now login to the system
Alternative flows	Redirect to the registration form

The table above shows the first use case ***Register*** to be accomplished by a system user in order to access the information and to perform business activities. The table indicates the conditions to be fulfilled by a user such as connecting to the network in order to access the system. The same applies to the system that must display the registration form to be completed by user. If the form does not complete correctly, the user must be redirected to correct the missing fields.

Table 7: Use case description -Login

Use Case	Login
Brief description	The Activity allows users to login to the system by using Username and Password
Primary Actors	Users
Secondary Actors	Agri-Officer
Preconditions	Non
Main Flow	1. The application displaced different field for user to search 2. The User can log out after finished activities
Post conditions	1. The application has to display main filed 2. User can click the menus to display different fields
Alternative flows	User not registered User passwords is Invalid Password Log out

Use case ***Login*** is being mentioned in the table above to describe conditions such as ***username*** and ***password*** for the system to grant access to a user. After login, the system will show the menu filed for a user to browse the different information available. Afterwards, the user can log out after finished the activities

Table 8: Use case Description-Update crops

Use Case	Update crops
Brief description	The app allows farmer to add or delete a picture
Primary Actors	Farmer
Secondary Actors	Agriculture Officer
Preconditions	Registration and login complete
Main Flow	1. The activity starts when the farmer takes a picture of crop 2. The app displays an interface where the farmer can upload the crop 3. The Farmer can fill out pre-defined metadata to describe crop
Post conditions	1. The app has displayed attributes of metadata 2. The app displays a message that the update was successfully completed
Alternative flows	None

After a user gained login credentials, use case ***Update crops*** describes the activities that the system will provide to the user such as ***add/delete*** crops and will be verified by the ***agri-office.*** The table indicates the flow such as the farmer takes a picture of crops, fills the pre-defined metadata and posts it to the system. The app can display the notification that the crops have been updated successful.

4.6.2 REQUIREMENTS

System Requirements are explaining the needs of stakeholders to be achieved by the developed software. The requirements include the constraints and framework which the system must operate within.

4.6.2.1 FUNCTIONAL REQUIREMENTS

Functional requirements explain the behavior of the software towards a certain problem domain. These requirements change regularly to accommodate any changes that will be presented by actors of the system.

The applied functionalities will be categorized based on the MoSCoW analysis approach. The framework provides a systematic simple way to sort features into priority order, mainly to help the developer to understand what is essential for takeoff first and what is not.

Table 9:Fuctional Requirements

	Functional Requirements	Priority
F1	User must be registered to the system for an account.	M
F2	User must login to the system after being registered with username and password	M
F3	System must categorize users based on their occupation such as farmer, buyer or agriculture officer.	M
F4	The webpage system must display the trending crops attached to descriptions.	W
F5	Farmer must use smartphone to take pictures and upload to the system (web page)	S
F6	Farmer must fill the pre-defined standard metadata to describe more about products when posting the picture	M
F7	Farmer can request the information about current market status	C
F8	Buyer can select preferred crops from the web page and make order	M
F9	Farmer can see the notification about the order	C

F10	Buyer can cancel the order or confirm the order	C
F11	The agriculture officer must verify users and posted information	M
F13	The system can accept or deny the request	C
F14	When the user finished transactions, must log out	S
F15	The system must update the product status and display updated information for the next user.	S

The table 10 presents the rationale requirements that indicate the relationship between the various actors and the software behavior. The table is the key point in software development because it is mapping the requirements forward and backward to support developer during tracing the requirements and stakeholders

Table 10:Rationale

Rationale	
User Requirements	F1 & F2: Needed in order to identify the user F5: Essential in order to identify the type of crop and guarantee the buyer its condition F6: Necessary in order to describe in detail about crop such as location, type, condition, price and contact details F7: Essential in order to set the price of crop and identify which crop is demanded more in the market F8: Important for buyer's satisfaction and build positive reputations to the system F10: Essential for buyer to have more options in case the order issued was wrong F11: Necessary for buyer and farmer to access updated information about market and agriculture scenario

System Requirements	F4 & F15: Essential in order to provide real time information about available product F9: Essential in order to proof order has been issued F13: Essential in order to control accessibility of information

4.6.2.2 NON-FUNCTIONAL REQUIREMENTS

Unlike other types of requirements, the non-functional requirements illustrate how the system will act in technical aspects. These requirements are being established by a development team and they are not changed often.

Table 11: Non Fuctional Requirements

Non-functional Requirements		Priority
NF1	App will be developed in java under SDK platform	M
NF2	Web Service to be developed in, CSS3, PHP, JavaScript	M
NF3	The Web page will have interactive menus to navigate the user	M
NF4	Databases to be created by SQL	M
NF5	The App interface will have menus for easy accessibility	M
NF6	The app should integrate within the web application	S
NF7	Phone should have camera	S

5 DESIGNE AND DEVELOPMENT

In this section, the designing and implementation of the prototype will be introduced. The development of the system will be focused on the descriptions of the initial stages of the system such as use cases and requirement specifications. Based on the scenarios from those chapters that describe how the system is supposed to behave, the development part will implement relevant cases to enhance various actors such as farmer, buyer and officer to perform their objectives.

The key ***methods such as registration, identification, order, upload picture*** and ***view market*** information will be considered as first priorities during implementation. These methods will be explained in this chapter to indicate the industrial programming standards used such as programming language and database. The rest of the methods which are not presented in this chapter are attached in the appendix.

The application has been branded ***MkulimaSOKO*** a Swahili word meaning ***Farmer Market.*** The main idea is to integrate it with elements as this product is for local farmers who only speak Swahili.

5.1 DEVELOPMENT METHODOLOGY

This stage covers the development of the prototype framework which will deliver customer value based on the limited time and available resources. Therefore, this study proposes an agile development methodology to be used in the programming aspect. According to Masoumeh T et al[42], an agile framework is viewed as an effective and efficient technique due to the fact that the methodology can adapt quickly to any unexpected changes in requirement specifications. In addition, W. M. Farid indicates that there is a huge popularity of agile methodologies in modern software development challenges, mainly due to its ability to deliver qualitative functional requirement specifications [43].

As the objective of this study is to produce simple prototypes as proof of concept, agile methodology will be the appropriate methodology to accommodate the identified requirements of this study.

However, there are many frameworks of agile methodology which can be optimized in different aspects. Those frameworks provide room for the development team to model them based on their

requirement preferences. In this study, two approaches will be introduced which are ***Scrum and eXtreme program XP.***

As one of the popular components of Agile, scrum assists developers to deliver the progress of the development into small interaction. Taking into consideration that the requirement will be categorized and prioritized, this model will produce a catalog work that's required to be done by the developer. Relating to this study, it is clear that there will be huge stratification if this model will be optimized[44]

This is unlike, other traditional methodologies such as the ***waterfall model*** for which the design process is implemented in sequential methodology whereby each of the stages such as design, implementation, and testing must be completed first, where after, the developer moves on to the next stage.[43]. The major challenge of this model is that there is no room for changing or error correction after finishing one stage unless otherwise, the developer must start over? from the beginning of the whole project. Such phenomena will consume more time and require more resources. [43]. Based on the reason above, this project will not use waterfall model.

After the scrum framework produced the catalog which contains prioritized requirements, the next frameworks of agile methodology takeover is extreme programming. Here, the programming will be conducted as team work in order to achieve a well-constructed code. The team will review codes and remove errors from it in order to adapt the requirements. [45]

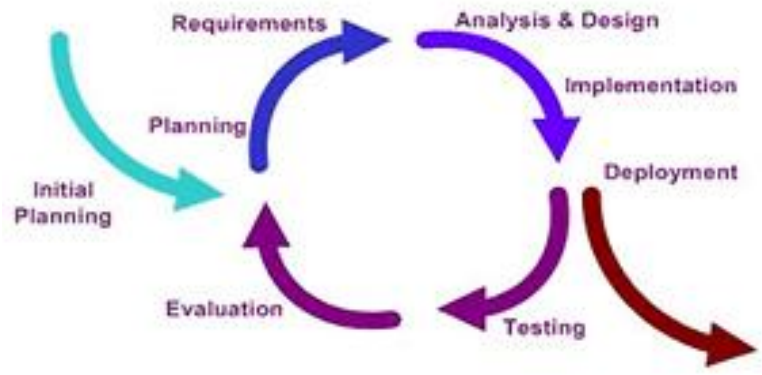


Figure 24:Iterative and Incremental Process Agile Framework[55]

How the approach relevant in this study

Despite the project does not consist of three key players such as project owner, scrum master and the team nevertheless the approach helps to open other usefully practices such as:

- The involvement of the customer (BlueTown) each stages of the development of project
- Breaking the project into small segment and meet with supervisor to see the progresses of the project
- Involvement of other expertise during pair program to deliver quality code

5.2 CLASS DIAGRAM

In this section, the UML framework will be presented as a standard way to design and create class diagrams. The key aspect of the drawings is to visualize the classes as objects as well as the relationship between one class and another.

The model categorizes in three sections. The upper one represents the class name. The middle section describes the attributes of the mentioned class on the top. The bottom section represents the methods which will be called somewhere from the code to do a certain specific task or to return something.

5.2.1.1 MOBILE APPLICATION

The figure below describes the four classes of the mobile app such as ***registration*** of the new use, user ***login*** interface after registration and the last two classes show the interface for user to ***add new product*** as well as to ***view the list*** of added products.

In addition, the figure describes the relationship between classes, for instance the ***many to one*** relationship shown between login page class and product view. Similarly to the product observer where by the activity cannot complete until it ***extends*** the new product activity

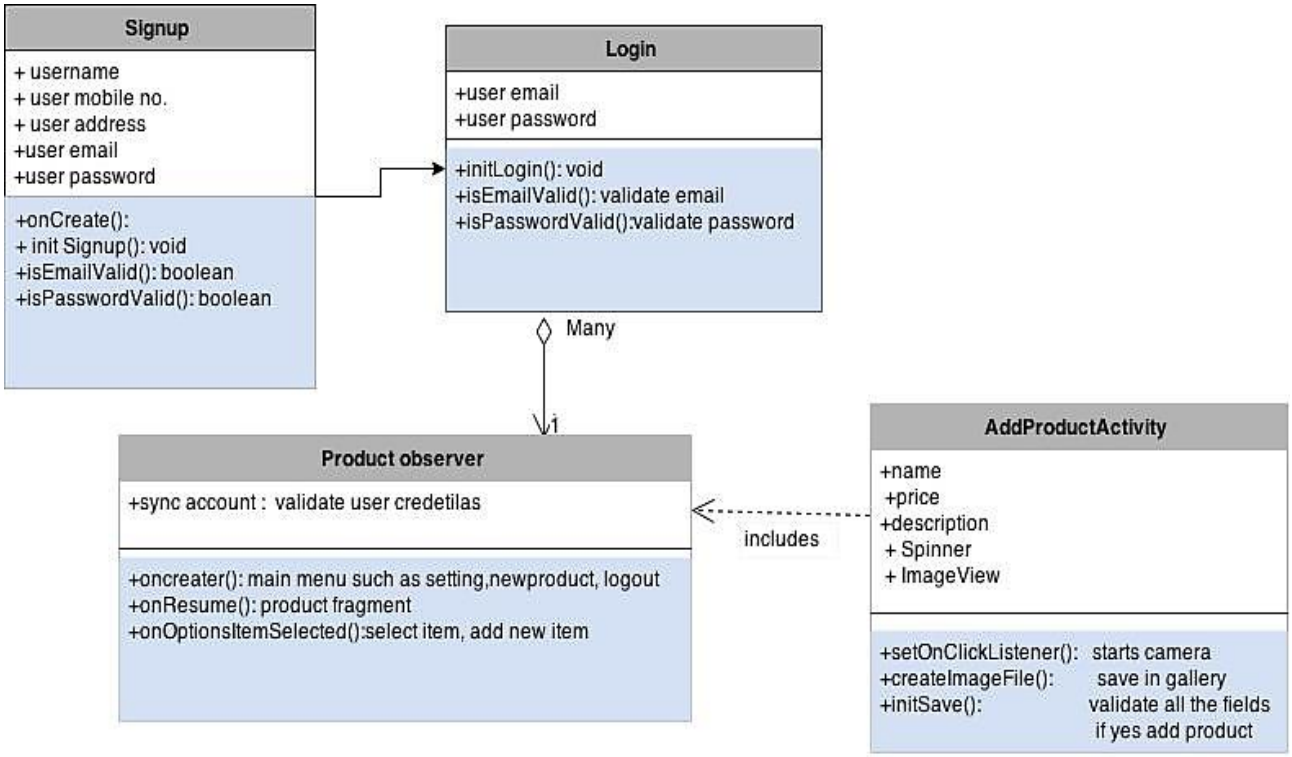


figure 25:Class diagram

5.3 SEQUENCE DIAGRAM

After the design of the use case diagram, this chapter illustrates the sequence diagrams which define particular interaction scenarios. The diagrams below present sets of sequence diagrams to cover the relevant user case aspect. Use case actors such as farmer, buyer and agricultural officer perform a sequence of actions to interact with the system in order to accomplish a certain task.

5.3.1 MOBILE APPLICATION

The first diagram shows the interaction between users and the system. The scenario is being presented from the user viewpoint interacting with three other components such as a GUI (webpage and App), Database and the electronic market system. In the presented diagram, there is one actor and three system components.

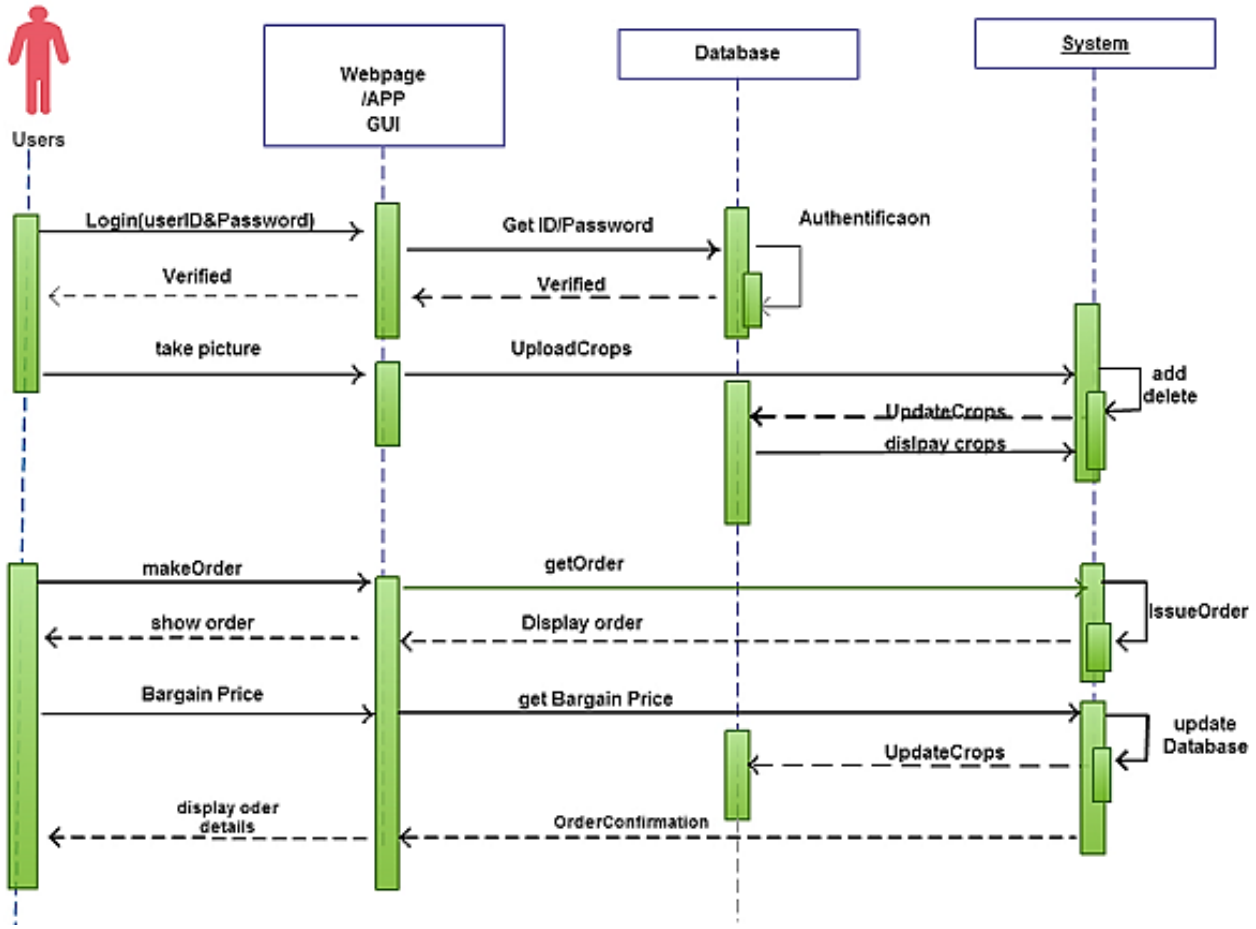


Figure 26: Sequence diagram-mobile app

5.3.2 WEB APPLICATION

The second drawing describes the set of sequence actions performed by the system to respond to a certain task presented by various actors. The figure includes system actions such as request information from a database as well as the responds from the database regarding those requests. The information will be posted on the GUI part which represents the web page and App. The user will invoke this information through the GUI to be displayed on their devices.

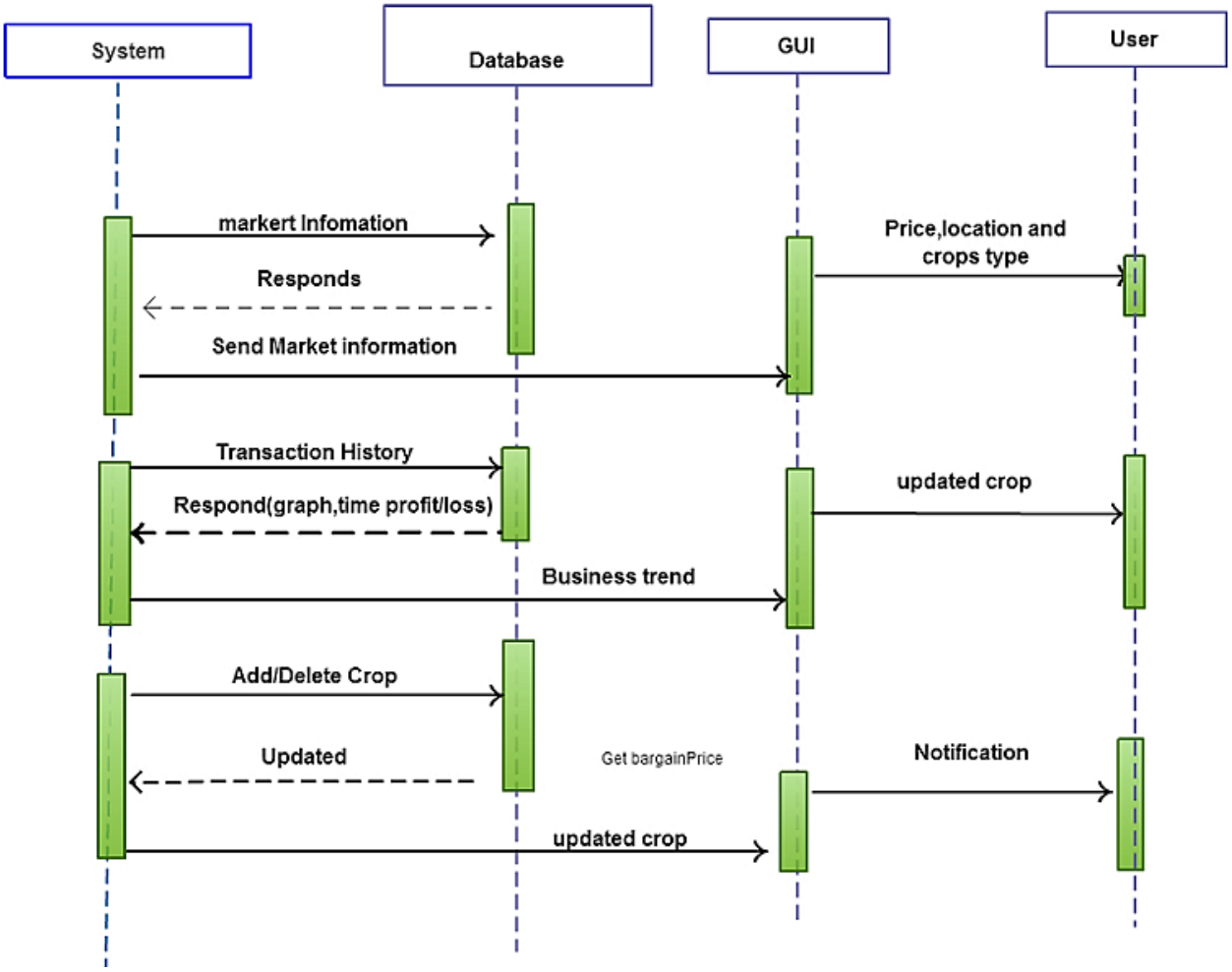


Figure 27: Sequence Diagram -webpage application

5.4 IMPLEMENTATION

In this section, The GUI, as well as source code will be presented to describe how the application, which will be run by farmers mobile, has been developed. The application Interfaces are shown below to indicate the activities such as ***registration, authentication and capturing of the crop photo.***

The wireframes are very important in the development of a quality product because it will show how the system will look like when it is completed. In addition, the wireframe is dynamic in a way that users can still contribute their input to improve the product. As this project uses agile approach, wireframe will be useful to adjust user requirements.

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5.4.1 WIREFRAME AND SOURCE CODE FOR APP

Once the farmer starts the mobile app for the first time, the registration form will prompt with pre-defined metadata to be filled by the user. After successfully having signed up, the information will be saved in the database and the user will be redirected to the login page whereby username/email and password will be required. Both the registration interface and sign up interface contain links for the farmers who have already registered to go to the login page as well as the farmer who did not register yet to go to the registration form.

Once the authentication of those credentials is done, user will be displayed in the mobile app interface which holds required functions such as camera and predefined metadata.

The interface on the right will be used by farmers to capture pictures and post them on the webpage after which other actors such as buyer and agriculture officer can view them. The picture will be attached with details such as name of the farmer, location, price and other descriptions filled by farmer.

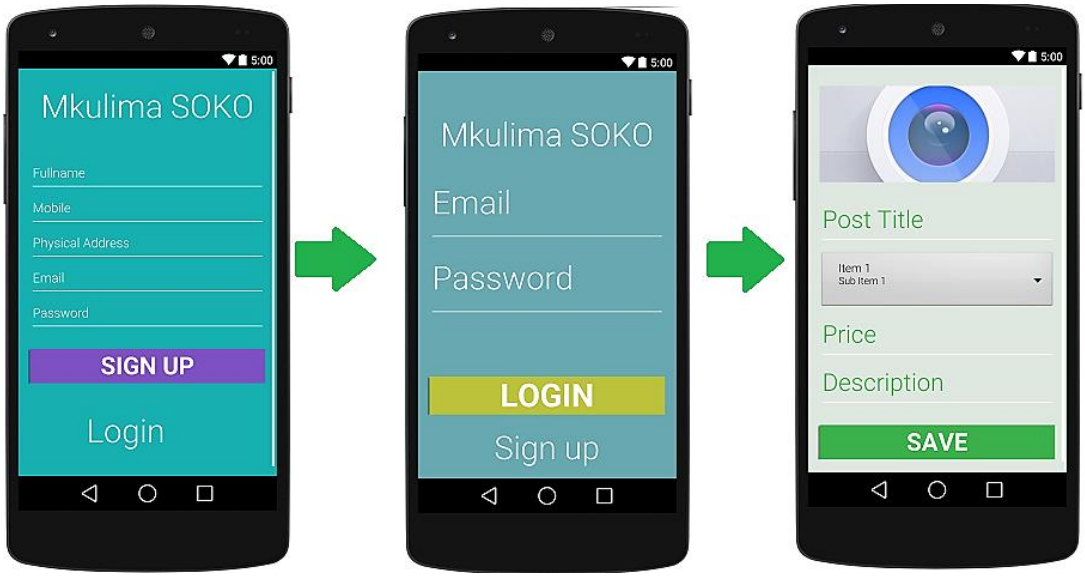


Figure 28: Mobile app Wireframe

```
public class SignupActivity extends Activity {

    private UserSignupTask userSignupTask = null;
    private View signupFormView;
    private View progressView;
    private EditText nameTextView;
    private EditText mobileTextView;
    private EditText addressTextView;
    //private Spinner accountTypeSpinnerView;
    private EditText emailTextView;
    private EditText passwordTextView;
    private TextView loginTextView;

    // Session Manager Class
    SessionManager mSession;

    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_signup);

        // Session Manager
        mSession = new SessionManager(getApplicationContext());
```

During sign up, the user is required to provide curtailed credentials such as name, mobile number, physical address, email and a password.

```
SessionManager mSession;

@Override
protected void onCreate(Bundle savedInstanceState) {
    super.onCreate(savedInstanceState);
    setContentView(R.layout.activity_login);

    // Session Manager
    mSession = new SessionManager(getApplicationContext());


    /**
     * This will redirect user to MainActivity if he is already
     * logged in
     * */
    if( mSession.isLoggedIn() ) {
        // User is already Logged in, Redirect user to Main
        Intent i = new Intent(getApplicationContext(), MainActivity.class);
        // Staring Main Activity
        startActivity(i);
    }

    emailTextView = (AutoCompleteTextView) findViewById(R.id.email);
    loadAutoComplete();

    passwordTextView = (EditText) findViewById(R.id.password);
    passwordTextView.setOnEditorActionListener((textView, id, keyEvent) -> {
            if (id == EditorInfo.IME_NULL) {
                initLogin();
                return true;
            }
            return false;
    });
```

In the ***log in*** class, the source codes contain the functionality that the app will perform such as validate user inputs (***email and password).*** Once succeeded, the user will be forwarded to the main activity or else he will be redirected to the signup page.

Once the login details passed, the user will be directed to the ***add product*** if it is the first time or else the user will be directed to the ***product view page.***

```
public class AddProductActivity extends ActionBarActivity {

    private AddProductTask addProductTask = null;
    private View addFormView;
    private View progressView;
    private EditText nameTextView;
    private EditText priceTextView;
    private EditText descriptionTextView;
    private Spinner unitSpinnerView;
    private ImageView postImageView;
    private TextView loginTextView;

    final static int CAPTURE_IMAGE_ACTIVITY_REQUEST_CODE = 1;
    Uri imageUri                      = null;
    private String mCurrentPhotoPath;

    // Session Manager Class
    SessionManager mSession;

    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_add_product);

        // Session Manager
        mSession = new SessionManager(getApplicationContext());
```

The figure below shows the two activities of the application which display the output of the pictures with the descriptions. A farmer has the ability to delete the picture with description in case the information has faults or is incorrect. Afterwards, a farmer can upload the information to the webpages whereby a buyer will be able to browse and issue an order based on the preference.

Figure 29: Product View -Mobile App

```
@Override
public void onCreateContextMenu(ContextMenu menu, View v, ContextMenu.ContextMenuInfo menuInfo) {
    if (v.getId() == R.id.listview_product) {
        AdapterView.AdapterContextMenuInfo info = (AdapterView.AdapterContextMenuInfo) menuInfo;

        Cursor cur = mProductAdapter.getCursor();
        cur.moveToPosition(info.position);
        menu.setHeaderTitle( cur.getString(COL_PRODUCT_NAME) );

        //Log.d("item info", cur.getString(COL_PRODUCT_NAME));

        menu.add(Menu.NONE, DELETE_MENU_INDEX, Menu.NONE, "Delete");
        super.onCreateContextMenu(menu, v, menuInfo);
    }
}
```

When the cursor moves on ***listview*** activity and position on top of the product, an item can be ***deleted*** by a user from the list view as shown on the figure above.

5.4.2 WEB PAGE APPLICATION

The Electronic market dashboard can be accessed by various users of the system who have been given different access privileges. The agricultural officer will be granted all privileges to access the list of

farmer's name, location and contact information and the buyer. Moreover, the agricultural officers can post information about market status to be viewed by the farmers in a particular area.

Other key players will be able to access information filtered based on user type to satisfy their needs. The information attached with crop's pictures such as farmer's names, locations, crop type, quantity as well as contacts will be used for ordering. For instance, when a buyer is browsing different crops, by clicking the picture will be taken to the order page.

Web page development

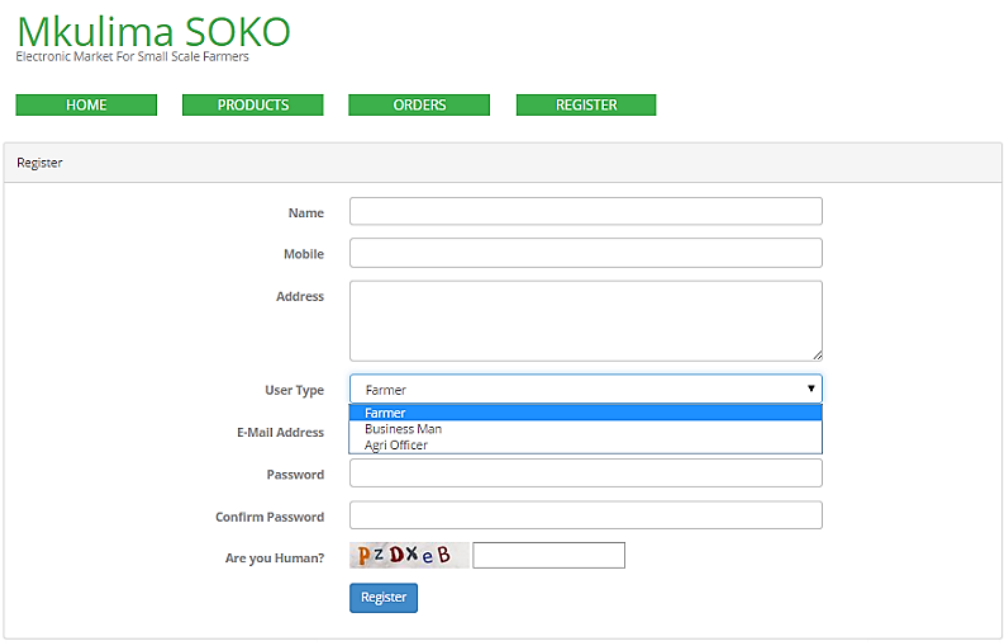
As mentioned in the state of the art that, the application will be built based on PhP and Java. The web page has been developed by **Laravel framework** as open source which using lightweight Php[46].

The webpage is RESTful because all request have been defined and handling logic in a single file called ***routes.php***

```
//Route::get('/', 'WelcomeController@index');

Route::get('/', ['as' => '/',
    'uses' => 'Auth\AuthController@getLogin'
]);

Route::get('register', ['as' => 'register',
    'uses' => 'Auth\AuthController@getRegister'
]);

Route::post('api_get_sync_key', ['as' => 'api_get_sync_key',
    'uses' => 'ApiController@getSyncKey'
]);

Route::post('api_save_products', ['as' => 'api_save_products',
    'uses' => 'ApiController@saveProducts'
]);

Route::group(['middleware' => 'auth'], function()
]{
```

Registration

The web page provides registration form which categorize the stakeholders based on the occupation. The form support user type such as ***buyers, agriculture officer and farmer*** to register and direct them to the different web pages based on their categories.



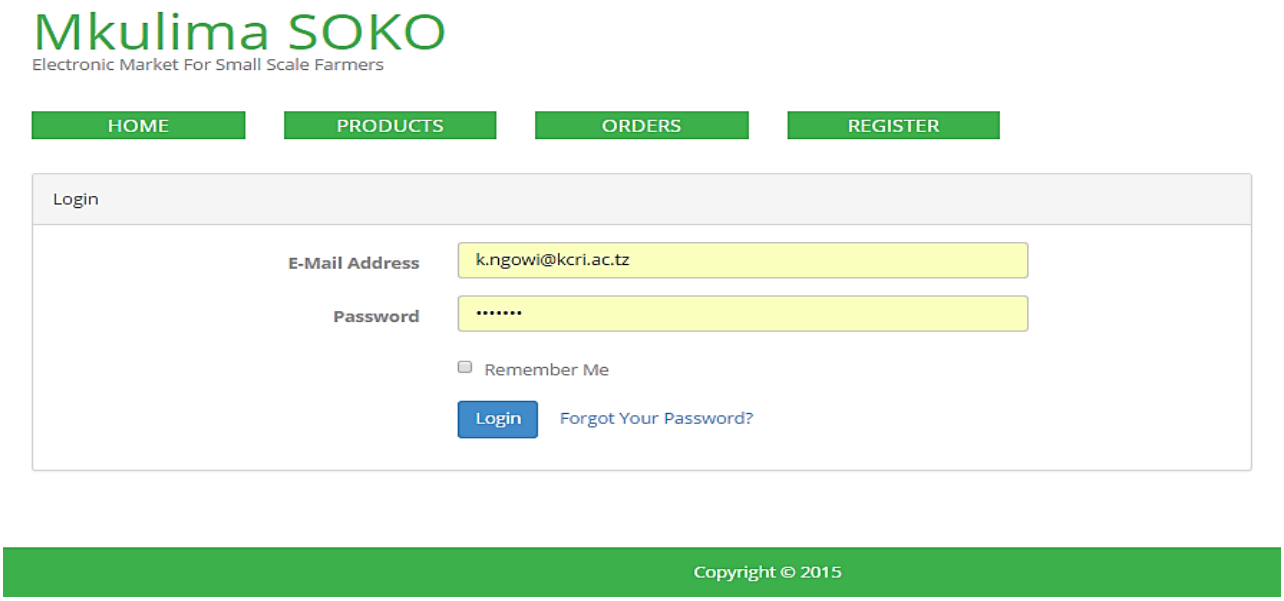

```php
use Validator;
use Illuminate\Contracts\Auth\Registrar as RegistrarContract;

class Registrar implements RegistrarContract {


    public function validator(array $data)
    {
        return Validator::make($data, [
            'name' => 'required|max:255',
            'mobile' => 'required|min:10|max:15',
            'address' => 'required|max:255',
            'account_type' => 'required',
            'email' => 'required|email|max:255|unique:users',
            'password' => 'required|confirmed|min:6',
            'captcha' => 'required|captcha',
        ]);
    }

    public function create(array $data)
    {
        return User::create([
            'name' => $data['name'],
            'mobile' => $data['mobile'],
            'address' => $data['address'],
            'account_type' => $data['account_type'],
            'email' => $data['email'],
            'password' => bcrypt($data['password']),
        ]);
    }

}
```

Figure 30: webpage -registration form

The code above indicates the attributes which are mandatory to be validated before stored in the database. The function ***create*** will **return** the list of array data such **as *name, mobile, accountant type, email and password.***

Login

The screen below shows the login page. Here, user required to provide the registered attributes such as ***email address and password***




```php
<?php namespace App\Http\Controllers;

use App\Product;
use Illuminate\Contracts\Auth\Guard;

class PostController extends Controller {


    public function __construct(Guard $auth)
    {
        parent::__construct($auth);
    }

    public function index()
    {
        $data = array();
        $account_type = $this->auth->user()->account_type;

        if($account_type == 1) //farmer
            $items = Product::where('user_id', $this->auth->user()->id)->get();
        else //business & officer
            $items = Product::all();

        $data['items'] = $items;
        $data['account_type'] = $account_type;

        return view('post.index')->with('data', $data);
    }

}
```

Figure 31: Login page

The figure 31 shows the ***validation and authentication*** function. After user presents ***email and password***, then the system will check the ***account type*** to direct the information page based on the registration information

Figure 32 shows the display of the crops after being posted on the web page by farmers through smart phone. The dashboard indicates the picture of the crop, metadata descriptions and the sign for making order.

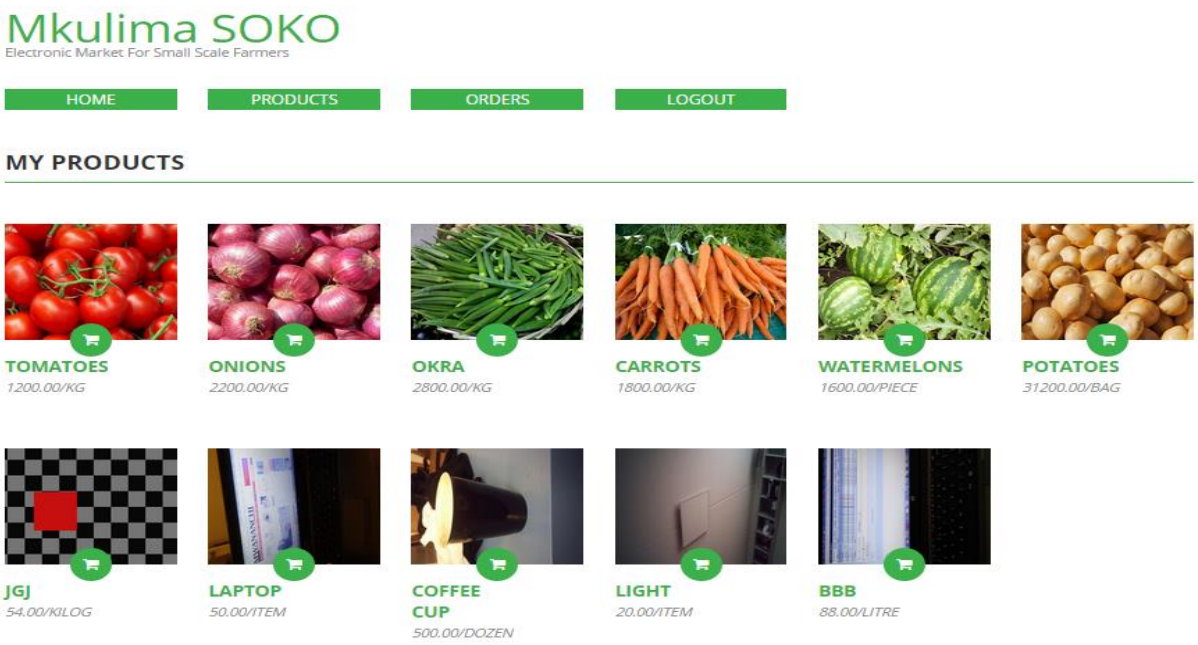


Figure 32: Product View

```php
<?php namespace App;

use Illuminate\Database\Eloquent\Model;

class Order extends Model{

    protected $table = 'orders';

    protected $fillable = ['name', 'description', 'image', 'unit', 'price_per_unit', 'location', 'status'];

    protected $hidden = [];

    public static $rules = [
        'product_id' => 'required'
        //,'user_id'      => 'required'
        //,'sms_balance' => 'required'
        //,'account_type' => 'required'
    ];

    public function user()
    {
        return $this->belongsTo('App\User');
    }

    public function product()
    {
        return $this->belongsTo('App\Product');
    }

}
```

The code above implement the order process to be issued by buyer. The ***function user and function products*** returns the details to the ***class order*** to identify the crops owner.

5.5 DATABASE

The database schema below is the implementation of the non-functional requirement that ***the system will be using MySQL*** database shown figure 34. The database consists of four table such as user, product, order and migration

User Table

The table consists of the attributes provided by user during registrations. The attributes are ***name, email, mobile no., and password and account type***. The table will have the primary ***key ID*** as unique identification for user.

The table will have relationship with other table like:-

- One user can have more than one order
- One user can have more than one product
- One user will migrate one product at once

Product

The table consists of pre-define metadata which will be filled by farmers during uploading of the picture of crop. Such metadata are ***price, location, name and image.***

Order table

The table describes the attributes to identify the order to be issued by buyer. Such details are ***ID of the customer, product name and offer type***

Migration Table

The table indicates the two attributes which describe the details about the information to be transferred form the mobile app to the webpage

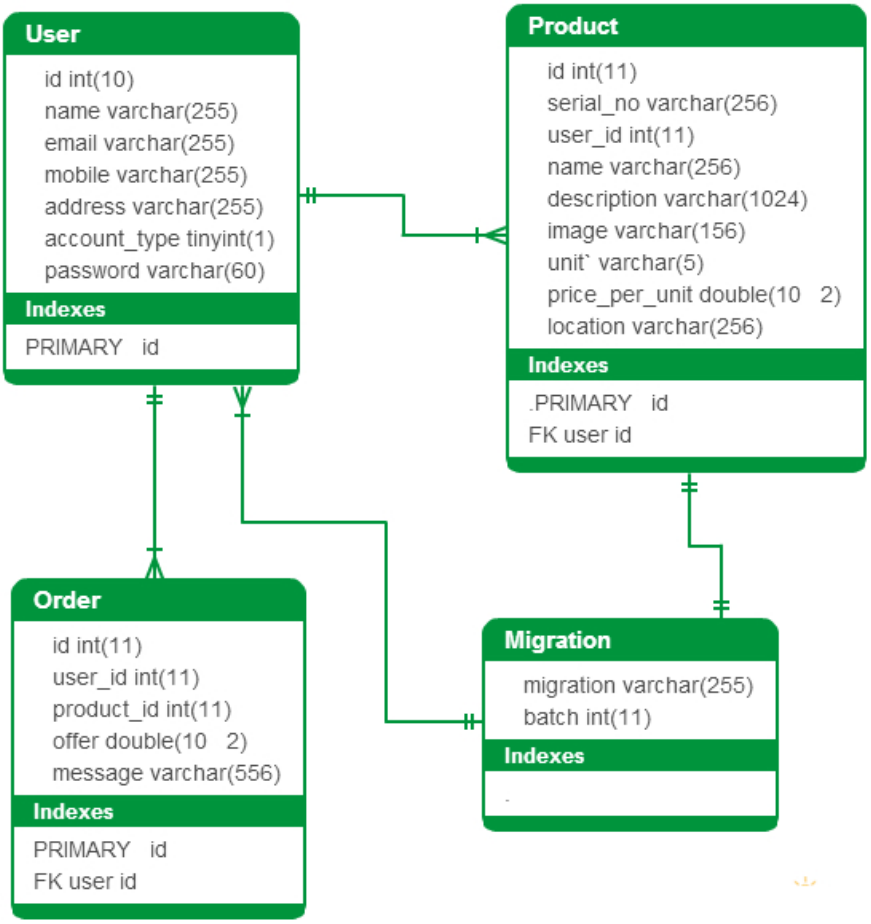


Figure 34: Database Schema

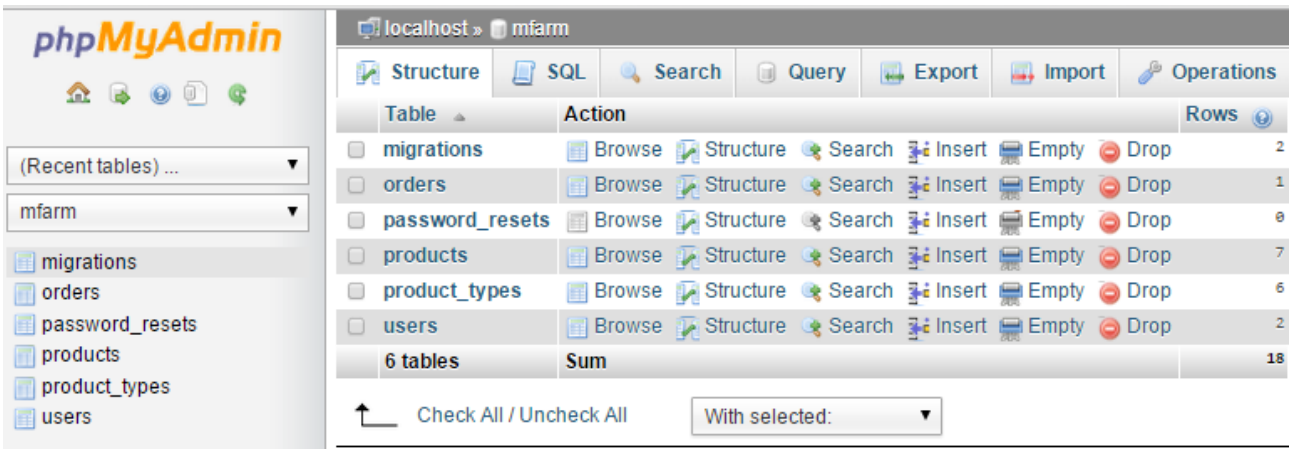


Figure 33: SQL Database

6 EVALUATION AND TESTING

The testing method is the last component of the software development before the deployment of the application. Since this study has chosen the agile approach as the methodology during software development, the testing segment will be conducted parallel with the development of each agile iteration. The main objective of this process is to ensure that the user requirements are well implemented as well as to correct errors which have been identified. In addition, the testing process provides specific evidence information about how the software will work, based on how it has been designed to perform. Such information builds confidence to the team because of the insurance from testing. In this chapter, various testing approaches will be covered such as Unit test, integration test and acceptance test.

6.1.1 UNIT TEST

This process aims to test the software components independently. Since the model of the application has been built separately, the approach is perfect to identify errors easily. Once the errors will be detected, much effort will be put to fix them separately.

From the android perspective, testing is part of the development process. The platform provides the tool which can be optimized to perform testing on every unit of software. In this study, the JUNIT frame will be used test some of the models of the prototype. Based on the time and resources allocated, the framework will not be used to test the whole project. [47]

The JUNIT framework was conducted on ***signup activity*** and got ***green bar*** as shown on fig.31 means ***passed.***

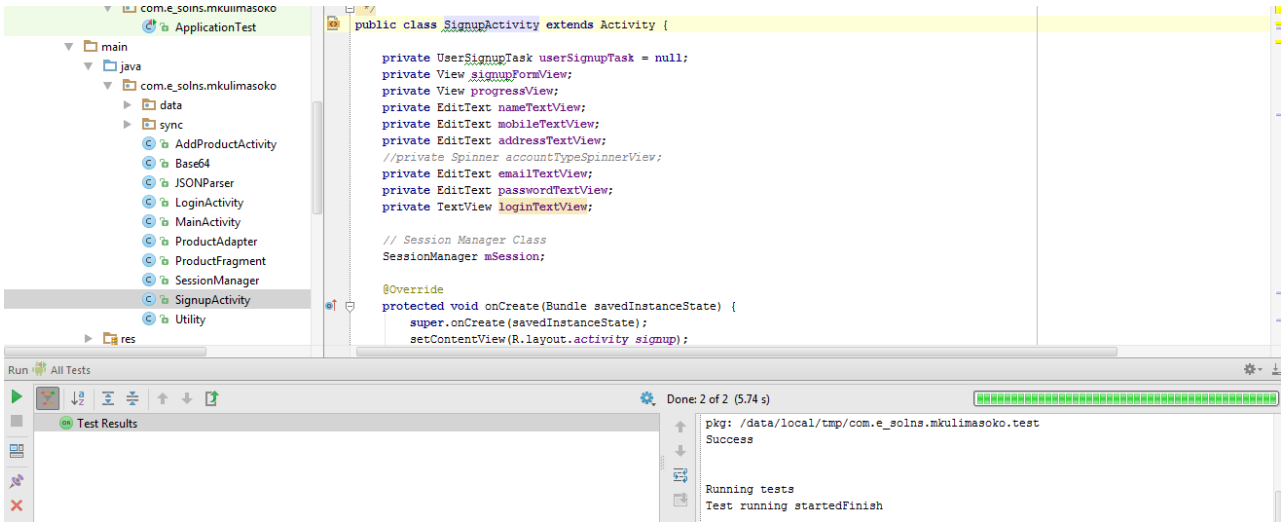


Figure 35: Unit testing

6.1.2 INTEGRATION TEST

This is the extension approach of the unit test mentioned in the previous chapter. Unlike the unit test which focuses on independently modules, the integration test merges software components to investigate the performance of their activities when they interact together. The testing builds different scenarios which collaborate different independent models to work together to perform a certain task. The output of the test will be evaluated to see whether the system will respond as requested.

Considering the prototype of this project which comprises mobile application and webpages, the programmer will carry out integration testing to evaluate different scenarios such as:

- The mobile application must run in different Android platforms
- Integration of camera in the application
- The collaboration between mobile application and the web page
- The workflow between the database and the application to respond based on user input

6.1.3 ACCEPTANCE TEST

This testing method aims to validate the system at end-user environment. The testing is carried out by a client after the installation is done on the user's device. The evaluation is performed in collaboration with the developer to see if the system has met the requirements provided by user.

The outcome of the process will identify faults and errors that will be optimized as new requirements for the coming new version of the application.

Since this project produced the demo as part of the testing approach to be validated by different users, their inputs have become helpful to improve the end product of the study.[48]

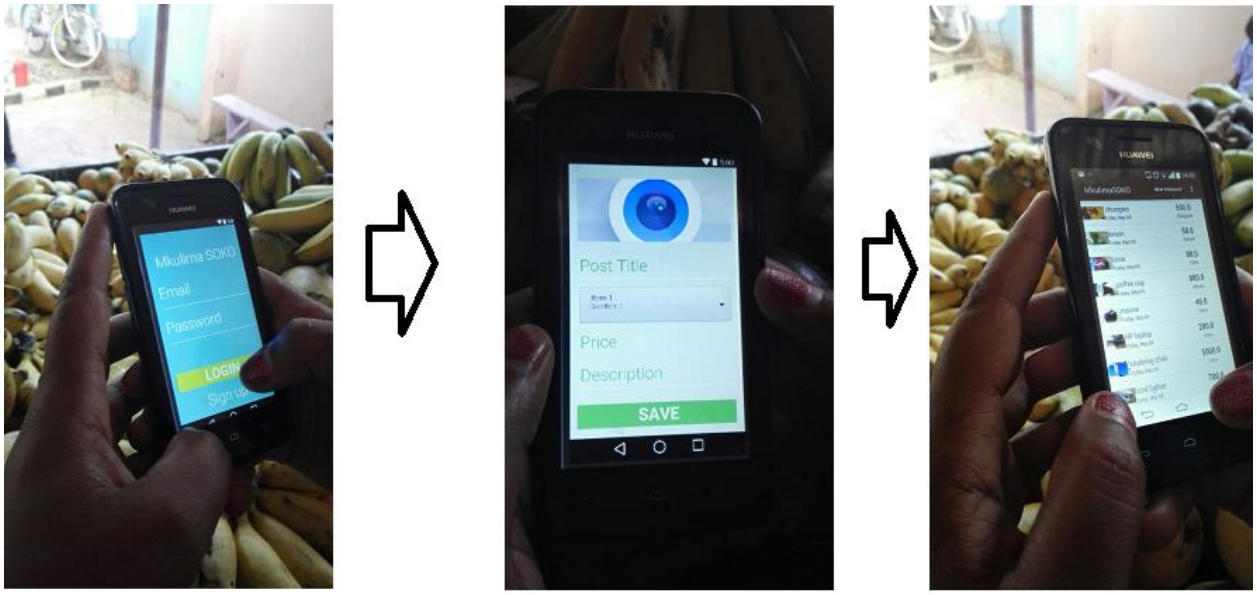


Figure 36: Acceptance testing

The figure 32, above illustrate the acceptance test conducted in Tanzania as one of the engineering discipline during software development. The main focus was to see if the requirements collected from the users are well implemented. The process involved one actor as farmer.

7 FUTURE PERSPECTIVE

The discussed system in this report has focused on the improvement of agriculture sector for small farmers living in Tanzania remote areas. The described solution identifies the key factors to solve the challenges facing the farmers such as.

- Easy way to present market information through the portable devices
- Better way for selling crops through the online portal.
- Better way to negotiate the best price between buyer and farmer

Although the outcomes illustrated above have proved the usefulness of the electronic market for rural farmers, these results place the basis for a better understanding future extension to this project. It will be more worth to straight the study in the following areas:-

7.1 PERSONALIZATION OF THE INFORMATION

Another area of interest to explore further in this study is personalization of the market information. The personalization aspects will allow user to configure the system based on their interests. The main objective is to enable the system to understand users' needs and build better interaction based on the various contexts. [49]

The future work of the system will track browsing information such as crops types, marketing formation and user's locations. After collecting those information, the system can utilize them wisely to tailor the system based on the user preferences.

The personalization of the system will maximize the relationship between the system and the user due to the fact that the contents to be displayed on the system have been influenced by user interests. For instance the systems can allow Buyer to reshape the interface to display information such as:-

- How to locate the nearest farmers
- How to identify the interesting crops with best price
- How to identify the reliable seller

7.2 ONLINE PAYMENT THROUGH M-PESA

As many banks require customers to provide a lot of information as well as to deposit certain money, the M_Pesa has provided a great opportunity to the small business entity based on slogan ***pay as you go***. This means, even any person who has less income can still perform transaction based on the available cash.

The availability of M-Pesa in all part of Tanzania will allow buyers to transfer money without involving any financial intuitions such as bank. Through simple text from buyer's mobile with verification code allows easy money transfer. The farmer takes the phone to nearby M-Pesa agent to pick the cash after verify the code sent by the buyer. [50]

In the future work of this project, it will be huge potential to integrate the electronic market with M-Pesa in order to increase sustainability in money transactions. The buyer will no longer need to carry cash from town to the village and avoid to be attacked by robbers.

According to ***Jens Raarup***, once the system will be launched, it's important to consider that the expenditures incurred need to be covered to enable the consistency of the service. For instance, maintenance of the applications, upgrading of the system and training will require financial assistance. Therefore, it's important in the future to integrate the system with M_Pesa to gain a small commission from each transaction which will be performed to support those expenses.

7.3 TRUST MODELING

The electronics market will be consists of many farmers posting crops every day to the web portal. As described in analysis chapter that it's hard for the buyers to make decisions during the order process considering that the information available on the portal might be false or not enough to convince him. Considering that the farmer can be dishonest by posting the products having the best quality while in actual sense the crops have already damaged. In this scenario the transaction of money and sensitive data will require supporting information to build the trustworthy environment between buyer and farmer

According to FIDIS[51], the traditional market environment doesn't not require identification to perform transaction. The customer will provide cash which cannot be tracked as well as not expose the identification of the buyer.

The same impression can be implemented in the future of this study. In order to enable the transaction to be more anonymously, the buyer has to know in prior the following information:-

- Who is the best seller (farmer)?
- Where he should find the best crops?
- Who is selling the cheap crops?

To solve those questions, the system will provide the rating features of which the seller and the buyer will be given range of the number based on the satisfaction of the service. The rating process will reduce the complexity for identifying the reliable farmer because other users will provide feedback about what they have been experienced on certain service and product [52]

Another form of identification to be implemented in future is the buyer pays using MPESA. Authorized agent will register participants and provide PIN code for them as confirmation code during money transaction.

Once the buyer agreed with crop's price, then the buyer will open M-Pesa menu and use farmer's mobile no to issue transaction as shown on the figure below. The farmer will receive the notification on mobile number used by buyer. Since both have been registered by MPSEA agent, they will receive the notification that the amount has been sent/received to the authorized seller.

For the farmer to verify the legitimate owner of the transaction, then the PIN code will be used to prove his identity. Once the farmer enter the PIN to withdraw the money, the notification will be sent to M-Pesa agent to pay cash to farmer

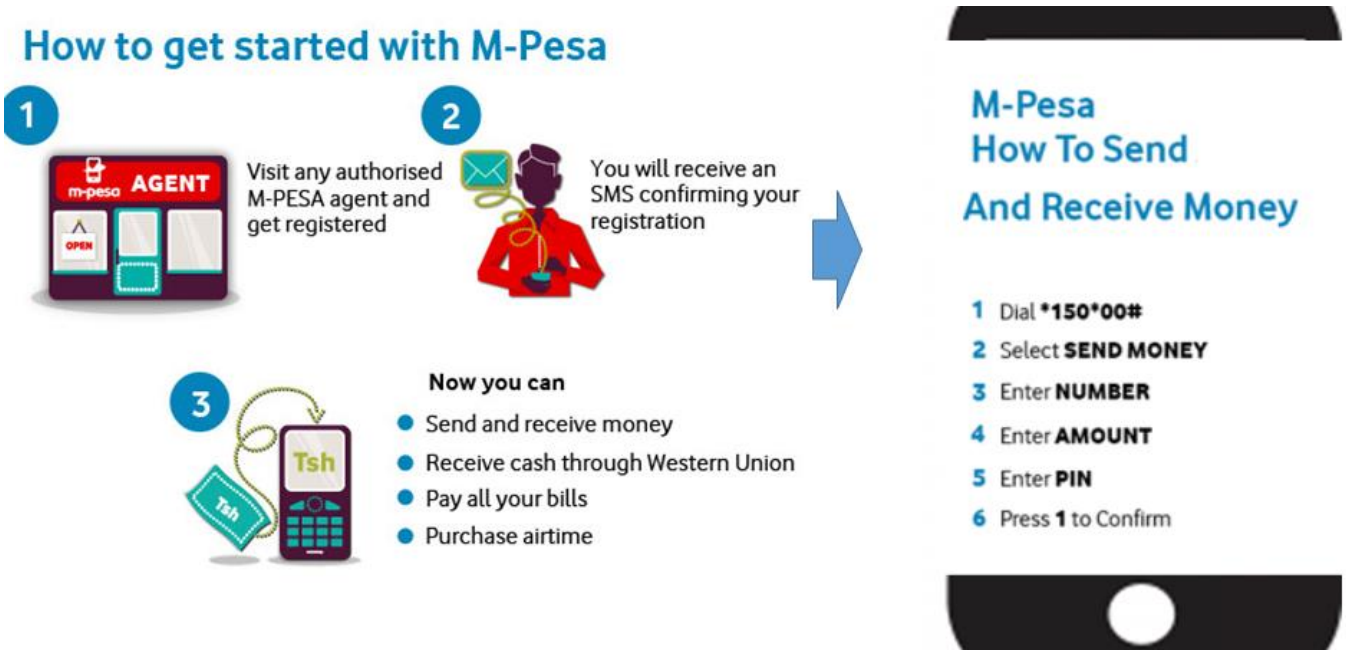


Figure 37: M-Pesa Identity Proof [53]

The figure above illustrates the process of sending and receiving money using M_Pesa. The user required to be registered by authorized agent and receive confirmation code. Afterward, user will use the mobile number to access the M_Pesa menu.

The menu consists of different services such as withdraw money, send money or paying bills to various service registered

Before the transaction has been approved, the user required to provide sim number then PIN code to prove the owner of the transaction.

8 CONCLUSION

This study was undertaken to design sufficient way to enable the better information flow between key stakeholders on agriculture sector, Tanzania rural area. It was indicated from begin of this project that there is high demand of the platform to enhance those key actors to share and exchange vital information regarding to the sustainable agriculture market. It was noted that despite agriculture in Tanzania is the backbone of the economy, less has been invested to ensure the farmers are well benefited from their harvest.

The focus of the study was therefore to identify the challenges in the market sector and lay the basic foundation to support the better opportunity for farmers to sell their crops. The proposed platform was built top of the existing candidates' technology such smartphone, cloud technology and programming language.

Since this study presents the prototype solution to contribute on suitable agriculture development, this chapter will close the loop by reviewing the research questions to see in what extents the study has achieved.

How ICT could be applied to improve the information flow between key stakeholders on agriculture market in Tanzania rural areas?

According to the desktop research and field site visit, it was noted that ICT could play a big role to improve agriculture, considering the high value of mobile phone usage in Tanzania. It was noted that the major challenges facing the key stakeholders are:-

- Crops price transparence
- Market information
- Ordering of crops

The presence of ICT as enabler allows this project to deliver a prototype which connects those key actors such as buyer, agricultural officer and farmer to share the vital information in transparence way.

The prototype enables farmer to post the picture of the crops with pre-define metadata which allow buyer to identify them and issue order direct from the system.

How to achieve a trusted electronic market with secure resources for small scale farmers?

The developed prototype expected to play a central role to increase the awareness on trust aspect. The study managed to explore the importance of identity management as engine to implement trustworthy environment between farmers and buyers.

The outlined of identity ecosystem, describes each member of the system to be aware of the standards and regulations implement inside the circle. The key reason to address this is to harmonize the decision process of sharing sensitive data between system participants. For instance, the implementation of standard metadata will enable members to identify the originality of the information including contact details and location.

One of the more significant findings to emerge from this study was that the involvement of the private investors in the public sectors. It was noted that the community is not much involved from the beginning during the process of the collaboration with private investors. However, the study proposed the amendment is required to improve the current regulations so that community interest will be considered as the first priority. The state of the art BlueTown has proved that the private sector could assist the government on improving life and eradicating poverty in remote areas. In additional, the study suggested the formation of a board which will review all the investment applications to check in what extent the interest of the target group will be protected.

The reputation of the electronic market to the community is very important in order to give confidence to the participants as well as to attract more customers to use the system. The study proposed the implementation of the rating system as the way to rank the service and product provided by the stakeholders. The rating mechanism will allow users to identify which member is dishonest due to the feedback from other users whom were not satisfied with the services offered.

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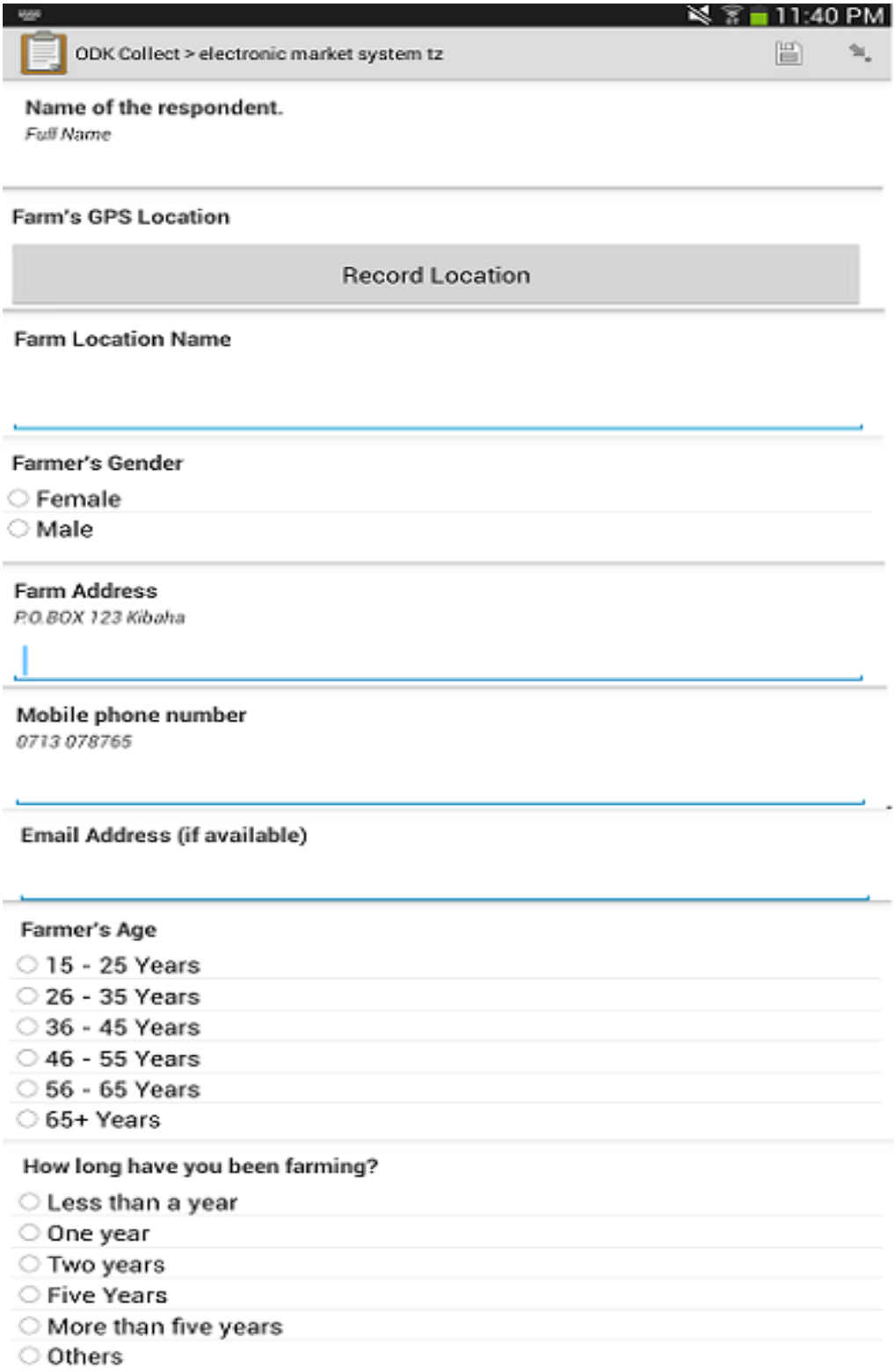
APPENDICES

As mentioned into report that the interviewed was recorded through online questionnaire, below are the list of questions which were being asked to the farmers

Appendix I: Questionnaire



Other Occupation apart from farming

Education Level

- ○ None
- ○ Primary level
- ○ Secondary Level
- ○ Higher level education
- ○ Professional education

Take farmers picture

Take Picture

Choose Image

What is the size of your farm?

- ○ 0.2 hectors
- ○ 0.2 - 1.0 hectors
- ○ 1 - 2 hectors
- ○ Above 2 hectors

Type of crops selling recently

- ○ Banana
- ○ Potato
- ○ other

What are the advantages/benefits that you have got from farming business?

Profit estimation over the amount of crops being sold

- ☐ Less than expected
- ☐ More than expected
- ☐ No profit at all

How do you receive reliable information about market status?

- ☐ phone
- ☐ Public audio
- ☐ Posters
- ☐ Others

Which services/features your mobile phone has? (select one or more) (interviewer) Which features do you use?

- ☐ Internet surfing
- ☐ Calendar
- ☐ GPS
- ☐ Email
- ☐ camera
- ☐ others

For what purpose do you use your mobile phone? Rate

- ☐ To make calls
- ☐ To surf the internet
- ☐ To listen to the music
- ☐ SMS
- ☐ Playing Games
- ☐ Take pictures
- ☐ Money transfer transaction (LUKU, MPESA)

Do you own any other Digital communication device?

- ☐ Laptop
- ☐ Tablet
- ☐ Others

How frequently do you visited by Agricultural officer?

- ☐ once a day
- ☐ once a week
- ☐ Whenever necessary
- ☐ Never
- ☐ Others

What do they observe mostly about your crops?

- ☐ Health Issue
- ☐ Marketing & Price
- ☐ General farm perfomance

What do you do with the observation of agri-officer?

- ☐ Keep record on the paper
- ☐ Keep record in the head
- ☐ Do nothing
- ☐ Others

Do have the tendency of keeping information about your selling?

- ○ Yes
- ○ No

How do you keep records?

- ☐ In books
- ☐ In computers
- ☐ In calendars
- ☐ In memory
- ☐ Others

What type of information do you keep?

- ☐ Health Information
- ☐ Production
- ☐ Farm Expenditure
- ☐ Sales
- ☐ Others

For how long do you keep such information?

- ○ Batch lifetime
- ○ A year
- ○ More than 3 years
- ○ Others

What do you do with the information you keep?

- ☐ Decision Making
- ☐ Business performance Analysis
- ☐ Tax payment
- ☐ Income Analysis
- ☐ Nothing
- ☐ Others

Do you see any advantage of keeping records online?

- ○ Yes
- ○ No

Apart from communication do you think your mobile phone can do anything else?

- ○ Yes
- ○ No

If there was a system that uses mobile phone to sell your crops; Would you use it?

- ○ Yes
- ○ No

What information will you prefer to access through the application?

What features will you prefer to see on application?

Would you prefer to negotiate crops price with farmer?

You are at the end of electronic market system tz.

Name this form

electronic market system tz

Mark form as finalized

Save Form and Exit

Appendix II: Milestone

This is the detailed Milestone plan. Each phase of milestone plan contains its own goals and documents to be delivered.

MILESTONE 1		STATUS
Milestone Goal		
1. Brainstorming **a. Pre-Project settings (Meeting with company Blue town)** **b. Establishment of project ideas** **c. Finalizing the project proposal with supervisor and company(Blue town)** **2. Proposal Approved by Supervisor and Company** **3. Complete the detailed milestone plan** **4. The detailed time schedule is made** **5. Thesis Contract signed**		CLOSED
Document delivering		
Progress Report -1st Draft **a. Motivation and Background** **b. The impact of mobile phone** **c. Cloud issues** **d. Broker based trusted model** **e. Problem Definition** **f. Questionnaire** **g. Milestone Plan**		CLOSED
MILESTONE 2	**Deadline: 1-4-2015**	**STATUS**
Milestone Goal		
1. State of the Art **2. Methodology** **3. 1st Problem analysis (data collection results)**		CLOSED
Document delivering		
Progress Report- 2nd Draft **a. Motivation and background are delivered** **b. Problem definition** **c. State of Art** **d. Methodology** **e. 1st Problem Analysis**		CLOSED
MILESTONE 3	**Deadline: 15-4-2015**	**STATUS**
Milestone Goal		
1. Designing **a. Requirement Specific** **b. Sequence Diagram** **c. UML** **2. GUI** **a. Design application layout (Wireframes and description)**		CLOSED
Document Delivering		
Progress Report -3rd Draft		CLOSED

a. Motivation and background are delivered b. Problem definition c. State of Art d. Methodology e. 1st Problem Analysis f. Requirement Specific g. Sequence Diagram h. Class Diagram i. Design application layout (Wireframes and description)		
MILISTONE 4	**Deadline: 15.05.2015**	**STATUS**
Milestone Goal		
Prototype Development		CLOSED
Delivery		
Prototype Demonstration		CLOSED
MILISTONE 5	**Deadline: 30.05.2015**	**STATUS**
Progress Report -4th Draft • **Conclusion of the project delivered** a. **Product evaluation** b. **Process evaluation** c. **Future work**		**CLOSED**
MILESTONE 6	**Deadline 10. 06. 2015**	**STATUS**
Final Report Delivery		

The table below shows the Summary of all Milestones

Task	Time spent	Start	End
Brainstorm(Motivation and Back ground)	4 weeks	01-02-2015	01-03-2015
Analyse the problem	4 weeks	01-03-2015	01-04-2015
Designing	2 weeks	01-04-2015	15-04-2015
Development	4 weeks	16-10-2015	16-05-2015
Conclusion(Testing and Evaluation)	3 weeks	17-04-2015	6-06-2015

Appendix: III

The list of the farmers interviewed during the collection of data in Tanzania. The list contains name, address, email, and image and contact details. The appendix has been extracted from the ODK system which was tool to collect data.

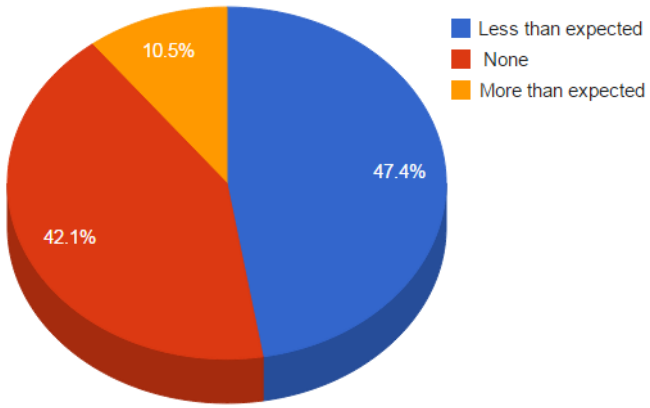
Previous electronic market system tz Next

mwakifulefule	P.O BOX Dar es Salaam	75855797	Hamisi.mwakifulefule@gmail.com			None			
Rajabu Mponda	P.o box 234 Bagamoyo	75415638	rmponda@gmail.com	46 - 55 Years	More than five years	Domestic Animal keeping	Secondary Level		Above 2 hectors
Otoman Nsajigwa	P.o box 255 eika Bagamoyo	755654569	o_nsaji@yahoo.com	36 - 45 Years	Five Years	Animal keeping	Primary level		Above 2 hectors
Emanuel Fanuel	P.o box 402 Bagamoyo	755932332	fanuelie@hotmail.com	36 - 45 Years	Five Years	Animal keeping	Secondary Level		1 - 2 hectors
Agapiti Nicholas	P.o box 211 Kiromo	755876657	agapiti.nico@live.com	36 - 45 Years	Five Years	No	Secondary Level		1 - 2 hectors
Amani Gwaidesh	P.O.BOX 7210 Kilimahewa		None			Machingguy	None		
Paul baruwundi	P.O.BOX 3954 Ukuni	782774193	Baruwundi88@yahoo.com	26 - 35 Years	Two years	Business	None		0.2 - 1.0 hectors

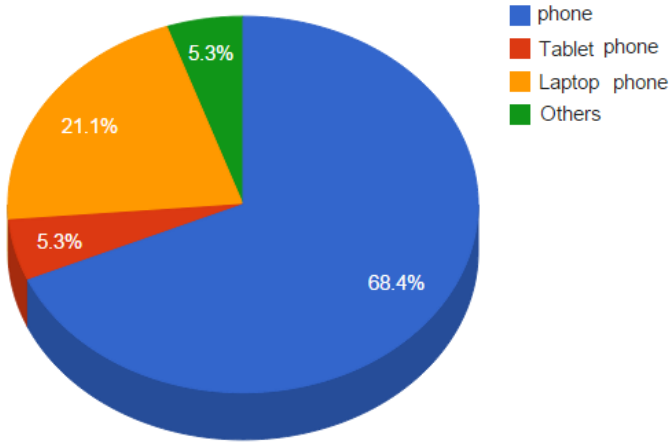
Seleman Makupa		754377689	None	36 - 45 Years	Five Years	Security guard	None		Above 2 hectors
Mkude Masinde		763116548	None	26 - 35 Years	Two years	Driver for village crops	None		1 - 2 hectors
Haji Khamis	'6 i	753448734	None			Animal keeping	None		
Ali Jambia				36 - 45 Years	More than five years	Building	Secondary Level		Above 2 hectors
Athumani Bakari	399	716414534	Abakari90@yahoo.com			None	None		
Juma ally	37	789454645	None	36 - 45 Years	More than five years	None	None		0.2 - 1.0 hectors
Erenest mfagio	6	768254379	ErnestMfagio@gmail.com	36 - 45 Years	More than five years	Nil	None		0.2 - 1.0 hectors

Appendix IV : questionnaire results

The figure represents the questions “Profit estimation over the amount of harvest being sold”



The percentage of people who own more than one devices



The traditional source of information form the village office to the farmers